MECHANICAL CHARACTERISATION OF PANCREATIC TISSUE: PRELIMINARY IN-VITRO RESULTS

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Introduction

Pancreatic cancer is the fourth cause of death from cancer worldwide and surgical resection, when feasible, is the only curative treatment. Pancreatic fistula is a treacherous postoperative complication with a rate of 10-20%. Pancreatic fistula is strongly related to pancreatic parenchyma consistency and structure. There is a lack of knowledge about the mechanical and chemical properties of pancreatic tissue. Therefore, the aim of this project is to investigate the porcine pancreatic parenchyma characteristics towards the definition of a standardized method also suitable for human pancreas in order to obtain the needed parameters to build up a pancreas phantom, a device not yet available and fundamental to improve surgical techniques and training programs in this field of surgery.

Methods

All the samples tested in this work come from porcine pancreas provided by a slaughterhouse. Cylindrical samples (d= 10.91 ± 0.33 mm, h = 4.16 ± 1.08 mm) were cut to perform unconfined compression (stress-relaxation) tests while dog bone specimens (l_0 = 31.54 ± 6.79 mm, w_0 = 4.16 ± 0.32 mm, h_0 = 2.87 ± 0.76 mm) were obtained to perform uniaxial tensile tests. Each specimen was withdrawn from a different lobe of the gland, and all the tests were performed using the MTS Synergie 3200H test machine. Compression experiments were performed using a displacement-controlled protocol (8 steps each one made by 5% deformation) while tensile tests were conducted by imposing strain rate from 3 to 200 mm/min. The stress-strain relationship was obtained, and the elastic modulus was determined. Further tests will be performed using the Anton Paar Bioindenter.

Results

After each stress-relaxation test, ten parameters Prony series were used to well fits results data. Frozen and fresh tissue were analyzed in order to investigate if the conservation method could influence the mechanical properties. According to preliminary results, freezing increases the elastic modulus at both small and large deformations (Fig. 1). Tensile tests were performed at several strains rate and the elastic modulus evaluated at small deformation (ε=0-0.03) is higher than the elastic modulus evaluated at large deformation (ε=0.06-0.08) (Fig. 2 and Fig. 3)

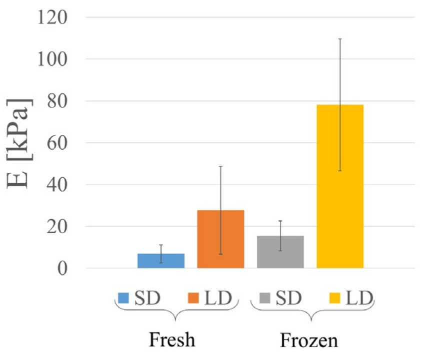

Fig. 1 Elastic moduli at small (<20%) and large (>20%) deformations (SD and LD respectively) for frozen and fresh pancreatic tissues obtained from compression tests.

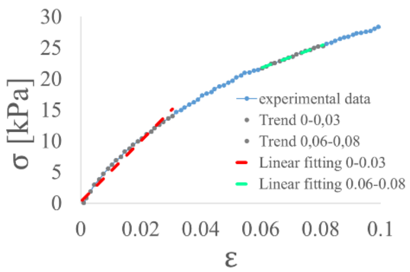

Fig. 2 Stress-strain relationship from tensile test, highlighting the regions where E1 and E2 are evaluated.

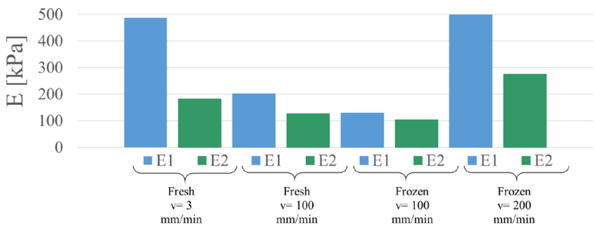

Fig. 3 Elastic moduli E1 (small deformation) and E2 (large deformation) for frozen and fresh pancreas under uniaxial tensile test at different velocities.

Discussion

This work demonstrates that porcine pancreatic tissue has a viscoelastic behaviour like the other abdominal organs (e.g: liver, kidneys, spleen). Further tests should be performed on each pancreatic lobe to assess either a peculiar behaviour of each lobe or heterogeneous properties of the whole gland. This method seems appropriate for the mechanical characterization of the porcine pancreas and could also be applied to the human pancreas, in order to obtain all the needed parameters to build up a pancreas phantom.