Mechanical Properties and Permeability under Deformation of PLLA Scaffolds
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Introduction
The application of different polymeric materials with three-dimensional structure to facilitate the adhesion, diffusion and proliferation of cells for cartilage regeneration has been widely studied (1). A well designed scaffold should reduce the stress-strain variation in the surrounding zone of the injury and should allow a good fluid exchange apart from the biological requirements. A complete characterization of the scaffold is important to evaluate its future mechanobiological behavior. The present work shows experimental parameters of a PLLA scaffold to evaluate its behavior under physiological conditions.

Materials and Methods
To characterize the mechanical properties of the scaffold, uniaxial static tests like Unconfined (UC) and Confined compression (CC) have been performed. The Young Modulus ($E_S$) and the Aggregate Modulus ($H_A$) are respectively calculated from the slope of the best linear fit of the stress-strain graph. Poisson’s ratio ($\nu$) can be directly deduced from $E_S$ and $H_A$. Interconnected porosity is an important variable in the mechanical characterization of the scaffold. The microtomography (Micro-CT) allows to define the trabecular volume, percentage of pore structure and also to perform FE models. A permeability test is carried out to determine how much interconnected the porous are.

Results

![Fig. 1. Microstructure and Finite Element Mesh Model of the scaffold](image)

| Mechanical Properties of healthy cartilage and PLLA Scaffold |
|----------------------------------|-----------------|-----------------|
| Cartilage (Collagen Matrix)      | $H_A$ (MPa)     | $E_S$ (MPa)     | $\nu$ |
| Cartilage                        | 0.34 ± 0.12     | 0.19 ± 0.06     | 0.35  |
| PLLA Scaffold 1:1 15 %           | 8.88 ±2.83      | 3.43 ± 0.56     | 0.42  |

Table 1. Comparison of healthy cartilage and PLLA scaffold main mechanical parameters.

![Permeability - Deformation](image)

Discussion and Conclusions
All the obtained results with the PLLA scaffold indicate that it could be a good candidate for cartilage tissue engineering. A complete scaffold characterization is necessary to implement and validate new computational models to improve the scaffold design closer to the physiological conditions of cartilage.

References

Acknowledgments
This work was supported by the CICYT-DPI2007-65601-C03-00 project. Thanks also to the Platform for Biological Tissue Characterization of the CIBER-BBN.

Disclosures
No commercial conflict of interest and authors have nothing to disclose.