INTRODUCTION: PMMA bone cement has been being used for more than 4 decades. It has excellent workability and stability. However lack of bioactivity, exothermic reaction and monomer toxicity is the major limitations of this product.

In vertebroplasty, kyphoplasty and vasselplasty cement leakage may lead to thermal necrosis in spine. In the worst case, it can lead to paralysis. Therefore partial resorbable, low heat release bioactive bone cement can enhance the safety of vertebroplasty procedure. Osteo-G bone void filler has been developed and has been used in Europe for more than two years. New cement has low setting temperature, lower PMMA content and high radiopacity. The modified Osteo-G bone void filler contains strontium substituted hydroxyapatite that release strontium ion as osteoporosis local treatment agent. Since CaSO₄ resorption rate in PMMA may different from accelerate dissolution test, this will affect strontium ion release from the PMMA cement. From this study we optimized the CaSO₄ and strontium dose of this product.

MATERIALS AND METHOD: Before carry out rat implantation study; we have performed Hank immersion study to assess the bioactivity of Osteo-G bone void filler. The mechanical strength was tested by MTS 858 system.

10 rats (8 weeks) were assigned into two groups, Osteo-G group (5 rats) and PMMA control group (5 rats). Both tibias were drilled a hole of 1.5mm in diameter with mechanical drill. Saline was dropped to prevent overheating of bone tissue during drilling process. The marrow was removed by syringe suction to provide more room for cement insertion. At 5 weeks and 8 weeks the rats were analyzed by µCT system. Osteo-G bone void filler and PMMA cement volume was calculated by manual selection of interconnected radiopaque cement region within tibia. The difference was used to calculate the resorption rate of bone cement. 8 weeks after implantation, all rats were sacrificed. Rat tibias, femur were harvested from the fresh rat cadaver. Tibias were fixed, dehydrated and embedded in polymethylmethacrylate and epoxy resin. Epoxy resin was used to analyze the bone-cement interface to minimize loss of PMMA component within Osteo-G bone void filler, while PMMA embedded specimen was also used to analyze tetracycline label to avoid auto fluorescence problem of epoxy resin. The affinity index was taken as the perimeter with bony ingrowth / total bone – bone cement interface by backscatter SEM, S440 Cambridge. The residual amount of CaSO₄ was estimated by EDX method (Oxford Instruments). Fibrous tissue formation and inflammatory was assessed by histological examination with Giemsa and Eosin staining.

Data were expressed as mean ± SD. The significance of difference was determined using one-way analysis of variance (ANOVA). Difference with p value <0.05 was considered statistically significant.

RESULT: From Hank solution immersion test, presence of amorphous calcium phosphate layer was observed on SEM images indicate the Osteo-G bone void filler is bioactive. Compressive strength was 81.82±3.78MPa. A representative 3D visualization of tibia section with Osteo-G bone void filler at 5 and 8 weeks were shown in Fig. 1a and 1b.

DISCUSSION: From Hank solution study, strontium substituted hydroxyapatite and CaSO₄ release Ca²⁺ and Sr²⁺ lead to heterogeneous precipitation of amorphous calcium phosphate layer. The difference between resorption rate in rat tibia model and accelerated dissolution study is due to lower degree of polymerization of PMMA matrix within rat tibia. In addition the surface area to volume ratio is higher that favor more complete dissolution of CaSO₄. From histological study, resorption of CaSO₄ provides room for bony ingrowth on bone – bone cement interface. Compare with PMMA counterpart, absence of soft tissue layer in Osteo-G bone void filler was observed. The stimulatory effects of Sr treatment were confirmed by the increase in affinity index.

CONCLUSION: Compared with PMMA bone cement, Osteo-G bone void filler has acceptable resorption rate. The structure remained intact after 8 weeks of implantation. Lower setting temperature and compressive strength of bone cement reduce risk of thermal necrosis and adjacent column collapse in vertebroplasty application. Osteo-G bone void filler is one of the most acceptable partial resorbable cement with good clinical performance, due to its good osteoconductivity, control resorption rate, handling properties and acceptable mechanical strength.


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