The crucial role of X rays multiscale structural evaluation in tissue regeneration

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The main fibril-forming component in the extracellular matrix (ECM) is type I collagen. It provides mechanical support to tissues and organs; its distribution and organization is tissue-specific, depending on the bio-mechanical function of the tissue itself. From the molecular order, up to supramolecular scale, type I collagen is organized in triple helices assembled in fibrils and fibers, in accordance with a liquid crystalline arrangement at nanoscale. Thanks to its hierarchical structure and functional domains, collagen supplies physical support to cells attachment and growth, influencing tissue development. Type I collagen biocompatibility, bioactivity and biodegradability make this protein so attractive in tissue engineering, indeed it is a gold standard biomaterial for implantable medical devices. The extraction sources (bovine, equine, fish etc.) and treatments (chemical and/or enzymatic processes) are variable and lead to structural alteration of the fibrillary arrangement. Since most of the structural features of type I collagen were assessed by classic X-rays investigations during last decades[1,2], in our studies we demonstrate the worthwhile contribution of Wide and Small Angle X ray Scattering (WAXS, SAXS)[3] techniques in the structural evaluation of sub and supramolecular changes of the protein, during the biomaterial fabrication steps from fresh collagen-rich tissues to the final scaffolds (Figure 1). The evidences show the impact of processing conditions on both molecular scale and fibrillary arrangement at nanoscale. Moreover, our studied demonstrated how manufacturing protocols deeply affect the features of the biomaterial itself, and allow to screen the suitable protocols according to the tissue to regenerate[4,5].

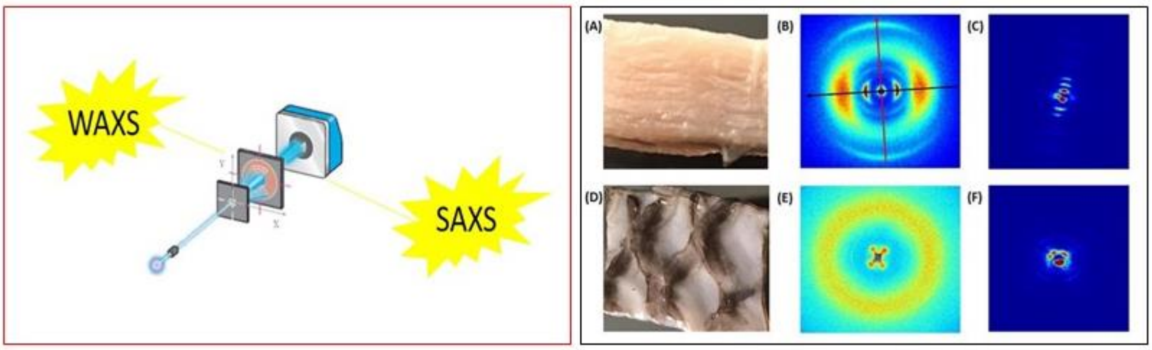

Figure 1. Left: a schematic representation of Wide-Angle X-ray Scattering (WAXS) and Small-Angle X-ray Scattering (SAXS) techniques. Right: X-rays analysis performed on collagen sources: equine tendon (A) and tilapia skin (D). WAXS and SAXS patterns are shown for equine tendon (B) (C) and tilapia skin (E) (F)

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