

# COMPARISON OF MECHANICAL PROPERTIES BETWEEN SINGLE AND MULTI LAMELLAR SAMPLES OF INTERVERTEBRAL DISC

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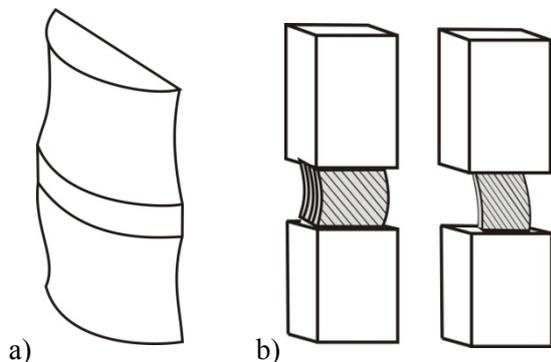
## 1. Introduction

Annulus fibrosus as important element of structure of intervertebral disc play fundamental role in mechanical function of spine. Lamellar annulus fibrosus wall mainly consist of collagen fibers, water and proteoglycans [2,3]. Arrangement of the fibrous matrix in intervertebral disc decide to nonlinear and strongly anisotropic tensile behaviour of the anulus fibrosus [1,2,4].

The presented study, provide information about influence number of lamellar, structural organization and connection vertebral bone with annulus fibrosus at mechanical properties.

## 2. Material and Method

Nondegenerate intervertebral disc were collected from 4 pigs spine. To this research, were used 3 motion segments from thoracic section of spine (Th8-Th9, Th9-Th10, Th10-Th11). Specimens were assorted and frozen at -20°C until testing. Samples of several annulus fibrosus were cut from outer anterior margin of motion segments with vertebral bones (fig. 1). Single lamellar samples was isolated using a scalpel from several wall of annulus fibrosus.



**Fig. 1:** a) Outer anterior margin of motion segments, b) multi and single wall of annulus fibrosus samples

Before mechanical testing samples were tested in 0.15 mol/l NaCl saline environment at room temperature. Dimensional of single and multi

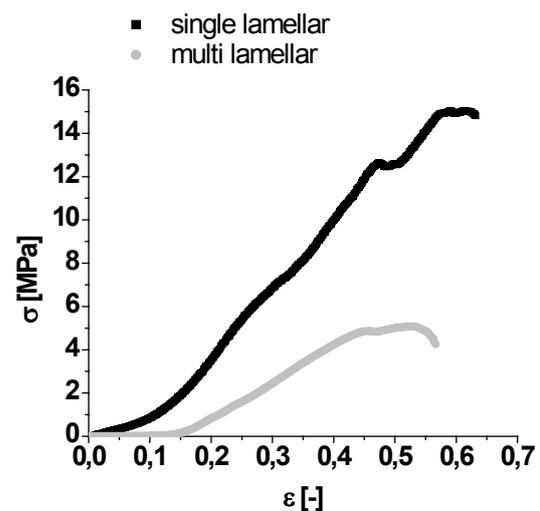
lamellar of intervertebral disc are summarized in Fig. 2.

DIMENSIONAL OF ANNULUS FIBROSUS SAMPLES		
	SINGLE	MULTI
LENGTH [mm]	6,00±1,10	5,25±0,87
WIDTH [mm]	16,00±1,41	5,64±1,18
THICKNESS [mm]	4,83±0,98	0,43±0,10

**Fig. 2:** Dimensional of single and multi annulus fibrosus sampels

Samples of annulus fibrosus with vertebral bodies bone were examined using uniaxial tensile test. All samples were preconditioned with 5 cycles to 1mm displacement. After that, using MTS Synergie 100 testing machine samples were stretch with constant speed of 0,5mm/s to failure of samples.

Tensile characteristics of intervertebral disc were determined between single and multi lamellar samples of annulus fibrosus (fig. 3).



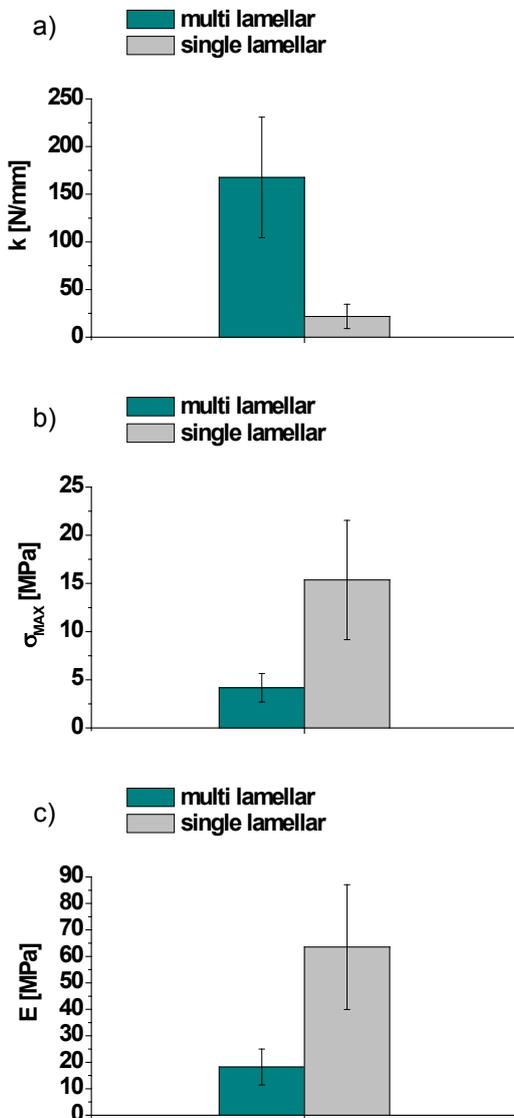
**Fig. 3:** Characteristics stress-strain of single and multi lamellar of annulus fibrosus

## 3. Experimental Results

These experimental results of nondegenerate intervertebral discs have shown difference

mechanical properties between single and multi lamellar samples of annulus fibrosus.

For characterization of mechanical behaviour parameters: stiffness coefficient ( $k$ ), ultimate stress ( $\sigma_{MAX}$ ) and Young's modulus ( $E$ ) were calculated from load-displacement and stress-strain curves.



**Fig. 4:** The mechanical properties of annulus fibrosus: a) stiffness coefficient ( $k$ ), b) ultimate stress ( $\sigma_{MAX}$ ), c) Young's modulus ( $E$ )

The higher value of stiffness coefficient ( $k$ ) were for multi lamellar samples than single lamellar samples (Fig.4.a). Whereas, ultimate

stress ( $\sigma_{MAX}$ ) and Young's modulus ( $E$ ) of the single lamellar annulus fibrosus samples excised from thoracic spine was higher than multi lamellar annulus fibrosus (Fig.4.b,c).

#### 4. Conclusion

Samples of outer wall of annulus fibrosus with two half of vertebral bodies have shown large influence elements of vertebral bones to mechanical properties. Stiffness coefficient were grown with number of lamellar annulus fibrosus but for multi lamellar samples the other mechanical properties (ultimate stress and Young's modulus) were become smaller.

Several samples of annulus fibrosus were undergone destruction in effect of separation annulus fibrosus with endplate from vertebral bone.

This is to confirm, that connection between endplate and vertebral bone is important place and should be taken into consideration in mechanical testing of intervertebral disc.

**Acknowledgements:** This research project is supported by grant No. NN518501139

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