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A polymeric implant for application in post-surgical resection of osteosarcoma

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ABSTRACT

Osteosarcoma is a malignant neoplasm of which there is osteoid formation by tumour cells. According to the American Cancer Society, osteosarcoma is prevalent in patients between the ages of 10 and 30 and those diagnosed with osteosarcoma over the age of 60, consist of 10% of the population afflicted. Surgery is a critical component in the treatment of osteosarcoma. Wide margin resections are standard in surgical treatment of osteosarcoma, therefore an osteotomy occurs, inducing a severe bone defect. Adjuvant chemotherapy is administered by IV after surgical removal of osteosarcoma to mitigate the risk of tumour micro metastases. The chemotherapeutic drugs are accompanied by severe side effects. To address the issue of a critical bone defect, the use of bone grafts and prosthetic devices (endoprosthesis or megaprosthesis), have been utilised. However, Osteosarcoma is mainly prevalent in adolescents, their growth poses a constant challenge to prosthetics and bone grafts have their own drawbacks. There is a need for customising implants for individual patients. To this end, this study focused on the development of a mouldable implants. The materials of these implants may have the ability to regenerate bone and provide localised drug delivery which may bypass the severe side effects of IV administered chemotherapeutics. Two hydrogel implants (one containing bioglass and the other without bioglass) were synthesised and compared. The polymers used were Alginate and Polyacrylamide. The hydrogel implants displayed great moulding ability when cast into different shapes and characterisation studies such as FTIR, XRD,TGA and DSC was conducted. Scaffolds containing bioglass initially possessed enough strength to match cancellous bone. Biomineralisation studies proved the formation of hydroxyapatite on the scaffold surface. Both hydrogel implants displayed ~20% of Doxorubicin released over 8 weeks. At 6 weeks, ALG-PAAM hydrogel implants degraded to 87,674% ± 5,042 of their original weight, while BG-ALG-PAAM hydrogel implants degraded to 86,528% ± 0,0987 of their original weight. Cell studies were conducted using MG-63 cells and proved that both scaffolds were non-cytotoxic and could facilitate cell adhesion. However, these hydrogel implants lacked the presence of pores from formation. Therefore, the same polymers were used to fabricate implantable scaffolds. These scaffolds were formed by lyophilisation and contained pores from formation. However, mechanical strength of these scaffold implants did not match the strength of bone and only two of the 5 criteria of the diamond concept were met in implantable scaffolds containing bioglass. Overall, it was concluded that BG-ALG-PAAM was better than the double network hydrogel without bioglass and had potential for application in Osteosarcoma as it met three of the five criteria mentioned in the diamond concept. Further research is needed to improve the scaffolds formed by lyophilization to meet at least three of the 5 criteria of the Diamond Concept.