IMPACT OF HUMAN SERUM ON HAP-GLUCAN COMPOSITE

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Introduction

Biomaterials for bone tissue regeneration, including polymer-based composites, are typically evaluated *in vitro* prior to the clinical trials. However, such composites tested *in vivo* may behave different due to the specific body conditions – for example, they may swell in acidified tissue liquids (due to the appearance of inflammation). This is likely for composite based on water-absorbing polymers, such as chitosan, starch or hyaluronic acid [1,2]. Such swelling of implanted biomaterials is likely to evoke side effects, for example to expand within bone defect. Massive swelling was observed for elastic HAp-glucan biocomposite for bone defects regeneration in inflamed (acidified) tissue [3]. To verify whether the composite swelling appears also in standard body environment, the composite was soaked in human serum of neutral pH. After the incubation, the changes in crucial physicochemical parameters of composite were evaluated.

Materials and Methods

Composite samples were synthesized as previously described [4] with a permission of Medical Inventi Ltd (owner of intellectual property for HAp/glucan composite). Composite samples (ø 5 mm and ø 13 mm) were sterilized in plastic/paper peel pouch (ethylene oxide method) and soaked in human serum of neutral pH (7.4) collected from healthy persons for 5 days at 37°C. Part of the samples was pre-soaked in Ringer solution for 30 min. Changes in weight and volume of samples in specified time points were measured. Then samples were subjected to evaluation of physicochemical parameters using different techniques (microCT, XRD, FTIR, mercury porosimetry, mechanical testing).

Results and Discussion

Relative weight and volume of composites presoaked in Ringer solution did not change significantly between the beginning and the end of soaking process. The changes varied maximum by 6% (relative weight) and 5% (relative volume). In contrast, more distinct changes in relative weight and volume of samples were observed for samples soaked exclusively in serum: maximum by 52% (relative weight) and by 16% (relative volume) (FIG. 1, 2). Microstructure, porosity, chemical composition and mechanical properties of the composite were not altered by neutral human serum after the incubation. The results suggest that pre-treatment in Ringer solutions prevents any undesired changes of biomaterial volume within the first period after the implantation.

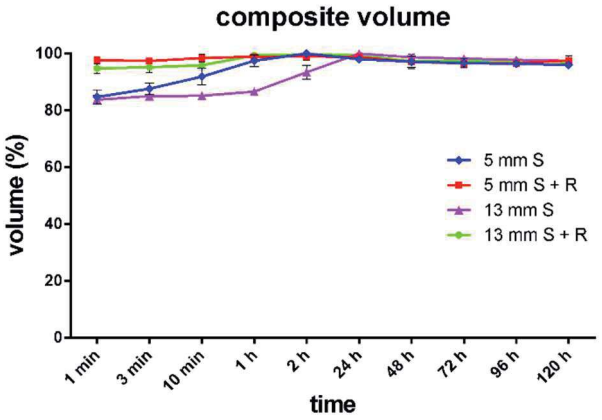

FIG. 1. Changes in composite volume (*source: L. Borkowski et al., J. Biomed. Mater. Res. Part B 2018, doi: 10.1002/jbm.b.34082*).

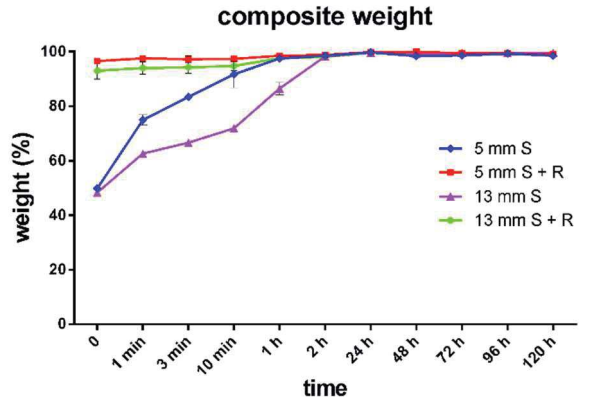

FIG. 2. Changes in composite weight (*source: L. Borkowski et al., J. Biomed. Mater. Res. Part B 2018, doi: 10.1002/jbm.b.34082*).

Conclusions

The results of HAp/glucan composite behaviour in media of neutral pH suggest that the composite swelling is size-dependent, time-limited (appear during up to 24 h of incubation) and that human serum penetrates the composite structure relatively slowly, in comparison with low-viscous media. Neutral pH of incubation medium allows to prevent the excessive increase of composite volume. Pre-incubation in Ringer solution (protein-free medium) protects the composite against undesirable swelling. Therefore, presoaking of the composite prior to the implantation (for example in saline or drug solution) is highly recommended to reduce the risk of post-operative side effects.

Acknowledgments

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References

[1] J. Ai et al., J. Nanomater. 2011 (2011) 1-5.
[2] W. Tachaboonyakiat et al., Polym. J. 33 (2001) 177-181.
[3] L. Borkowski et al., J. Biomed. Mater. Res. B. Applied Biomater. 105 (2017) 1178-1190.
[4] A. Belcarz et al., Centr. J. Eur. Biol. 8 (2013) 534-548.