New biomaterials based on supramolecular and thermosensitive polymer networks

Advances in biomaterials engineering for bone fracture reconstruction are still insufficient, especially for comminuted fractures of the distal part of limbs, which are difficult for anastomosis using classical methods (e.g. Kirschner wires). The development of biodegradable biomaterials as scaffolds for regenerating damaged tissue is currently the most promising approach. Importantly, the ability to perform an *in situ* anastomosis *in vivo* would be a particularly advantageous feature, as it would enable the surgeon to produce a precise reconstruction that guarantees the patient's full motor function of the limb. Therefore, the use of the photopolymerisation technique - a photochemically initiated process that takes seconds/minutes - is an extremely promising approach. During this process, a monomer (usually a liquid) is transformed into a solid that, under living conditions, also becomes an implant or scaffold for cell proliferation. Thus, the potential risk of tissue damage from classical metal wires is eliminated and surgical time is significantly reduced.

The demand for such materials has motivated the design of a pioneering study to develop new supramolecular and stimuli-sensitive polymer networks obtained by UV-light-initiated photopolymerisation, which have not been described in the literature so far. The research will focus on the synthesis of new materials using non-toxic natural origin and synthetic molecules (derivative of fatty acids, lactic acid, cyclodextrins and N-isoprolylacrylamide), which, while forming physical gels (polypseudorotaxanes), will be cross-linked using UV light. The fabricated materials will additionally be enriched with bioactive ceramic particles and gelatine/alginate microbeads to produce a robust yet porous structure that mimics trabecular (highly porous) bone. The composition will be designed to achieve a viscosity that guarantees the injectability of such materials. New knowledge of the sol-gel transition and the kinetics of photocrosslinking will be gained. The degradation and bioactivity profiles of the new materials under simulated *in vitro* physiological conditions will be determined. The biofunctionality of the new materials will be assessed by mechanical tests while observing material fracture in a scanning electron microscope *in situ*. *In vitro* cellular biocompatibility studies will be performed and the final step to verify the biofunctionality of the new injectable biomaterials will be made by anastomoses of limb bone fractures in rabbits. The study of new supramolecular and stimuli-sensitive composite biomaterials, demonstrating bioactivity and osteoconductivity and fine-tuned for injectability, which to our knowledge, has never been synthesized and represents a scientific novelty not previously reported in the literature.

This research work aims to gain new knowledge in the field of fundamental research in biomaterials engineering and will be an important step towards future applied research. They will also contribute to the development of young researchers and the dissemination of results internationally in high-impact journals.