Mechanical Behavior of Ordered Collagen-Matrix Embedded With Fibroblasts
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INTRODUCTION
The present work focuses on ordered collagen matrix (OCM) seeded with dermal fibroblasts, a dermis substitute with a supra-molecular organisation close to those of human dermis.

The aim of this study is to characterise, from a mechanical point of view, these matrix, i.e. to determine their visco-elastic properties by submitting them to tests of compression-relaxation. In order to study the influence of cells, the measurements have been realised on matrix without cell and at day 20 of culture on matrix seeded by fibroblasts. We compare these results to those obtained on human dermis.

MATERIALS AND METHODS
The process to be followed to achieve the reconstruction of a living dermal equivalent (DE) will involve a combination of the following states: (a) the fibroblasts are taken from skin biopsy specimen in monolayer till cells reach confluence or sub confluence. They are detached from the plastic substrate, suspended in culture medium in which we have added ten per cent fetal calf serum, fungizone, penicillin and streptomycin; (b) type I collagen is extracted from rat-tail tendons and immersed in acid acetic solution; (c) the fibroblasts are added, in precise proportions to a mixture of culture medium and collagen solution. The culture medium used is Earle's Modified Eagle's Medium (EMEM); (d) the mixture polymerizes rapidly when placed in an incubator at 37 C while the fibroblasts dispersed uniformly throughout mixture. The collagen concentration is 5 mg.ml$^{-1}$ and fibroblasts concentration is $1.5 \times 10^5$ and $15 \times 10^5$ cells per DE.

RESULTS
We have compared the results obtained on OCM with those obtained on human dermis, and on an other substitute with special focus on the instantaneous behaviour (Fig.). For these samples, we can see that the “pic” stress increases with the deformation as an exponent. We also note that for deformations lower than 50%, the levels of stress are close between human dermis and OCM.

DISCUSSION AND CONCLUSION
The present experiments allow characterising the rheological properties of a dermis substitute. We show the predominant visco-elasticity properties of the OCM without cells, as the stress is function of the displacement rate. On the other hand, the presence of cells induces a diminution of the material global elastic modulus, maybe attributed to the digestion of the collagen network by fibroblasts. This leads to an increase of porosity, and to a diminution of the stress.

The results also show a similar behaviour between OCM and human dermis, for deformation lower than 50%. Up to this deformation, the “pic” stress is lower for OCM; this may probably be corrected by a modification of the protocol of insertion of fibroblasts.

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