THE EFFECTS OF PRECONDITIONING ON TENSILE PROPERTIES OF PIG'S SKIN

ANETA LIBER-KNEĆ*, SYLWIA ŁAGAN

INSTITUTE OF APPLIED MECHANICS,
CRACOW UNIVERSITY OF TECHNOLOGY, POLAND
*E-MAIL: ALIBER@PK.EDU.PL

[ENGINEERING OF BIOMATERIALS 148 (2018) 15]

Introduction

Preconditioning is a procedure to load and unload the soft tissues several times before the data collection to achieve more repeatable testing results. Soft tissues e.g. tendons, skin or aorta are usually preconditioned before performing mechanical testing, such as tensile, creep, relaxation and hysteresis tests. This preconditioning significantly influences their mechanical properties [1-4]. This study investigates the influence of preconditioning on tensile properties of pig's skin tissue.

Materials and Methods

Skin tissue samples were taken parallel to the backbone from the back of 8-month old domestic pig, weighting about 100 kg. All samples had the same length of 100 mm and the width of 10 mm, however, these were of different thickness. The average thickness was 2.6 ± 0.2 mm. Samples were stored in the saline solution (0.9 %) at the temperature of 4°C no longer than 12 hours (fresh) before the test.

The uniaxial static tensile test was determined with the use of the MTS Insight 50 testing machine. The samples were mounted using scissor action grips with self-tightening and they were extended at a speed of 5 mm/minute at a room temperature of 22 ± 1°C. The initial gauge length was 50 mm. Registered force - elongation curves were recalculated into stress – strain curves. Before the tensile test, half of the samples were subjected to a preconditioning process. The preconditioning was performed in the load controlled experiment. The upper limit of load was taken to ensure that the strain remained within the linear region. The maximum load of each load-unload cycle was fixed at 5 N. Loading and unloading were repeated until the stress-strain loop of sample appeared to be periodic. It was after 3 to 5 cycles of loading-unloading for each sample. For each test at least 5 samples were taken for results analysis.

Results and Discussion

The exemplary stress-strain curves before preconditioning were shown in FIG. 1 and after preconditioning in FIG. 3.

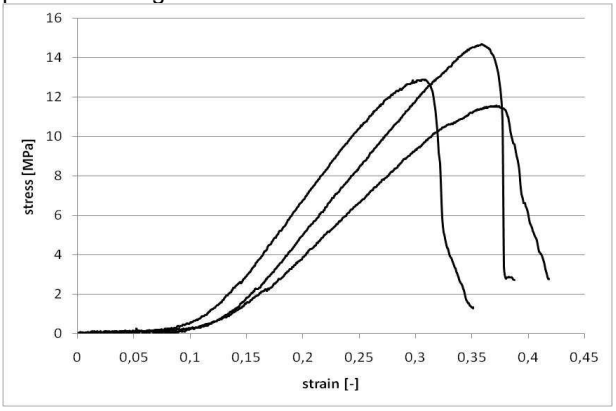

FIG. 1. The exemplary stress-strain curves before preconditioning.

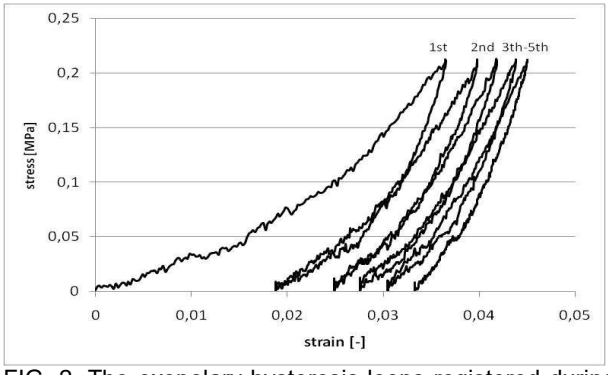

FIG. 2. The exepolary hysteresis loops registered during preconditioning.

Under the repeated cyclic loading stress-strain loops moved towards right and become repeatable, demonstrating preconditioning phenomenon of skin tissue (FIG. 2). However, preconditioning influenced on mechanical properties of skin (TABLE 1) and caused the increase of repeatability of results, it is difficult to clearly determine the impact of the preconditioning process.

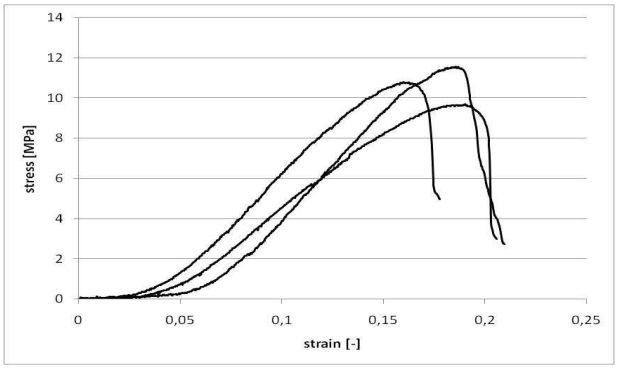

FIG. 3. The exemplary stress-strain curves after preconditioning.

TABLE 1. The average values of tensile strength (σ_{max}), strain at maximum force (ε_M) and Young's modulus (E)

	σ_{max} [MPa]	ε_M [-]	E [MPa]
before preconditioning	13.0±1.6	0.34±0.30	89.1±14.5
after preconditioning	10.1±0.6	0.18±0.02	122.5±18.5

Conclusions

The preconditioning in repeated cycles is common feature of skin tissue but still there are no exact procedure of it. According to Fung, the tissue should be preconditioned at the same stress levels as the subsequent testing. These obviously cannot be achieved in case of loading at large deformations so still further research is needed.

References

[1] Fung Y.C., Biomechanics, Mechanical properties of living tissues, Springer, New York, 1993.

[2] Liu Z., Yeung K., The preconditioning and stress relaxation of skin tissue. Journal of Biomedical and Pharmaceutical Engineering, 2008, 2:1, 22-28.

[3] Remache D., Calies M., Gratton M., Dos Santos S., The effects of cyclic tensile and stress-relaxation tests on porcine skin. Journal of the Mechanical Behavior of Biomedical Materials, 2018, 77, 242-249.

[4] Sopakayang R., A new viscoelastic model for preconditioning in ligaments and tendons. Proceedings of the World Congress on Engineering 2013 Vol III, WCE 2013, July 3 - 5, 2013, London, U.K.