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Data Article

Biomechanical and histological data from abdominal aortas harvested in autopsy

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A R T I C L E I N F O

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A B S T R A C T

This data article describes biomechanical and histological information of abdominal aortas harvested in autopsy. Eight abdominal aorta aneurysms (AAA) and 30 normal diameter abdominal aortas were collected and submitted to an inflation test up to their rupture. This inflation procedure was part of the research entitled “Experimental study of rupture pressure and elasticity of abdominal aortic aneurysms found at autopsy”, submitted to Annals of Vascular Surgery.

The rupture borders and control samples (harvested from places other than the rupture site) were submitted to uniaxial destructive tensile test and to histological analysis. The following variables were evaluated in the biomechanical test: failure stress, failure tension and failure strain. The

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histological processing of the samples enabled a quantitative analysis of the percentage of coverage of collagen fibers and elastic fibers in the samples.

The present data could be reutilized because they are experimental evidence that cadaveric abdominal aortas, even when previously stressed by inflation, conserve significant resistance against tearing comparable to no previously stressed aortas described in the literature. Considering real whole cadaveric AAAs are especially scarce, this information would be a useful reference source for further in-depth research in the aortic biomechanics field.

Specifications Table

Subject	Cardiology and Cardiovascular Medicine
Specific subject area	Vascular surgery; Vascular biomechanics
Type of data	Table Graph
How data were acquired	• Biomechanic uniaxial tensile test, histological analysis • Instruments: Biomechanic tensile test equipment and software for histological analysis • Make and model of the instruments used: * INSTRON SPEC 2200 / INSPEC software * Pannoramic Viewer and Case Viewer
Data format	Raw
Parameters for data collection	No parameters were used for data collection. The cadaveric specimens were randomly harvested.
Description of data collection	After the aortas were submitted to the inflation experiment up to their rupture, samples were harvested for further analysis. The uniaxial tensile test evaluated the following variables: failure stress, failure tension, and failure strain. Each sample test generated a graph representing the relationship between stress and strain. Histological quantitative analysis was made for evaluation of collagen and elastin fibers.
Data source location	**Institution:** University of São Paulo School of Medicine **City/Town/Region:** São Paulo, São Paulo, Southeast region **Country:** Brazil Latitude and longitude for collected samples/data: 23°33′20.7″S 46°40′13.0″W **Primary data sources:** **Institution:** University of São Paulo School of Medicine City/Town/Region: São Paulo, São Paulo, Southeast region **Country:** Brazil **Latitude and longitude for collected samples/data:** 23°33′20.7″S 46°40′13.0″W
Data accessibility	Repositories names: 1. Dataset on human normal diameter abdominal aorta biomechanics (uniaxial) and histology (specimens harvested during autopsy) [1]. 2. Dataset on cadaveric human abdominal aorta aneurysm biomechanics (uniaxial) and histology [2]. Data identification number: 1. https://doi.org/10.17632/yfj4wfszbw.4 2. https://doi.org/10.17632/x64srrc39p.4 Direct URL to data: 1. https://doi.org/10.17632/yfj4wfszbw.4 2. https://doi.org/10.17632/x64srrc39p.4

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Related research article	V.C. Gomes, M.L. Raghavan, L.F.F. da Silva, Experimental study of rupture pressure and elasticity of abdominal aortic aneurysms found at autopsy. Ann. Vasc. Surg. In Press [3] doi: 10.1016/j.avsg.2020.08.111.

Value of the Data

- The importance of the present data is to describe the biomechanical properties of cadaveric abdominal aortas' walls previously stressed by inflation. These are experimental evidences that those samples conserved significant resistance against tearing comparable to no previously stressed aortas described in the literature [4,5].
- All researchers involved with the study of aortic biomechanics and abdominal aortic aneurysm rupture prediction (i.e. vascular surgeons, biomechanical engineers, computational engineers) could use these data in further studies.
- These data enable comparisons of failure stress, failure tension and failure strain between normal aortas and AAA, considering important demographic information as age and gender.
- The present data could serve researchers that study aortic biomechanics, but do not have available human specimens from autopsy in their institution. Real aorta specimens are the ideal materials for researchers in the aortic aneurysm biomechanics field to obtain information from.
- These data could help in the better understanding of the abdominal aortic aneurysm, still an important cause of death worldwide.

1. Data Description

Samples from all cases (AAA and normal aorta groups) have been harvested for both biomechanical and histological analysis.

I) Biomechanical Data: For each valid sample test, three documents have been generated:

- **Stress X strain graph:** This chart is called elastic diagram and represents the relationship between the traction force to which the sample has been submitted and the simultaneous deformation observed. All graphs contain a notification in their left upper corner registering the failure stress, strain and tension of each sample. The failure strain is described as "ultimate yield". Fig. 1 illustrates one of CASE A biomechanical tests.
- **Table - excel file containing all the values related to the stress X strain graph:** All stress X strain graphs have a correspondent excel file with all the measured values of force and deformation represented in the chart. This file allows verifying the exact measurements registered during the tensile test.
- **A report from the biomechanical test software:** This is a file containing details of test conditions such as temperature, humidity, speed of sample stretching, sample thickness, maximum load, maximum sample extension. This information makes each test highly reproducible.

It is essential to highlight that some of the uniaxial tensile tests have not been considered valid because sample rupture occurred too close to the grips or the sample slipped out of the grip during the test. Those tests have been discharged because they were not a reliable source of information. All available files related to valid biomechanical tests of the 38 harvested aortas have been included in the two Mendeley datasets associated with the present article.

Tables I and II (included in the Supplementary material section) list all the biomechanical test files uploaded to the Mendeley repositories corresponding to the AAA and the normal aorta groups, respectively.

II) Histological Data: Four samples were harvested from each aorta, whenever it was feasible. All available histology slide images have been included in the Mendeley repositories related to

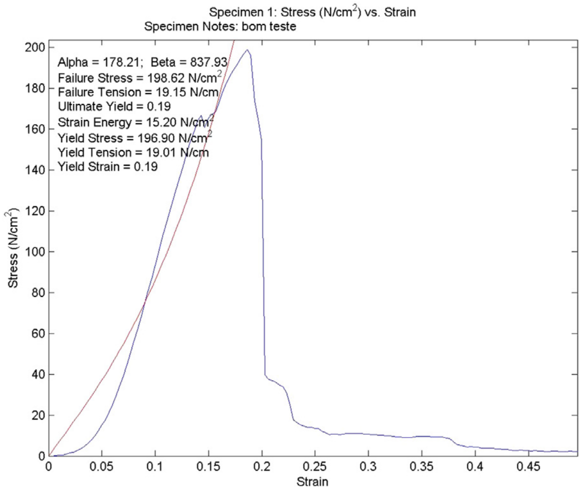

Fig. 1. Example of elastic diagram, chart produced with the measured values of stress and strain during the tensile test.

this article. Each case has a “histology files” folder containing all histology slides corresponding to each case.

Unfortunately, some samples intended to histological analysis have been damaged during tissue processing; therefore they have not been included in the repositories. The document “Histology files description” describes all the histology slides included in the Mendeley repositories. This document is available in the “Supplementary materials” section.

III) Demographic Data: In both Mendeley repositories corresponding to the normal aortas group and AAA group, demographic information of the donors, such as sex and age, has been registered in tables. The largest transverse diameter of each aorta has also been included in these tables.

Files names:

- In the AAA group Mendeley dataset: “Donors Demographic information .xlsx”
- In the normal aorta group Mendeley dataset: “Demographic data and largest aorta transverse diameter.xlsx”

2. Experimental Design, Materials and Methods

**** Biomechanical uniaxial test:**

The abdominal aorta specimens described here were previously inflated up to their rupture [3,6]. The borders of the rupture site were collected for biomechanical uniaxial destructive test. Whenever it was possible, samples from an area that remained intact after the inflation were used as a control (usually harvested in proximal and distal aorta). The collected samples were kept in 0,9% saline solution chilled at 4 °C, until the execution of the biomechanical test, within the maximum period of 48 h. The samples were sectioned with a special blade set to produce specimens featuring the ideal width (4 mm) for the pulling biomechanical test.

After that, the clip system to which the fragment is attached was connected to the INSTRON SPEC 2200 device, which is responsible for pulling the fragments during the uniaxial tension test. The test was coordinated using INSPEC software, installed in a palmtop computer attached to the pulling device. Data management was carried out in a PC by using SERIES IX software. The study from Raghavan et al. [7] made on aorta samples served as the main reference for standardization used in the biomechanical test. The association between deformation values and

Fig. 2. Scanned image obtained from an artery wall sample stained with Verhoeff (for identification of elastic fibers).

Fig. 3. Scanned image obtained from an artery wall sample stained with Sirius red (for identification of collagen fibers). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

respective strength values (stress) is made through the PC throughout the tensile test, using the software SERIES IX. A graph denominated elastic diagram is generated (Fig. 1).

The uniaxial biomechanical properties measured were: failure stress (maximum stress), failure tension (maximum stress resultant) and failure strain (strain at maximum stress).

** **Histological analysis**

The samples intended to histological analysis were also collected from de rupture site borders, and, when it was possible, from areas (in the proximal and distal abdominal aorta) that remained intact after the inflation, used as a control. They have been preserved for 48 h in buffered formaldehyde (phosphate buffered, pH 6.8–7.2; 0.1 M). After this period, the samples were washed with saline solution 0,9% and then preserved in ethanol until processing [8].

The specimens were set in the tissue processor and then embedded in paraffin. The blocks containing the tissues samples were cut with the aid of a micrometer standardizing the thickness of 5 µm. The Histological slides were stained with Voerhoeff- Van Gieson - for identification of elastic fibers (Fig. 2) and Sirius red - for identification of collagen fibers (Fig. 3).

All slides have been scanned in a digital pathology slide scanner. A quantitative analysis was made using the software Pannoramic Viewer Image Pro-Plus.

Previously to the analysis, parameters are set in the software Pannoramic viewer indicating the colors that are compatible with collagen fibers, for example. The different layers of the arterial wall (intima, media, and adventitia) are identified and delimited for the software analysis. Fig. 4 illustrates the scanned image obtained from an artery wall sample stained with Sirius red (for identification of collagen fibers). A green line delimits the intima layer. Then the software registers the quantity of collagen fibers inside this area and the percentage of the total area

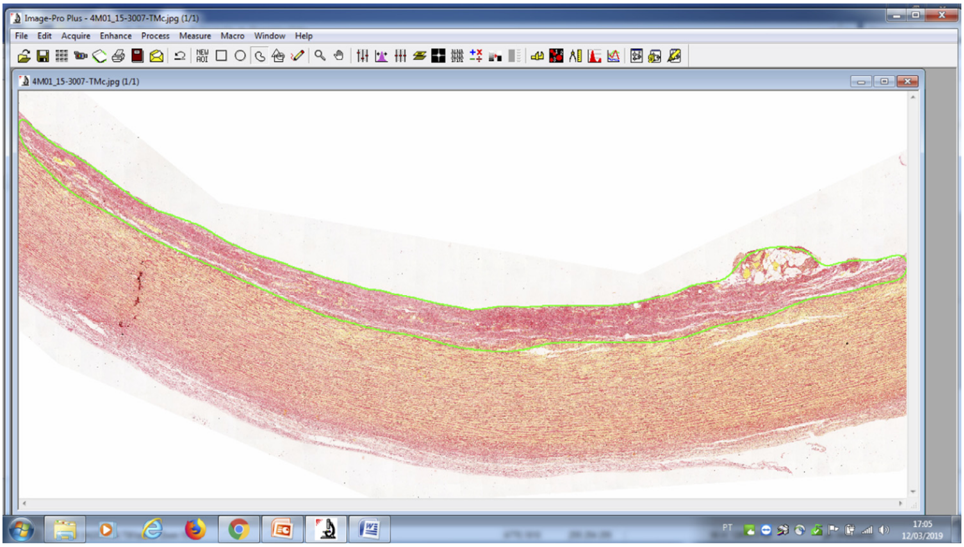

Fig. 4. Scanned image obtained from an artery wall sample stained with Sirius red, with the intima layer delimited by a green line. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

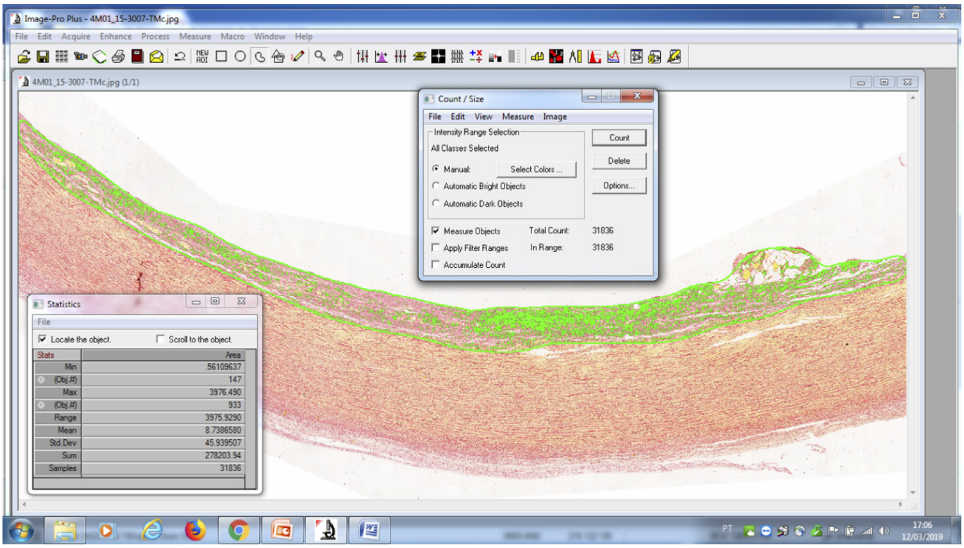

Fig. 5. The same sample from Fig. 4, now with collagen fibers highlighted in green within the previous delimited area. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

covered by them (Fig. 5: the software highlighted in green the collagen fibers within the previous delimited area). The same procedure is repeated for the media and adventitia layers and for the Voerhoeff- Van Gieson stained slides.

The percentage of coverage of collagen and elastic fibers is expressed in decimal numbers (for example, 0.48 = 48%). In the AAA group Mendeley repository, the table

"Data in Brief HISTOLOGY.xlsx" has been included with all the histological analysis produced by our pathologist. In the normal aorta group Mendeley repository, the table "HISTOLOGY - NORMAL AORTAS.xls" has been included with all the histological analysis produced by our pathologist.

The same laboratory technician prepared all the slides, and the same pathologist analyzed all of them.

Ethics Statement

The study was approved by the institutional review board (Ethical Committee of University of São Paulo School of Medicine #263/15 and #0027/17). The specimens were harvested during autopsy in the Service for verification of death of University of São Paulo School of Medicine, São Paulo, Brazil, which applies an informed consent to family members to sign.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships, which have, or could be perceived to have, influenced the work reported in this article.

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Supplementary Materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.dib.2021.106953.

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