EFFECT OF PRESERVATION SOLUTION AND PERIOD ON RHEOLOGICAL PROPERTIES OF LIVER

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Introduction

For a successful liver transplantation, the liver harvested from a donor must be preserved and transported to a suitable recipient immediately. During this process, the content of the preservation solution and the preservation period are highly critical to reduce the tissue damage. However, there is still dispute among the physicians on the content of the preservation solution as well as on the extent of the preservation period. The goal of this study is to investigate the changes in viscoelastic material properties of bovine liver preserved in different chemical solutions as a function of preservation period. While the material properties of animal and human livers have been investigated in the past[1], to our knowledge, the number of studies investigating the effect of preservation solution and period on the material properties of liver is very limited[2].

Methods

3 fresh bovine livers are obtained from a slaughterhouse. A custom-made soft-tissue cutting apparatus is designed to obtain 18 tissue samples from each liver with a diameter of 25 mm and a thickness of 2 ± 0.5 mm. The samples are divided into 3 groups and preserved in 3 different solutions: Wisconsin University (UW) and Custodiol (HTK) are the most commonly used solutions in liver transplantation and the Ringer solution is used for the control purpose. Using a rheometer (Anton Paar, MCR 102), frequency sweep experiments are performed on the tissue samples at 5 h, 11 h, 17 h, 29 h, 41 h, and 53 h after harvesting the livers, at shear strain of 0.5%, normal strain of 5%, and a temperature of 4^{o} C for the frequency range of ω= 0.1-20 Hz.

Results

Two-way ANOVA test shows that the preservation period, solution and their interaction have significant effects on the storage and loss moduli of the livers ($p < 0.05$ for all effects). The paired t-tests show that the storage modulus of the liver samples preserved in Ringer, UW, and HTK solutions change significantly after 11th ($p < 0.05$), 29th ($p < 0.001$) and 11th ($p < 0.001$) h , respectively (Figure 1). On the other hand, the loss modulus of the same samples preserved in Ringer, UW, and HTK solutions change significantly ($p < 0.001$) after 17th, 29th and 29th h, respectively (Figure 1). In particular, the storage moduli of the samples preserved in Ringer and UW solutions increase to almost two-folds at the 41st h and to almost four-folds at the 53rd h when they are compared to the moduli values obtained at the 5th h, respectively. However, the storage and loss moduli values of the samples preserved in HTK solution show relatively small changes throughout the whole preservation period.

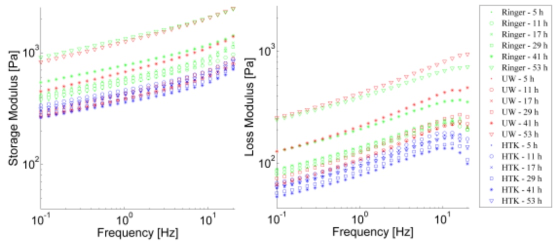

Figure 1: Storage and loss moduli of bovine liver as a function of perservation period, solution and oscillation frequency.

Discussion

We measured the storage and loss moduli of bovine liver using an oscillatory shear rheometer to investigate the effect of preservation period and solution on the viscoelastic material properties of the liver. The results of the study suggest that liver tissue becomes stiffer and more viscous as the preservation period increases, supporting our earlier findings[2]. In addition, the results show that the liver samples are preserved well in UW and HTK solutions up to 29 h, but if longer preservation is required, HTK should be preferred over UW. In the future, we are planning to investigate the changes in histological properties of the same liver samples to correlate them with the changes in material properties.

References

1. Basdogan, C., Studies in Mechanobiology, Tissue Engineering, and Biomaterials. (2012); Vol. 11, pp. 229-241.

2. Ocal S. *et al.*, J Biomech Eng. (2010); 132(10): 101007.

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