Experimental analysis of a keloid on upper arm by using biomechanical devices

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Keloid scars are benign skin tumors-like, that affect only humanity, and more specifically asian and african populations. Keloids consist in the excessive accumulation of dermal collagen that extends beyond the boundaries of the original wound [1]. They are located on specific sites, tend to enlarge over time, and pose cosmetic and psychological problems for patients. The physiopathology of keloids is unclear and there is still no therapeutic consensus. Nevertheless it appears that keloids result from a combination of genetic, cellular and mechanical factors [2].
The present study deals with a multi-devices experimental analysis in order to characterize the mechanical behavior of the keloid, the surrounding healthy skin and the contralateral healthy skin on the left upper arm of one young female clinical case.

This study abides by the rule of the Institutional Review Board (IRB) of the hospital center of Besançon in accordance with the Declaration of Helsinki.

Suction tests have been carried out with the SEM 575 Cutometer® (Courage & Khazaka Electronic GmbH, Cologne, Germany). A measuring probe is placed on the skin and a negative pression of 400 mbar is applied during 3 seconds (cycle of loading, holding time and unloading) then a 2-seconds relaxation time. This process is repeated three times. Keloid scar and surrounded healthy skin have been tested with this device. The ultra-light uniaxial mechanical device developped by Jacquet et al. [3] has been used to highlight the non-linear hyperelasticity and viscosity of the keloid and contralateral healthy skin. The device, equiped by a displacement and force sensors, consists in a non-invasive in vivo test that can be considered as a traction test on the surface of the skin. Specific pads have been designed and reduce the influence of peripheral skin surrounding tested skin on the registered results. Tissues are charged by three successive loading-unloading sequences at a constant strain rate. In order to determine the stress-strain curve of each tissue, the thickness has been identified by 20 MHz Atys Dermcup® Ultrasound echograph. The displacement field on the surface of the tissue is obtained by a digital image correlation method.

First, preliminary mechanical tests have been performed on two symetrical anatomic sites in order to validate the hypothesis that symetrical sites with healthy skin have similar mechanical behavior. The typical R-parameters of cutometry have been identified and provide the elasticity, viscoelasticity and fatigability of skin [4]. The obtained results show a reduction of elastic properties of keloid compared to the healthy skin ones. From the extension test, keloid skin appears to be largely stiffer than healthy skin and the extensibility of keloid is about two times less than healthy one.

As a conclusion, mechanical properties of keloid and healthy skin have been identified and compared. As shown by Dunn et al. [5] for hypertrophic scar tissue, the observed difference is probably due to the abnormal composition and structure of keloid. Sutho et al.[6] have recently reported the structural heterogeneity of keloid by performing an histological characterization.

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