



## The prospect of using elastomers in the surgical treatment of neonatal oesophageal atresia



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**Keywords:** oesophageal atresia; uniaxial stretching; elastomers; mechanical properties; soft tissue

### 1. Introduction

Oesophageal atresia in neonates is one of the congenital defects which consists in undevelopment of a fragment of an oesophagus. This condition causes a problem with proper swallowing, which results in additional symptoms. The treatment of atresia consists in surgical reconstruction of the continuity of the oesophagus by stretching the undeveloped tissue [1,2].

Current methods of surgical treatment have many advantages, but they also have disadvantages. Uncontrolled elongation of the tissue may cause microdamages in the structure, which may result in the forms of fibrosis and scars, which may negatively affect the biomechanics of the oesophageal wall in the further development of the child. The search for new methods of treatment is not possible without characterizing the mechanical properties of the oesophageal tissue, which was the aim of this study. In addition, the mechanical properties of the elastomer were also characterized, which could be used in the future in alternative methods of surgical treatment.

### 2. Mechanical properties of white Pekin Duck oesophagus

Fragments of the oesophagus of white Pekin ducks were examined. An uniaxial tensile test was performed at a rate of 10 mm/min until a tissue rupture. On the basis of the test, the force-displacement characteristics for the stretched samples were determined and the tissue stiffness was set. The tests were carried out on the *MTS Tytron 250* testing machine. The research group consisted of 15 fragments of the 50 mm long oesophagus. Fig. 1 and 2 show exemplary tests results.

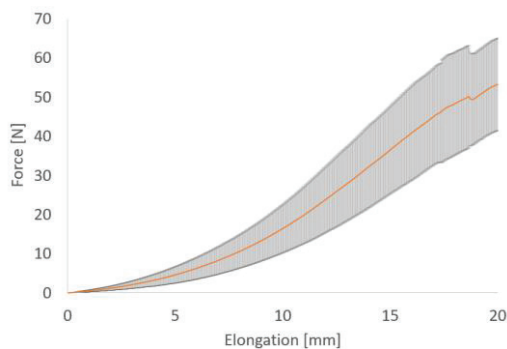


Fig. 1. Average force-elongation characteristics for the analyzed research group (with standard deviation)

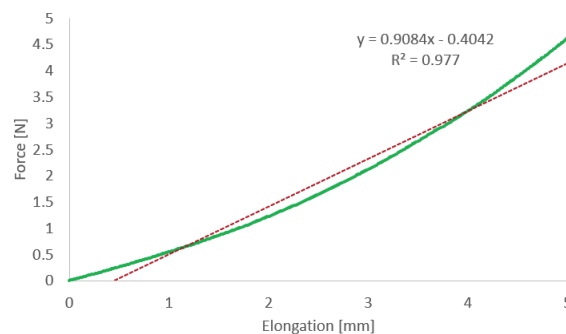


Fig. 2. Low deformation area for averaged force-elongation characteristics

### 3. Force-elongation characteristics of elastomers

The elastomers were subjected to a tensile test of successively: 20, 30 and 40 mm. After reaching the set elongation, the return to the initial position took place. The measurement started after reaching the preload with a force of 100 mN, the loading speed was 10 mm/min. 10 samples from each type of elastomers analysed were tested. Based on measurements, the force-elongation characteristics for individual samples were determined (Fig. 4, Fig. 5). The tests were carried out on the *MTS Tytron 250* testing machine, the diagram of the measurement stand is shown in Fig. 3.

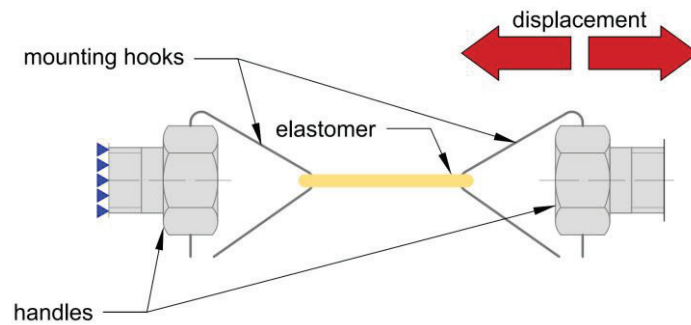


Fig. 3. Scheme of measurement stand for elastomers testing

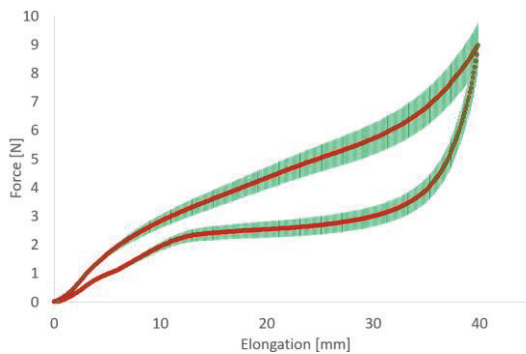


Fig 4. Averaged force-elongation characteristic for the elastomer with standard deviation

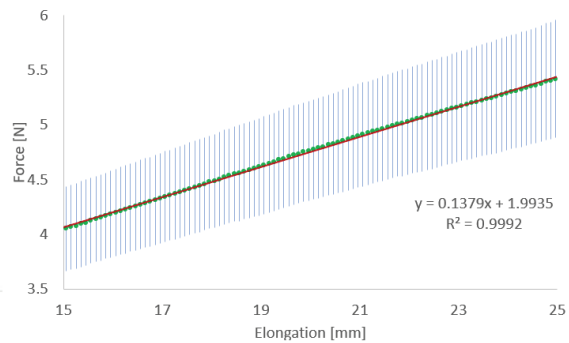


Fig. 5. Linear force-elongation characteristic fragment (with standard deviation) for the elastomer during stretching

#### 4. Results

On the basis of the obtained measurements concerning the stretching test of fragments of the oesophagus, the stiffness of the tissue in the area of low and high deformations was determined. In the case of the low deformation area, the average stiffness was  $C_N = 0.91 \text{ N/mm} \pm 0.029 \text{ N/mm}$ , while in the high deformation area it was  $C_W = 4.21 \text{ N/mm} \pm 0.22 \text{ N/mm}$ .

In the case of the analysis of elastomers tests, the stiffness of the material in the linear stretching area was determined (Fig. 5). It was  $C = 0.14 \text{ N/mm} \pm 0.015 \text{ N/mm}$ . It was also observed that the tested elastomer tends to generate a force of similar value in the area of 15 to 25 mm elongation.

#### 5. Conclusion

Based on the results of stiffness and the ability of the elastomer to generate a force of similar value over a certain area, it was found that elastomers can be used in alternative methods of surgical treatment of oesophageal atresia in neonates. At a later stage of the research, an attempt to determine the method of treatment based on susceptible materials will be made.

#### References:

- [1] K. Kozera et al., Esophageal atresia, *Post N Med*, 11, 2017, pp. 625-628.
- [2] K. Toczewski et al., Biomechanics of esophageal elongation with traction sutures on experimental animal model, *Sci Rep*, 12, 2022, 3420.