DEVELOPMENT OF AN ORTHOSIS PRINTED USING THERMOPLASTIC BIOPOLYMERS COUPLED WITH AN ELECTROSTIMULATOR OF COMBINED MAGNETIC FIELD

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SUMMARY

The occurrence of bone fractures has progressed globally proportionally to the increase in life expectancy of people. Advances in bone immobilization and regeneration techniques used in medical practice, however, progressed more slowly. The use of orthopedic plaster and fiberglass are still widely used materials, although they imply clinical complications. The additive manufacturing of 3D orthoses appears as a potential innovation, but it still has restrictions for its dissemination, mainly related to the difficulty of immobilization and modeling on the fracture. Furthermore, the use of electrostimulators to accelerate the osteogenic effect in the fracture region is an important practice to reduce treatment time. However, the majority of these devices has properties and dimensions that make it difficult to be used concomitantly with orthopedic immobilizers and for adherence within the daily life of patients. Thus, it was proposed in this work the development of an orthosis printed using thermoplastic biopolymers coupled with an electrostimulator of combined magnetic field (CMC). The objective was to create a system that has advantageous characteristics compared to those observed in technologies currently used for orthopedic immobilization and bone fracture regeneration. Thus, the printed orthosis was composed of two meshes, immobilization and fixation. The developed electrostimulator consisted of an electronic circuit and a mobile application. The project concept, including orthosis and electrical stimulator, were evaluated by health professionals specialized in orthopedics after the approval by the Research Ethics Committee (REC). The results obtained through these techniques indicated that the use of thermoplastic polyurethane (TPU) is indicated for the orthosis

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fixation. The immobilization mesh, in turn, must be composed of polylactic acid (PLA), as this has better typical mechanical resistance and lower Tg when compared to polyetyrene ethylene glycol terephthalate (PETG) and acrylonitrile butadiene styrene (ABS). Furthermore, no materials showed significant changes when exposed to chemical reagents in SEM analysis. ABS proved to be the only biopolymer in the wettability analysis with a hydrophobic surface. The CMC electrostimulator was able to apply the frequency of 76.6 Hz, identified in the scientific literature as favorable for the osteogenic effect. As well as their alternating and continuous fields strengths at values of 40 µT and 20 µT, respectively. There were no impacts on the field intensity by the biological tissue, indicating a relative magnetic permeability close to 1. The heating of the electrostimulator transducer reached 63.5°C, indicating that ABS was the most suitable for the manufacture of the transduction coil support from the studied polymers. The mobile application was completed, working seamlessly with a remote database. The electrostimulator could be integrated into the printed orthosis. The project concept was evaluated by 7 specialists in orthopedics, where 88.89% of the proposed characteristics for the orthosis and electrostimulator were considered relevant, indicating its innovative potential. Based on the results presented, it can be concluded that the design of the printed orthosis (PLA/TPU) with the coupled CMC electrostimulator has advantageous characteristics compared to those observed in currently used immobilization and bone regeneration systems.

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