An empirical model linking physico-chemical biomaterial characteristics to intra-oral bone formation

Created on: 08-06-2023 - Last modified on: 08-06-2023

SCOPE OF THE METHOD

The Method relates to	Animal health, Human health
The Method is situated in	Basic Research
Type of method	In silico
This method makes use of	Animal derived cells / tissues / organs
Species from which cells/tissues/organs are derived	bilateral sinus lift procedures in rabbits
Type of cells/tissues/organs	Intra-oral bone region

DESCRIPTION

Method keywords

Empirical modeling
intra-oral bone formation
calcium phosphate
physico-chemical
biomaterials

Scientific area keywords

Bone tissue engineering
Intra-oral bone regeneration
insilico medicine
physico-chemical characterization
scaffold design

Method description

This empirical model is used to assess the weighted value of driving biomaterials properties in the intra-oral bone regeneration process. We used partial least square regression (PLSR) to construct empirical models that relate combinations of (quantified) biomaterial characteristics to intra-oral bone regeneration outcomes across diverse types of bone biomaterials. This computational method uses linear correlation to reduce the dispersion of a multi-variate data set by identifying the most important information from the original data set.

Lab equipment

Any characterization method that provides a quantified physico-chemical specification of scaffolds (e.g. mechanical characterization, surface roughness analysis, macroporosity measurement, etc.).

Method status

Internally validated

PROS, CONS & FUTURE POTENTIAL

Advantages

The model provides a way to identify driving biomaterial properties and morphological cues of the intra-oral bone healing process as well as predict the bone regeneration potential of new biomaterials based on their physico-chemical characteristics.

Challenges

The model should be fed with the quantified characteristics of scaffolds obtained from high-quality characterizations.

Modifications

More samples with a wider range of physico-chemical characteristics would further increase the robustness of the model.

Future & Other applications

Biological agents (drugs, growth factors, etc.) could be drawn into the analysis in future research. The interplay between physico-chemical biomaterial factors and biological ones could also be assessed quantitatively for the intra-oral bone biomaterials. This model can be also applied to other areas of tissue engineering.

REFERENCES, ASSOCIATED DOCUMENTS AND OTHER INFORMATION

References

1- E. Sadeghian Dehkord, G. Kerckhofs, P. Compère, F. Lambert, L. Geris, An empirical model linking physico-chemical biomaterial characteristics to intra-oral bone formation (to-be-submitted)
2- G. Kerckhofs, Y.C. Chai, F.P. Luyten, L. Geris, Combining microCT-based characterization with empirical modelling as a robust screening approach for the design of optimized CaP-containing scaffolds for progenitor cell-mediated bone formation, Acta Biomater. 35 (2016) 330–340. https://doi.org/10.1016/j.actbio.2016.02.037.
3- S.J. Roberts, L. Geris, G. Kerckhofs, E. Desmet, J. Schrooten, F.P. Luyten, The combined bone forming capacity of human periosteal derived cells and calcium phosphates, Biomaterials. 32 (2011) 4393–4405. https://doi.org/10.1016/j.biomaterials.2011.02.047.
4- J. Bolander, W. Ji, L. Geris, V. Bloemen, Y.C. Chai, J. Schrooten, F.P. Luyten, The combined mechanism of bone morphogenetic protein- and calcium phosphate-induced skeletal tissue formation by human periosteum derived cells, Eur Cell Mater. 31 (2016) 11–25. https://doi.org/10.22203/ecm.v031a02.
5- W. Ji, G. Kerckhofs, C. Geeroms, M. Marechal, L. Geris, F.P. Luyten, Deciphering the combined effect of bone morphogenetic protein 6 and calcium phosphate on bone formation capacity of periosteum derived cells-based tissue engineering constructs, Acta Biomater. 80 (2018) 97–107. https://doi.org/10.1016/j.actbio.2018.09.046.

Associated documents

Other remarks

Designing the optimized bone graft for intra-oral applications involves many parameters that directly affect the bone regeneration rate in the defect site. Thus, in order to obtain the optimal scaffold design for a specific application, more insight should be achieved into the influence of biomaterials characteristics on the regeneration process.

PARTNERS AND COLLABORATIONS

Organisation

Name of the organisation University of Liège (ULiège)

Department GIGA in silico medicine

Specific Research Group or Service Biomechanics Research Unit

Country Belgium

Coordinated by

Financed by