Aesth Plast Surg
https://doi.org/10.1007/s00266-021-02590-z

LETTER TO THE EDITOR

Characterization of Contractile Forces Generated by Stretch Marks Fibroblasts: In Vitro Study.

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Received: 5 September 2021 / Accepted: 11 September 2021

Abstract Authors present a study about the contraction forces observed in striae distensae fibroblasts (SMF) in a collagen scaffold. Collagen lattices were used to study the mechanical behavior of SDF within the collagen matrix compared to the lattices produced using the healthy skin derived fibroblasts (NSF). A Forcebox device was used to measure the contractile forces. Striae Rubrae fibroblast's contractile force was by 28% greater than that generated by the NSF and striae albae fibroblasts ($P<0.05$). Anomalies and especially differences in forces generated by SMF were observed through all our experiments. These findings complete and corroborate the results and information published in our previous studies.
Level of Evidence V This journal requires that authors assign a level of evidence to each article. For a full description of these Evidence-Based Medicine ratings, please refer to the Table of Contents or the online Instructions to Authors www.springer.com/00266.

Keywords Stretch marks · Striae distensae · Platelet rich plasma · Ascorbic acid · Fibroblast

Dear Sir,

We are really grateful for your kind interest in our paper about striae distensae [1]. We hereby present a study about the contraction forces observed in striae distensae fibroblasts (SDF) in a collagen scaffold. The 3D collagen lattices are a dermis equivalent model consisting of a mixture of fibroblasts immersed in a collagen gel. These models are used to study the capacity of fibroblasts to retract the gel in which they are seeded and to form a compact structure. This experiment completes our previous study since it was carried out at the same time and using the same fibroblast cultures [1]. Collagen lattices were used to study the mechanical behavior of SDF within the collagen matrix compared to the lattices produced using the healthy skin derived fibroblasts (NSF) harvested from the same patient. A Forcebox (Fig. 1) device in our laboratory was used to measure the contractile forces. Retraction forces were accurately measured and reported on 48 hours follow up. Contraction forces in healthy skin fibroblasts, striae rubrae derived fibroblasts (SRF) and striae albae derived fibroblast (SAF) were observed and recorded. Three stages of contraction were identified. The first stage was observed in the first 2 hours of measurement . No contraction forces were observed in this stage. The second stage was observed between the 2nd and the 22th hour. A steady increase in the contraction forces was observed. During the 3rd stage the contraction forces plateaued.

Within the second phase, contraction forces significantly increased in striae rubrae fibroblast around the 12th hour. This peak was by 28% greater than the contractile force

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Published online: 04 October 2021

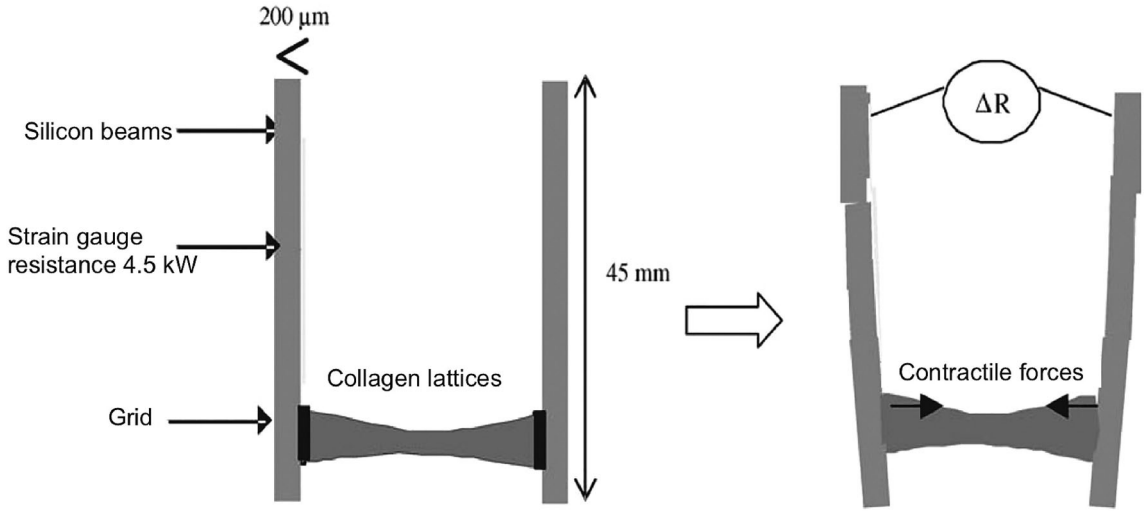
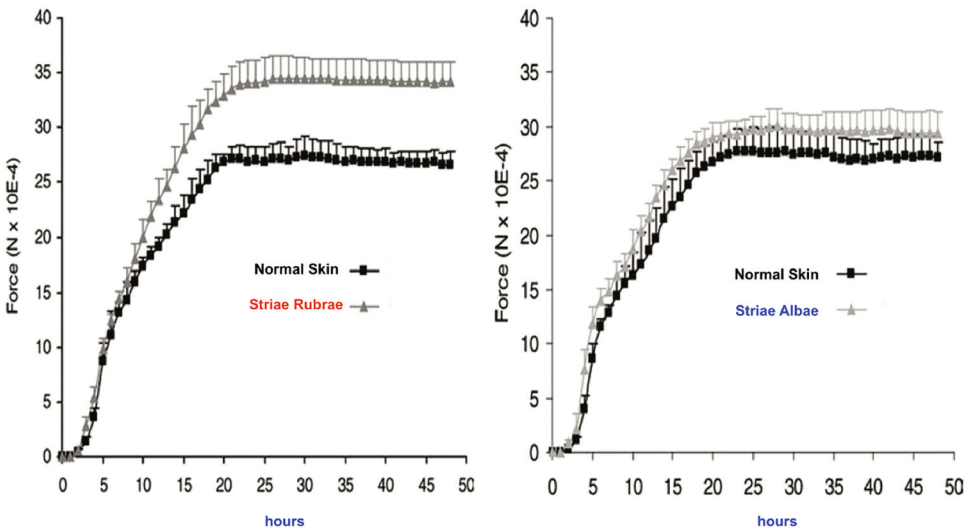


Fig. 1 Forcebox illustration. This device was used to study the modification of SAF (striae albae derived fibroblasts), SRF (striae rubrae derived fibroblasts), and NSF (healthy skin derived fibroblasts) derived lattices. 3D collagen scaffolds developed in a cell chamber consisting of 8 culture wells (26 × 33 mm). Two opposite silicon rods were immersed into each well, 27 mm apart from each other. On the lower segment of the silicon rods , a grid connected the lattice to this sensor. A strain gauge device with a 4.5 kW resistance was applied to the rod surface by phase vapor deposition (PVD) carved through a photolithography method and connected to create a Wheastone bridge. The output signal from the strain gauge was expanded , then transformed and recorded by a computer, provided with a storage card and a specific software to directly record the forces on a real-time basis . The Forcebox was adjusted on weights ranging from 0 g to 1.9 g. The adjustment showed the elevated linearity of the Forcebox and a sensitivity of 0.1 mN. Sterilization of the entire cell chamber was conducted (120°C for twenty minutes)

Fig. 2 Contractile force measurements. Forces generated by striae rubrae, striae albae and normal skin



peak generated by the NSF ($P<0.05$). However, the contraction forces observed in SAF were similar to those generated by NSF (Fig. 2).

Anomalies and especially differences in forces generated by SMF were observed through all our experiments. In a stressed matrix, (as a collagen lattice), the strength of SRF is significantly greater than that developed by NSF and SAF. This observation would therefore explain one of the key moments in the development of striae distensae: the stretch forces to which the cutis is subjected during any kind of weight change (including pregnancy). This stress leads to the contraction of fibroblasts through the contractile activity of the actin-filament cytoskeleton, which develops into stress fibers characteristic of myofibroblasts [2]. These findings complete and corroborate the results and information published in our previous studies [1–5].

Declarations

Conflict of interest The authors have no conflicts of interest to disclose.

Human and Animal Rights All procedures described in our paper involving human participants complied with the ethical standards of the institutional and national research committees and with the 1964 Helsinki Declaration and its later modifications or comparable ethical standards.

Ethical Approval Ethical Approval was granted by the French institutional committee and the relevant judgment's reference number is 2021-A2150-99.

Informed Consent Informed consent is not applicable to this study.

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