ESRF	**Experiment title:** In vitro 3D imaging of dissecting pressurized arterial segments	**Experiment number:** LS-2904
Beamline: ID17	**Date of experiment:** from: 27/01/2021 to: 30/01/2021	**Date of report:** 26/04/2021
Shifts: 12	**Local contact(s):** Alberto Bravin	*Received at ESRF:*

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Report:

During the experiments we did in situ tension inflation test on notched rabbit aortic segments in order to observe a dissection at different steps of pressure until propagation of the notch. The results obtained during the experiment at ESRF exceeded our expectations. The resolution and contrast allowed us to observed the medial lamellae of the aorta, which we couldn't do with conventional microtomography. We were able to observe the dissection of five samples. This was the first time that a dissection was observed with such a precision. These data will help to better understand aortic dissection and fill the lack of experimental data in the literature to validate numerical models.

A paper will be published soon on these results, but it takes time due to the large amount of data. I added an extract of an abstract accepted for a conference that detail some of the results.

Extract of an oral presentation entitled "In situ observation of an in vitro aortic dissection in rabbit aortic tissue with synchrotron-based X-ray microtomography" that will be given at the 46th Congress of the Société de Biomécanique (October 25), Saint-Etienne.

The samples dissected at critical pressures ranging from 388 to 665 mmHg. The notch propagated in the antegrade and retrograde directions for most of the specimens. No re-entry tear was observed; however, a rupture of the false lumen was often present, as observed in clinics (Roberts 1991). A cross-section of a dissected sample is shown in Figure 1. The morphology of the tear remained relatively constant during the inflation; nevertheless, correlations were found between the critical pressure and different morphological quantities (tear depth, tear openning length, and tear width).

The diameter and thickness of the different aortic layers were quantified for all pressure steps and the circumferential Cauchy stress was calculated. Around 100 mmHg, the aortic diameter reached a plateau, and the circumferential Cauchy stress increased drastically as observed on other tissues during inflation testing.

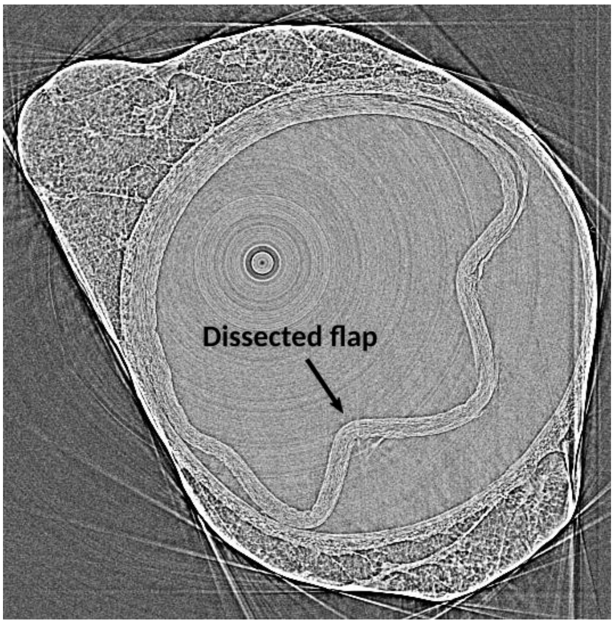

Figure 1: Cross-section of an aortic sample after dissection. The dissected flap can be observed. The dissection involves almost all the circumference of the specimen.

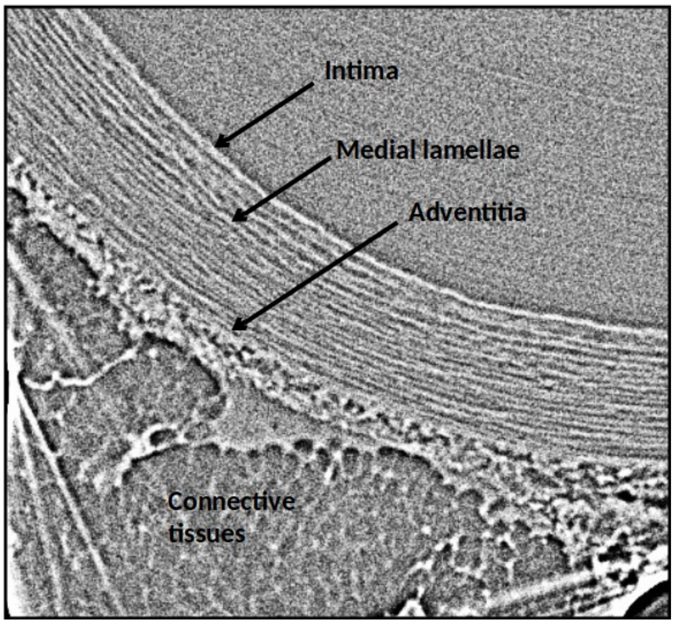

Figure 2: Cross-section of an aortic sample at 0 mmHg. The different aortic layers and medial lamellae are clearly visible.

The resolution of the synchrotron-based microtomography images allowed us to observe and quantify the medial lamellae and their involvement in the propagation of the notch (Figure 2). A bulge was observed at the tip of the notch before and after dissection of the specimen creating a complex stress state. Thus, the initiation and propagation of the tear seems to be a combination between fracture modes I and II. An elastic recoil of the flap was quantified between 5 and 12%. Furthermore, the dissection process was observed in real-time with radiographic images. The samples dissected most of the time in less than a second or in few seconds, as observed in the literature (Roberts 1991).

To conclude, aortic dissection was investigated from the initiation of the failure to the complete dissection of the sample and multiple mechanisms underlying this disease were highlighted. To the authors' knowledge, it is the first time that an aortic dissection is observed in real-time with a resolution showing individual lamellae. Furthermore, the data collected in this study could fill the lack in the literature and be used to validate numerical models. Finally, synchrotron-based microtomography was demonstrated to be a promising imaging technique to observe complex and intramural phenomena.