Data Descriptor

Mechanical Properties of Human Stomach Tissue

Szymon Grymek[1*]

[1] Faculty of Mechanical Engineering and Ship Technology, Gdańsk University of Technology (11/12 Gabriela Narutowicza Street, Gdańsk, Poland)

* Correspondence author: sgrymek@pg.edu.pl; ORCID: 0000-0003-4393-8982

Abstract

The dataset entitled Determination of mechanical properties of human stomach tissues subjected to uniaxial stretching contains: the length of the sample as a function of the corresponding load (tensile force) and the initial values of the average width and average thickness of the sample. All tests were conducted in a self-developed tensile test machine: PGTissueTester. The dataset allows the coefficients of various models of incompressible and nearly incompressible hyperelastic materials used to model human tissues to be determined.

Keywords: human stomach; biomechanical properties; hyperelastic materials

https://doi.org/10.34808/x55q-sz53_dyr_roz14

Specification table (data records)

Subject area	Mechanical engineering, Biomedical engineering, Materials engineering
More specific subject area	Measurements of mechanical properties of living tissues
Type of data	Text
How the data was acquired	The data were collected at the Gdańsk University of Technology using the PGTissueTester tensile test machine equipped with a commercially available KMM20 force transducer and a video-extensometric system
Data format	The tables are in .xls format
Experimental factors	The data contained in the dataset were not processed
Experimental features	The samples were obtained from fragments of dissected human stomachs

Data source location	MOST Wiedzy Open Research Catalog, Gdańsk University of Technology, Gdańsk, Poland
Data accessibility	The dataset is accessible and is publicly and freely available for any research or educational purposes

Background

The mechanical properties of human tissues are important variables used in the computer modelling of surgical procedures, optimisation of operative techniques, designing of surgical equipment and virtual reality surgical simulations (Brouwer et al., 2001; Delingette and Ayache, 2004; Rosen et al., 2008). One of the methods to estimate the range of tissue's mechanical properties is an uniaxial stretching (Jia et al., 2015).

Our dataset, Determination of mechanical properties of human stomach tissues subjected to uniaxial stretching, has been created to enable the determination of the mechanical properties of human stomach tissue. The dataset contains: the length of the sample as a function of the corresponding load (tensile force) and the initial values of the average width and average thickness of the sample. This suffices to determine the coefficients of various models of incompressible and nearly incompressible hyperelastic isentropic materials (Martins et al., 2006).

Methods

The tests were conducted in a self-developed tensile test machine: PGTissueTester 1.0 (Rotta and Grymek, 2020).

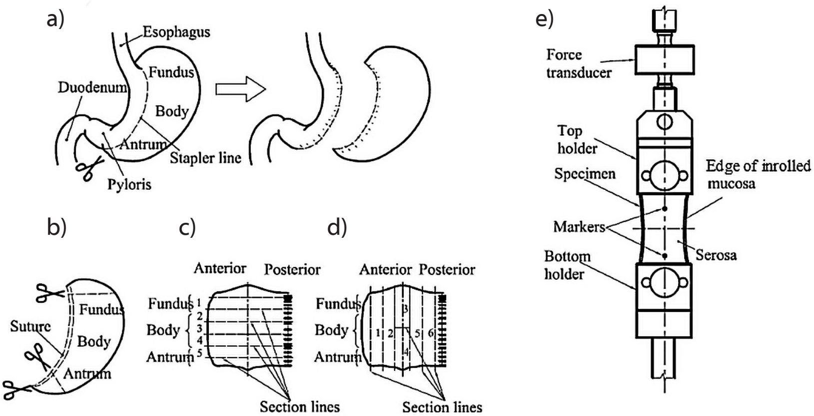

Fig. 14.1. Preparation of the test samples: (a) extent of resection during sleeve gastrectomy; (b) removal of unnecessary parts of resected stomach; (c) preparation of circumferential samples; (d) preparation of longitudinal samples; (e) fixing in holders

All samples were prepared as shown in Fig.14.1. The initial values of the average width and average thickness were calculated from 5 measurements (for each dimension) made with a calliper. Every sample was stretched at a constant speed of 0.4 mm/s. The measurement of deformations (distance between markers) was carried out by the non-contacting video extensometer method. The measurement of load (tensile force) was carried out by the KMM20 force transducer (range 0–50 N).

The measurement procedure utilised was described in detail by Rotta et al. (2019).

Data quality and availability

All of the stomach specimens were transported from the operating room to the laboratory within 5 min after resection and tested within an hour of the process. The test samples did not go through the preconditioning process because they were fresh; instead, the samples were pre-stressed to a force of 0.5 N. The tests were carried out in an air-conditioned room, at a temperature of 20°C and 60% relative humidity of the ambient air.

The relative error in the measurement of load (tensile force), sample width and deformation (distance between markers) was less than 2%. But, there is an uncertainty issue of calculating the relative error in the measurement of the sample thickness. Nevertheless we estimated that it should not be greater than 15%.

Dataset DOI
10.34808/kp2c-yb14

Dataset license
CC-BY-NC

Acknowledgements
The generation of this dataset was supported by statutory research grants from Gdańsk University of Technology and from the Medical University of Gdańsk.

References

Brouwer, I. et al. (2001) 'Measuring in vivo animal soft tissue properties for haptic modeling in surgical simulation', *Studies in Health Technology and Informatics*, 81, pp. 69–74. DOI: 10.3233/978-1-60750-925-7-69.

Delingette, H. and Ayache, N. (2004) 'Soft tissue modeling for surgery simulation', *Handbook of Numerical Analysis*, 12, pp. 453–550., DOI: 10.1016/S1570-8659(03)12005-4.

Jia, Z.G., Li, W. and Zhou, Z. R. (2015) 'Mechanical characterization of stomach tissue under uniaxial tensile action', *Journal of Biomech*anics, 48 (4), pp. 651–658. DOI: 10.1016/j.jbiomech. 2014.12.048.

Martins, P.A.L.S., Natal Jorge, R.M. and Ferreira, A.J.M. (2006) 'A Comparative Study of Several Material Models for Prediction of Hyperelastic Properties: Application to Silicone-Rubber and Soft Tissues', *Strain*, 42(3), pp. 135–147. DOI: 10.1111/j.1475-1305.2006.00257.x.

Rosen, J. et al. (2008) 'Biomechanical properties of abdominal organs in vivo and post-mortem under compression loads', *Journal of Biomechanical Eng*ineering, 130(2), 021020. DOI:10.1115/1.2898712.

Rotta, G. and Grymek, S. (2020) 'Test Stand for Multi-option Stretching of Soft Tissues', in Śnieżek, L. (ed.), *Fundamentals of Machine Design. Selected problems*. Warszawa: Wydawnictwo WAT, pp. 287–296.

Rotta, G. et al. (2019) 'Mechanical properties of the human stomach under uniaxial stress action', *Current Science*, 116 (11), pp. 1886–1893. DOI: 10.18520/cs/v116/i11/1886-1893.