ONGOING RESEARCH

COMPLIANCE AND VISCOELASTIC CHARACTERIZATION OF LIVER TISSUE DURING POST RESECTION REGENERATION

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UFFICIO 6

Autorizzazione n. 434/2019-PR

IL DIRETTORE GENERALE

Vista la domanda di autorizzazione del progetto di ricerca **"Sfaturazione ex vivo della compliance e della caratteristiche viscoelastiche del fegato sano ed in corso di rigenerazione epatica"**, ex articolo 31 del decreto legislativo 4 marzo 2014, n. 26, acquisita con prot. 22418 DI del 09/05/2019 ad integrazione del 03/06/2019, inoltrata dall'**Ospedale Policlinico San Martino – Sistema Sanitario Regione Liguria – Istituto di Ricovero e Cura a Carattere Scientifico per l'Oncologia, sede legale in Genova, Largo R. Benzi, 10**, per il tramite dell'Organismo preposto al benessere degli animali di cui all'articolo 25 del medesimo d.lgs. n. 26/2014, e finalizzata all'esecuzione del progetto di ricerca come descritto nella documentazione allegata alla domanda.

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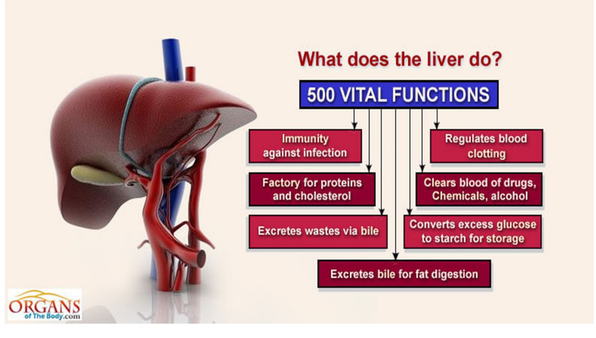
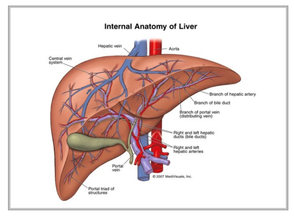
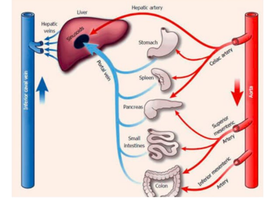
The Liver



The liver is a **major metabolic organ**, which performs many essential biological functions such as detoxification of the organism, and the synthesis of proteins and biochemicals necessary for digestion and growth.

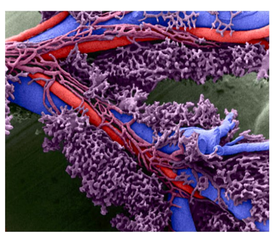
The liver vascularization

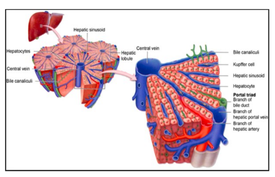




The liver receives blood rich in digested nutrients from the entire gastrointestinal tract from the spleen and from pancreas by the **portal vein.** It receives oxygenated blood by the **hepartic artery.**
After several metabolic processes the blood returns by the **hepatic veins** to the vena cava and finally to the heart.

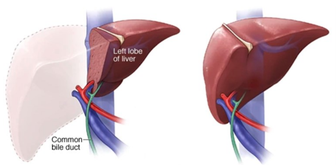
The liver lobule

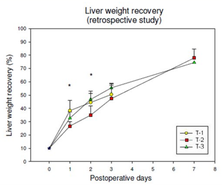




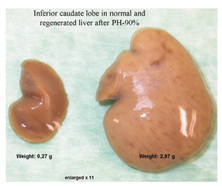
Microscopically, the liver tissue is made up of **hepatic lobules**.
The lobules are **anatomical unit** where the blood is in contact with the liver cells (**hepatocytes**) through a complex system of specialized capillaries (**sinusoids**).

The liver regeneration



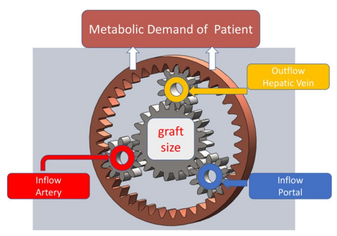


The liver is able to grow after tissue lost, in a process called **hepatic regeneration**.
This amazing propriety enable us to resect a portion of liver waiting for an **enlargement of the remnant tissue** (compensatory hypertrophy).
This is the prerequisite for liver surgery and liver transplantation.



Rat liverregeneration after 7 days

Liver function and hemodynamic



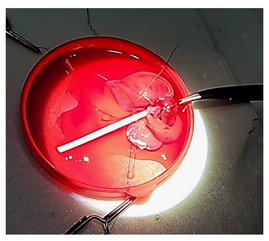
Enhanced portal flow after resection drives the regeneration process but is also linked to the development **hepatic disfunction** (small for size liver syndrome) in liver with reduced compliance.

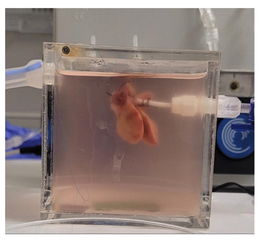
Indeed, during hepatic regeneration, various **changes in microcirculation** occur, leading to changes in the viscoelastic properties of liver tissue.

In order to establish a **correlation between the portal flow and the intrahepatic compliance in normal and regenerating liver**, we are conducting pc-controlled, **ex-vivo normothermic perfusion tests**.

Research Protocol

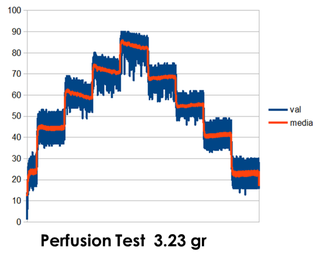
Under general anesthesia surgical **resection of 70% of the liver** is performed.
At **0-3-5-7 days** after surgery, the **liver** is removed and **tested.**
Automated Perfusion Test with the **Genoa Organ Perfusion System:** the liver is perfused through the portal vein, starting from physiological value (≈1 ml/min*gr) and increased by successive steps up to fivefold and then decreased to normality.



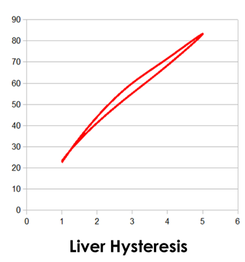


Perfusion Test

PRELIMINARY RESULTS



Perfusion Test 3.23 gr

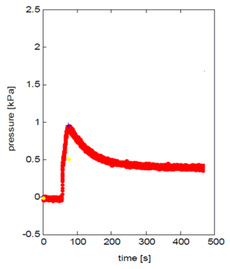


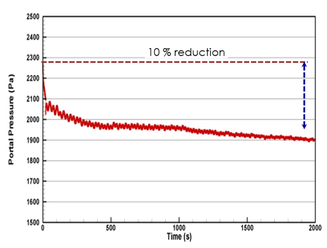
Liver Hysteresis

The liver shows a visco-elastic behavior during the whole test: hysteresis can be recorded and measured

Perfusion Test

PRELIMINARY RESULTS





The liver shows a visco-elastic behavior during the single step: stress relaxation can be recorded and measured

Preliminary Conmclusions

The **Genoa Organ Perfusion System** offers flow control and pressure measurements that are accurate to **quantify the liver compliance** in our research protocol.

Further results are needed to better understand the correlations between regeneration, intrahepatic blood floow and liver function and to improve our mathematical model.

The Genoa Organ Perfusion System **can be scaled and modified** in order to perform **different types of research** on organ and tissue perfusion as hyperthermic peritoneal perfusion, isolated limb perfusion, and hypothermic organ preservation models.

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General Considerations

Arduino offers a stimulating way to **improve lab equipment**, making electronics projects **accessible** to anyone; it is a **valuable learning tool**, with which anyone can play and experiment with electronics, learn the foundations of electronic and build their own devices.

In a wider contest, Arduino and the **open-hardware** movement may represent a sustainable and valuable way to **enhance scientific education** and to **increase the opportunities for scientists** with limited financial resources.

Thanks for your attention!