Revitalization of human bone after extracorporeal high hydrostatic pressure treatment.

Abstract: Bone defects due to malignant tumor often lead to repeated surgery or amputation. Thus, a major objective in orthopedic surgery is the extracorporeal devitalization of tumor-bearing bone segments following reimplantation. Extracorporeal irradiation or autoclaving are possible methods even though they may cause severe loss of biomechanical and biological properties. Yet previous studies have shown that high hydrostatic pressure (HHP) allows for complete devitalization of tumor-afflicted bone segments, while the biomechanical and biological properties of bone tissue remained unchanged. The subject of the present study is revitalization of human bone segments after HHP treatment to acquire knowledge about the ingrowth and regeneration of osteoblast-like cells after such treatment. Bone pieces of 5 mm(3) were obtained from cancellous bone, taken from human femoral heads of 6 patients undergoing surgery for total hip arthroplasty, and exposed to hydrostatic pressure levels of 0, 300, and 600 MPa for 10 min at 37°C. Following the HHP treatment, bone segments were coated with primary human bone cells (10,000 cells/segment), cultured for 42 days and cell viability and proliferation quantified at different time points. An adhesion rate of 73.8% on day 1 and an increase in proliferation between day 14 and 42 were determined.
Pretreatment of bone segments with 300 and 600 MPa did not affect cell adhesion or proliferation. Histology showed intact cells and new bone formation on the bone specimens; elevated expression of alkaline phosphatase, osteocalcin, and collagen type I was seen by immunohistochemistry. The present study demonstrates, for the first time, the successful revitalization of HHP-treated bone segments. Concerning proliferation and osteogenic differentiation, the findings are a promising demonstration of sufficient osseointegration. Along with previous results, we anticipate that a pressure of a maximum 350 MPa does induce devitalization of malignant bone tumor segments, while HHP treatment of bone matrix up to 600 MPa does not affect osteoconductivity and osteoinductivity.

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