BIOMECHANICAL INVESTIGATION OF INTACT AND INFLAMMATION OF THE NEW ZELAND WHITE RABBITS URETHRA

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1. Introduction

The aim of the study was to determine the mechanical characteristics of samples originating from a physiologically normal urethra from New Zealand White Rabbits and with induced inflammation during a tensile test in the radial and axial direction on a testing machine and determining a mathematical material model for urethral tissue in nonlinear condition. The structure and mechanical properties of the urethra should be performed to determine the parameters for the construction of new urethra stent models. Urethral strictures are common in male patents, it is rarely a congenital disease, in most of the cases it is acquired. In the USA the percentage of the patients with urethral stricture is 0.3% for men below 55 years old, and increase in the group above 55 years of age to 0.6% [5]. Between 1992 and 2000, more than 1.5 million office visits were made for male urethral strictures, and the cost of surgical treatment of one patient is 18 thousand dollars [1]. There are several techniques for the treatment of urethral strictures, but they do not guarantee satisfactory results. Most often a surgical treatment is carried out, which consists in the mechanical or surgical enlargement of the urethra lumen with dilators, catheters or a resection of the fibrosis and autogenic transplantation of the tissue. Implantation of relatively stiff stents into the urethra lumen, due to its arched shape, may be a cause of stent migration or sudden loss of the mechanical properties (breakage or bending of the stent) which leads to urinary retention.

2. Material and Methods

The test material consisted of 14 male New Zealand White Rabbits with a body weight of 2.1-3.0 kg. This animal model was chosen because of the histological and functional similarity between the human and the rabbit urethra [2,8]. During the tests the rabbits were divided into two groups of 7 specimens: the control group and the group with the irritated epithelium urethra. In both stages, fresh urethral specimens were used, for which the time from the moment of euthanasia to the end of the endurance test did not exceed 8 hours. In order to verify the condition of the urethra (intact, fibrosis or inflammation), histological examination was also performed using hematoxylin and eosin staining (H&E stain) [4]. The quasi-static tensile test of urethras were performed using the Zwick / Roell EPZ 005 testing machine. Curves of force-streching obtained from the tensile test were the basis for further research. Knowing the cross reaction and longitudinal dimensions of the samples, the obtained data was converted into stress and strain values in Microsoft EXCEL software. In STATISTICA 12 Software developed curves of the stress-strain curves of the regression parameter, and Young's Modulus for the different range of deformation.

3. Results

The urethra tissue samples from control group was subjected to histological verification which did not show pathological abnormalities of connective and muscular tissue structure as well as discontinuities of the multi-row layer epithelial. The histological analysis of inflammation urethra samples revealed changes in lamina

propria of mucous membrane. The congestion and in some cases concomitant hemorrhages were present, as well as edema and mononuclear cells infiltration.

4. Discussion

Based on the results obtained during the quasi-static tensile test, it can be noticed that the obtained results are similar to the experimental examination results published by other researchers (Table 1). It should be noted, that species variation (species, size, sex, living conditions, etc.) has a strong influence on the mechanical properties of the urethra.

Author's research (2018)	New Zealand White Rabbits	**Intact urethra** E=0.37-0.98MPa **Inflammation urethra** E=0.01-0.028MPa
Feng (2010) [3]	New Zealand White Rabbits	E=0.5 MPa
Zhang (2017) [8]	New Zealand White Rabbits	E=0.25 MPa
Natali (2016) [6]	Horse	E= 0.0058-0.0156 MPa
Nava (2004) [7]	Human	E=0.1-0.2MPa

Table 1: Mechanical properties of the urethra

The mechanical properties of the urethra with the occurrence of inflammation showed a significant, almost 10-fold reduction in the strength properties of the tissue compared to the control. Based on stress-strain curves for the axial and the radial directions, a comparison was made with non-linear material models. The best fit was found in the hyperelastic 9-parameter Mooney-Rivlin model [9].

Acknowledgments This investigation was supported by a research grant, as a part of the project DEC-2016/21/B/ST8/01972 financed by The National Science Centre. The protocol of the study was approved by the Local Ethics Committee in Wroclaw (decision No. 7/2012).

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