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Original Article

# Feasibility of calcium hydroxyapatite (Radiesse®) for improving the biomechanical properties of facial burn scars: A pilot study

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ABSTRACT

*Background:* Effective treatments for facial burn scars remain limited, emphasizing the need for innovative therapeutic approaches. This study explored the feasibility of the use of calcium hydroxyapatite (CaHA, Radiesse®) as a treatment to improve the biomechanical properties of facial burn scars.
*Objective:* To evaluate the potential effects of CaHA injections on the biomechanical properties of facial burn scars and to compare these effects with those of untreated skin.

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*Methods:* A prospective longitudinal feasibility study was conducted with 13 patients who had mature facial scars (2–5 years) covering more than 90% of the face, including hypertrophic, atrophic, and/or keloid scars. The forehead, cheek, and jaw areas were measured before treatment (baseline control) and at 2, 4, and 6 months after CaHA application, resulting in 312 measurements. CaHA was injected subdermally on one side of the face, with the opposite side serving as a control. Biomechanical properties were assessed via a Cutometer MPA 580 alongside clinical assessments, photography, and validated scar scales (Vancouver Scar Scale and Patient and Observer Scar Assessment Scale).

*Results:* Preliminary findings suggest that CaHA injections may improve skin extensibility, elasticity, viscoelasticity, hydration, erythema, and pigmentation in the forehead, cheek, and jaw areas. These observations were supported by visual assessments and scale evaluations.

*Conclusion:* This feasibility study indicated that subdermal CaHA injections have potential as a noninvasive approach for improving the biomechanical properties of facial burn scars. However, further studies with larger sample sizes and long-term follow-up are needed to confirm these findings.



## Introduction

The skin serves as a vital protective barrier, adapting to environmental demands.[1] However, burns can lead to pathological, hypertrophic, and keloidal scars, for which effective treatments remain limited, highlighting the need for innovative options.[2]

Since the 1980s, dermal fillers, initially developed with collagen,[3] have undergone significant advancements, including newer materials like hyaluronic acid and polylactic acid, which offer improved and longer-lasting results.[4,5] Among these, biostimulants such as calcium hydroxyapatite (CaHA, Radiesse®) have emerged as promising agents.[6]

CaHA is an injectable, biocompatible filler that promotes fibroblast activity and stimulates collagen production, transitioning from type III (characteristic of early wound healing) to type I collagen, which provides skin strength and elasticity.[7]

Unlike passive volumizing treatments, CaHA remodels the extracellular matrix in a controlled manner without causing subdermal scarring, making it a potential treatment for pathological scars, including burn scars.[8,9,10]

Pathological scarring results from excessive fibroblast proliferation and extracellular matrix deposition, leading to physical and psychological challenges.[11] Such scars restrict movement, exacerbate depressive symptoms, and significantly impact quality of life.[12,13]

This study investigates the feasibility of subdermal CaHA injections for improving the biomechanical properties of facial burn scars. It aimed to establish preliminary insights into CaHA's role in scar management and lay the groundwork for future research by assessing elasticity, extensibility, and hydration using objective cutometer measurements.

## Patients And Methods

This prospective longitudinal study, approved by the Institutional Review Board, included patients aged >18 years with mature scars (2–5 years) from second- and third-degree burns covering >90%

of the face. Scars were hypertrophic, atrophic, or keloid, causing functional impairment and unresponsiveness to prior treatments (dressings, compression garments, or corticoids). Exclusion criteria included open wounds, pathological skin conditions (e.g., psoriasis, eczema), or psychiatric disorders. Participants were recruited from the National Center for Burn Care and Research, Mexico, and provided written informed consent.

*Data Collection*

Comprehensive facial analyses included scar visualization, photography, and validated scales (Patient and Observer Scar Assessment Scale [POSAS] and Vancouver Scar Scale [VSS]). Each patient's face was divided into thirds (forehead, cheek, jaw) transversely and longitudinally by the midline, referencing aesthetic facial units. Treatment and control sides were randomly assigned via a coin toss. Treatment areas were marked at 4 cm from the midline on the forehead and cheek, and 6 cm on the jaw (Supplementary Figure 1). Measurements were taken before treatment and at 2, 4, and 6 months postprocedure, with untreated areas as controls.

*Biomechanical Analysis*

Skin biomechanical properties were assessed using a Cutometer MPA 580 with a 2 mm probe in time-deformation mode (10 cycles at 450 mbar for 2 seconds, 2-second relaxation). Parameters included R0 (extensibility), R5 (net elasticity), and R6 (viscoelasticity to elasticity ratio). Melanin and erythema indices were measured with a Mexameter MX18, and skin moisture with a Corneometer CM825. Five measurements per site were averaged.

*Treatment Protocol*

CaHA (1.5 ml) was mixed with lidocaine (2%, 1.5 ml) for a total of 3 ml, homogenized using a syringe-to-syringe method (15 cycles, Supplementary Figure 2). CaHA was injected subdermally via an 18G $\times$ 70 mm cannula in a fan shape, distributing 1 ml per area. Post-application care included cleansing and gentle pressure.

*Follow-Up*

Patients were monitored at 0, 2, 4, and 6 months using POSAS, VSS, photography, and cutometer assessments. Measurements were consistently performed by the same physician, with results graphically correlated to clinical progress.

## Results

This study included 13 patients (six men and seven women) aged 20–48 years (mean age: 32.6 years) with facial burn scars meeting the inclusion criteria (Table 1). Measurements were taken from six areas per patient (forehead, cheek, and jaw) before treatment (control) and at 2, 4, and 6 months post-treatment, resulting in 312 measurements. Prior to treatment, patients experienced facial mobility impairments due to scar contractures. Post-treatment, significant improvements in biomechanical properties, such as skin moisture, erythema, and extensibility, were observed across all areas (Tables 1 and 2, Supplementary Figures 1-6).

*Quantitative Assessments*

Significant improvements were documented using the Cutometer MPA 580:

Forehead: Increased extensibility and reduced erythema (Figure 1).
Cheeks: Enhanced net elasticity, viscoelasticity, and skin moisture (Supplementary Figure 3).

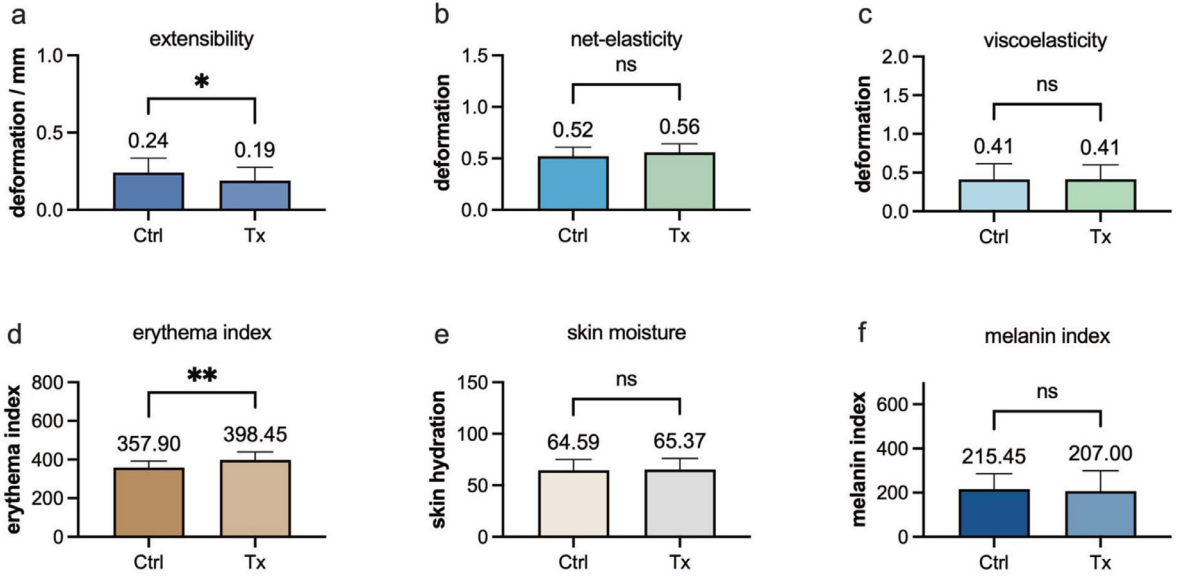


**Figure 1.** Graphs showing the analysis of the forehead 6 months after treatment: a) skin extensibility, b) net elasticity, c) viscoelasticity/elasticity ratio, d) erythema index, e) skin moisture and f) melanin index, comparing the control (Ctrl) and treatment (Tx) areas. A t test was performed, which revealed data with significant associations. ($^{*}P < 0.05$, $^{**}P < 0.01$).

**Table 1**
Clinical characteristics of patients.

| Case | Age | Gender | Percentage | Degree |
|---|---|---|---|---|
| 1 | 20 | Male | 60% | Second |
| 2 | 33 | Male | 25% | Second |
| 3 | 42 | Male | 55% | Second |
| 4 | 32 | Male | 34% | Third |
| 5 | 27 | Male | 40% | Third |
| 6 | 33 | Male | 54% | Second |
| 7 | 24 | Female | 60% | Third |
| 8 | 29 | Female | 62% | Second |
| 9 | 38 | Female | 32% | Second |
| 10 | 22 | Female | 45% | Third |
| 11 | 46 | Female | 60% | Third |
| 12 | 34 | Female | 20% | Third |
| 13 | 48 | Female | 35% | Third |

**Table 2**
Biomechanical properties of the skin of patients (control and after treatment), p values.

| Biomechanical | P value | Significance |
|---|---|---|
| Extensibility | 0.02184 | * |
| Elasticity | 0.13821 | ns |
| Viscoelasticity | 0.17778 | ns |
| Erythema | 0.00266 | ** |
| Skin moisture | 0.00021 | *** |
| Melanin index | 0.49603 | ns |

Jaw: Notable improvement in skin moisture (Supplementary Figure 4). Table 2 shows summary of biomechanical changes, with significant p values (*P < 0.05, **P < 0.01, ***P < 0.001), is shown in Table 2.

These improvements are attributed to CaHA's biostimulatory effects, which stimulate fibroblasts and promote the synthesis of type III collagen, transitioning to type I collagen over time, enhancing skin structure without causing subdermal scarring.[9,10]

*Visual Assessments*

Photographic documentation showed significant visual improvements in treated areas at 4 and 6 months (Supplementary Figures 5 and 6). No adverse reactions were reported.

*Clinical Scale Evaluations*

VSS and POSAS scores showed significant post-treatment improvements (Tables 3 and 4). Minimal initial discomfort was reported during CaHA infiltration, with no treatment-related adverse effects.

## Discussion

Facial scars vary widely based on anatomical location, influencing their appearance and behavior.[14] While visible damage highlights the complexity of pathological scars, assessing region-specific characteristics is essential due to their significant social and occupational impact.[15,16]

CaHA was chosen for its biostimulatory properties, including collagen and elastin production, angiogenesis, and cell proliferation.[8,9,10] Its dual role as a volumizing agent and biostimulator is mediated by fibroblast activation, promoting type III collagen production, which transitions to type I collagen, enhancing biomechanical properties without causing subdermal scarring.

**Table 3**
Data obtained before applying the treatment are presented in the first column, and the final assessment performed after the application of the treatment is presented in the second column.

| Vancouver Scar Scale (VSS) | | | |
|---|---|---|---|
| | Before treatment Score | After treatment Score | P-value |
| A) pigmentation | 2 (0-2) | 1(0-2) | **0.00012(***)** |
| B) vascularity | 2 (0-3) | 1(0-3) | 0.10241 |
| C) flexibility | 5 (0-5) | 1(0-5) | **0.03522(*)** |
| D) height | 3 (0-3) | 1(0-3) | 0.10241 |

(*P < 0.05, **P < 0.01, ***P < 0.0001).

**Table 4**
The data reported before the treatment were applied are presented in the first column, and the data reported in the second column represent the final assessment 6 months after treatment.

| Observer Scar Assessment Scale (POSAS) | | | |
|---|---|---|---|
| | Before treatment Score | After treatment Score | P-value |
| A) pain | 6 (1-10) | 3 (1-10) | **0.00512 (***)** |
| B) itching | 7 (1-10) | 3 (1-10) | 0.01886 (*) |
| C) change of color | 5 (1-10) | 7 (1-10) | 0.04512 (*) |
| D) stiffness | 7 (1-10) | 3 (1-10) | 0.02113 (*) |
| E) thickness | 6 (1-10) | 3 (1-10) | **0.00504 (**)** |
| F) irregularity | 5 (1-10) | 4 (1-10) | 0.04511 (*) |

(*P < 0.05, **P < 0.01, ***P < 0.0001).

As one of the first US Food and Drug Administration-approved fillers, CaHA has been widely studied in facial rejuvenation and acne scars.[17] This study demonstrated its feasibility for treating facial burn scars, with improvements in extensibility, hydration, and elasticity, particularly in the forehead (extensibility, erythema) and the cheeks and jaw (hydration, viscoelasticity). Noninvasive cutometer assessments provided precise, repeatable data.

CaHA supports scar management by enhancing fibroblast activity in atrophic scars and modulating collagen remodeling in hypertrophic scars.[18-21] Tailored dosing and injection techniques may optimize outcomes for different scar types. However, long-term safety data remain limited, and further research is needed to assess the risk of ectopic calcification and other complications.

This study used validated assessment tools such as VSS and POSAS,[22] although it was limited by a small sample size, a single-center design, and a short follow-up period. The lack of a placebo-controlled design also limits conclusions on CaHA's effectiveness versus natural scar remodeling or external factors. Although triamcinolone was not directly compared, CaHA's sustained effects could reduce injection frequency.[23]

This study also highlights the cutometer's potential for evaluating scars in other anatomical regions.[24] This noninvasive, reproducible technology could be valuable for broader pathological scar research.[25-27]

Despite promising results, long-term safety data for CaHA in burn scars remain limited.[28] Ectopic calcification, a known burn scar complication, has not been extensively studied with CaHA. Extended follow-up is needed to address potential safety concerns, especially for permanent substances.

The study's limitations include a small sample size, single-center design, and 6-month follow-up, restricting generalizability and long-term safety evaluation. The absence of a placebo-controlled design limits attributing improvements solely to CaHA, as natural scar remodeling or external factors may have influenced outcomes. Subjective assessment scales also introduce variability despite standardized evaluations.

Future studies should include larger, diverse populations, longer follow-up periods, and placebo-controlled designs to confirm efficacy and safety. Broader pathological scar research and tailored approaches to different scar types are recommended.

## Conclusions

This feasibility study demonstrated that CaHA (Radiesse®) injections can improve the biomechanical properties of facial burn scars, with preliminary evidence of enhanced extensibility, elasticity, and hydration. However, these findings should be interpreted cautiously due to the small sample size and short follow-up.

Further studies with larger, diverse populations, placebo-controlled designs, and extended follow-up are needed to confirm efficacy, assess long-term safety, and evaluate the risk of complications like ectopic calcification. While CaHA shows promise as a complementary treatment for scar management, its role across different scar types requires further investigation.

This study provides a foundation for exploring CaHA's broader applications in reconstructive and aesthetic treatments, emphasizing the need to tailor interventions to the characteristics of specific scar types.

## Role/Participation In Manuscript Authorship

All Authors Contributed To The Conception, Analysis, Interpretation, Drafting, And Revision Of The Manuscript.

## Conflict Of Interest

The Authors Have No Competing Interests To Declare.

## Financial Disclosure Statement

The authors declare that they have no financial conflicts of interest related to the content of this article.

## Institutional Review Board (IRB) approval

This research received approval from the Institutional Review Board of the Instituto Nacional de Rehabilitación Luis Guillermo Ibarra Ibarra (ID code: 9222). All procedures adhered to the ethical standards set by the responsible human experimentation committee, both national and international, and complied with the principles of the Helsinki Declaration of 1975, which was last updated in 2008.

## Patient Consent For Photo Publication

The patients consented to the use of their data and images for the publication of this article. They were informed about the procedure's benefits and risks, and written informed consent was obtained from all study participants.

## Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi: 10.1016/j.jpra.2025.02.006.

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