A METHODOLOGY TO STUDY THE MECHANICAL PROPERTIES OF NORMAL BREAST TISSUES

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Introduction

The breast is a heterogeneous organ composed of adipose, glandular, and fibrous tissues as well as the suspensory ligaments. It changes along the woman's life and in a presence of a pathology [1]. It is known that the mechanical properties of such structures are affected by pathologies, i.e. tissues got stiffer in the presence of a disease [2]. Therefore, understanding the mechanical properties may improve current approaches either in diagnosis, treatment, or aesthetical procedures. It is important not only to understand the mechanical behavior of disease tissues but also the normal breast tissues. Thus, this short study aims to carry out a mechanical characterization of normal breast tissues.

Materials and Methods

In this study, the samples were harvested from a post-bariatric patient (after massive weight loss) who underwent a breast reduction shaping surgery. It was obtained one sample from each breast (right and left) The samples were cut in a cylindrical shape, with a diameter of 20 mm and a height of 10 mm. The mechanical characterization was achieved by performing indentation tests with a flat-ended indenter of diameter of 5mm, a 10N load cell, and a saline bath at 37ºC (Figure 1).

The mechanical protocol was a two-step approach:

I. Preconditioning: 20 cycles with 10% strain at 30%/min
II. Stress-relaxation test: load up to 30% strain at 30%/min, hold for 360s at the final position and unload up to 0% at the same rate

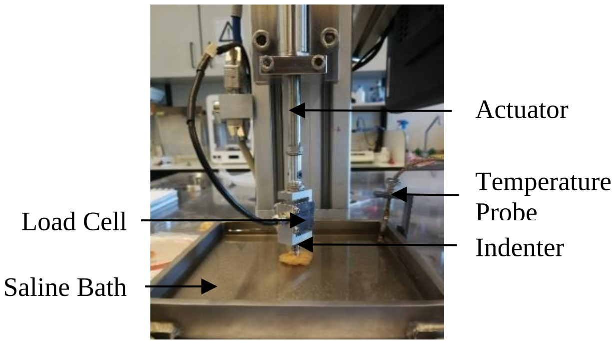

Figure 1: Mechanical apparatus for indentation of breast tissue samples.

Histology was also performed to evaluate the main tissue type presented in these samples.

Results

Following the mathematical approach of Delaine-Smith et al. [3], Young's modulus was calculated in the two linear regions of the loading curve. The results are presented in the following table:

Sample	1st linear region	2nd linear region
Right	2.69 – 7.35	6.01 – 16.42
Left	1.96 – 5.35	3.12 – 8.54

Table 1: Young's modulus (kPa) for the two samples analyzed. Range of values obtained (minimum-maximum) depending on the mathematical approach.

Furthermore, the percentage of relaxation was approximately 36% for both samples.

Discussion

In literature, the results of stiffness of normal breast tissues (adipose and glandular) have a wide range of values. Not only do the intrinsic factors of a woman (e.g. age, menstrual cycle, pregnancy, menopause, and disease) contribute to this variability, but also the parameters of the mechanical tests have an impact on the results. The test speed, the strain amplitude, or the preconditioning are examples of parameters that might influence the stiffness. Therefore, the results obtained in this work can be compared and are in accordance with the values available in the literature [2,4,5].

Looking at the percentage of relaxation, we can observe that more time is needed to reach an equilibrium state.

This study contributes to improve the knowledge concerning the mechanical behaviour of normal breast tissues and launches a foundation for future large scale studies.

References

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