IJAE

Italian Journal of Anatomy and Embryology

Official Organ of the Italian Society
of Anatomy and Histology

75° Congresso della Società Italiana di Anatomia e Istologia
75TH Meeting of the Italian Society of Anatomy and Histology

Padova, 14-16 september 2022

IJAE
Vol. 126, n. 1 (Supplement): 150, 2022
ITALIAN JOURNAL OF ANATOMY AND EMBRYOLOGY

Anatomical and functional custom-made restoration techniques with Direct Metal Laser Forming technology

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In orthopedic and prosthetic craniomaxillofacial reconstructive surgery, the need to replace portions of anatomic bony tissue following the loss of the parts above for any injury or surgical resection attributable to another pathological cause is often required. In these patients, both morphological and functional aspects might be evaluated, leading to the evolution of the techniques used in the industrial manufacturing. During the past few years, scientific research in this area has been oriented towards using and implementing materials that would allow an active role of the bone surrounding the implant. In this regard, histological studies have shown that the porous surfaces of the grafts seem to have a wider interaction with bone cells, while retaining structural and mechanical properties similar to the surrounding bone. In particular, a range of porosity between 100 and 700 μm was shown as ideal for the purposes. The main problem regarding the morphological structure of the implant is linked to the mechanical alterations that the graft undergoes to present a suitable surface for the integration; it must avoid being excessively weakened by too numerous pores, and conventional construction methods of these systems do not seem to have satisfied the needs.

The aim of this research is to explore the use of Rapid Prototyping technology. Among the different systems, the Direct Metal Laser Forming (DMLF) technology allowed the building of structures of controlled porosity through a process of melting where a laser beam, controlled by a computer, can join tiny cells of metals, then creating the design of three-dimensional (3D) object layer by layer. This study shows how engineered grafts interact with the bone and their mechanical properties could help produce better, more efficient surgery. The novelty of this research is that bone structures can be produced with carefully controlled physical and mechanical properties, so that their strength and bone in-growth characteristics can be customized and optimized for the specific location being treated.

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