Mechanical Characterization of the Pancreas Under Quasi-Static Compression

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Abstract: Pancreatic cancer, particularly pancreatic ductal adenocarcinoma, is an aggressive disease with a rising incidence. It is currently the fourth leading cause of cancer-related deaths and is expected to become the second one by 2040 [1]. Surgical resection remains the only potentially curative treatment, but it is associated with a high rate of postoperative complications, typically pancreatic fistula (PF), which significantly impacts patient recovery and survival [2]. PF occurs when the connection between the pancreas and surrounding tissues fails, leading to the leakage of pancreatic fluid, increasing infection risk, and delaying healing [3].

The consistency of pancreatic tissue is a key factor in PF risk, but its objective assessment during surgery remains a challenge. Understanding the mechanical behavior of the pancreas, particularly in the anastomotic zone, is crucial to optimizing surgical techniques and minimizing the risk of postoperative complications.

In this study, we propose a comprehensive biomechanical characterization of the pancreas under quasi-static compression. Porcine pancreatic samples were extracted, prepared under controlled conditions, and analyzed using a home-made portable compression device dedicated to soft biological tissues. To ensure precise dimensional measurements, 3D scanning was performed before mechanical testing.

Among the results obtained, the mechanical response revealed a nonlinear behaviour, with significant variations in compression modulus depending on anatomical regions and post-mortem conditions.

To further improve clinical applications, we propose to identify a hyperelastic constitutive law based on our experimental data. This law will enable better integration of pancreatic tissue deformation under stress into predictive models, contributing to a more accurate assessment of PF risk [4].

This research enhances our understanding of pancreatic biomechanics, paving the way for improved surgical planning and reduced postoperative complications, particularly PF.

Keywords: Pancreatic cancer, Surgical treatment, Pancreatic fistula, Soft tissues, Anastomotic zone, Biomechanics, Postoperative complications.

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