

A new tissue-engineered product indicated for bone reconstruction: a proof-of-concept

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3D-SIDE
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PURPOSE

Critical-size bone defects remain challenging situations in orthopedics. It occurs after trauma, infection or cancer resections, and need the use of grafts. The difficulties of the treatment of massive bone defects are related to **reconstruction of a large bone segment** (1). The gold standard is bone grafting with autologous bone graft, but available quantities are limited and the harvesting procedure is burdened by comorbidities (2).

The treatment may also combine bone allografts and osteoinductive materials such as **bone morphogenetic proteins 2 (BMP-2)** to promote repair of bone defects. In the literature, studies demonstrated the efficacy of BMPs in enhancing bone growth (3).

- ▶ To design **slow resorption patient-specific bone graft** whose properties of bone regeneration are increased by its geometry and composition
- ▶ To assess it in **in-vitro** and **in-vivo models**

METHODS



- Hydroxyapatite (HA) and β -TCP
- Cylinder with 3D gyroid porosities and 7 mm medullary space based on swine's anatomy.
- Produced using a stereolithography 3D-printing machine (V6000, Prodways).

Immersion in a BMP2 solution (10 μ g/mL)
or saline (CTRL)

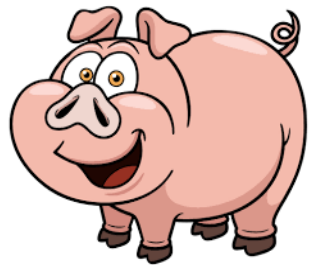


► In vitro cell culture : with osteoblast

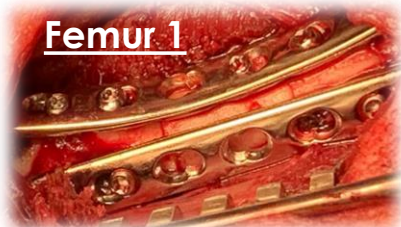
► In vivo : in minipig femur

METHODS

► In vivo



Surgery on both femur
(critical-sized bone defect)



Femur 1

Scaffold + rhBMP2



Femur 2

Scaffold alone

- Blood test/ week



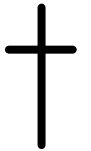
- RX/2 weeks



- CT/6 weeks



- Non-decalcified histology
- Micro-CT scan

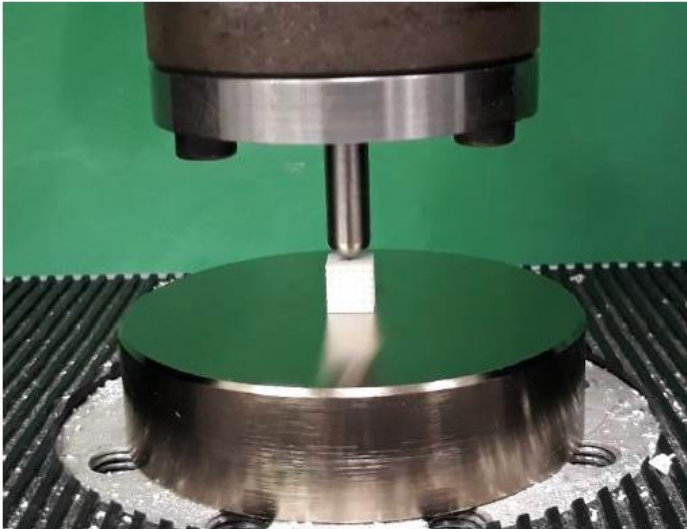


RESULTS

► In vitro

3D scaffolds composition : 80% HA and 20% β -TCP ($\pm 5\%$)

Indentation compressive strength : 4.14 MPa



Bending strength : 11.8MPa

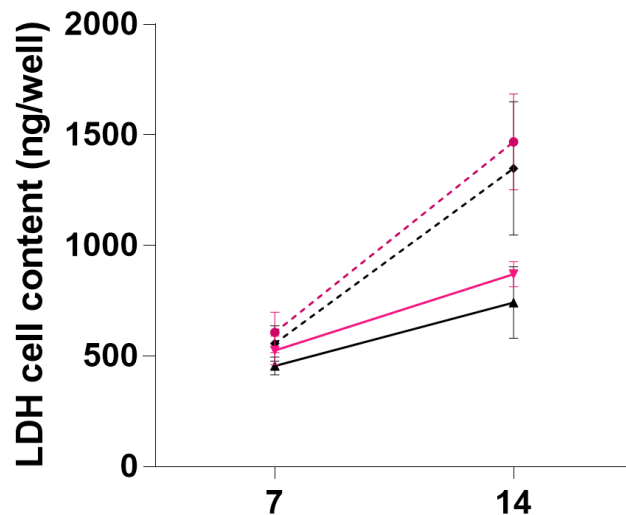


RESULTS

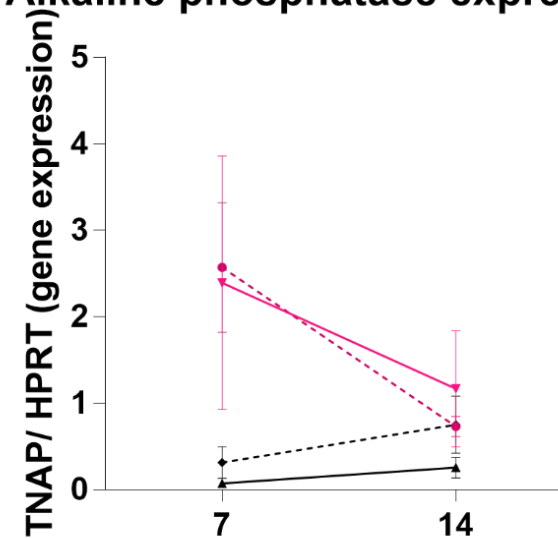
▶ In vitro

- ▶ Excellent viability
- ▶ No impact of rhBMP2
- ▶ $<0,01$ with vs without BMP2 at 7 days (ALP and COL1A1)
- ▶ NS at 14 days

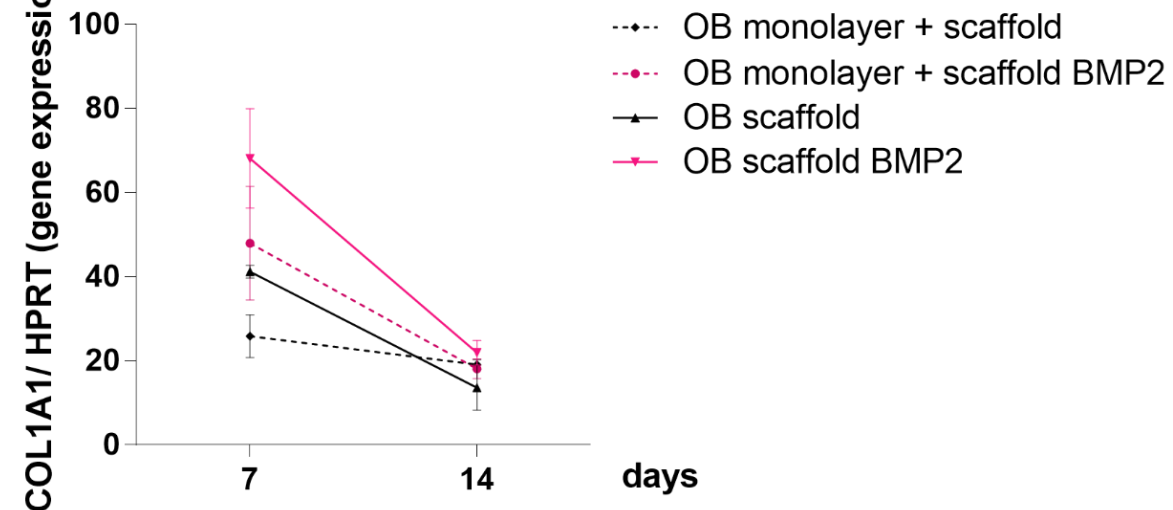
Viable cells



Alkaline phosphatase expression



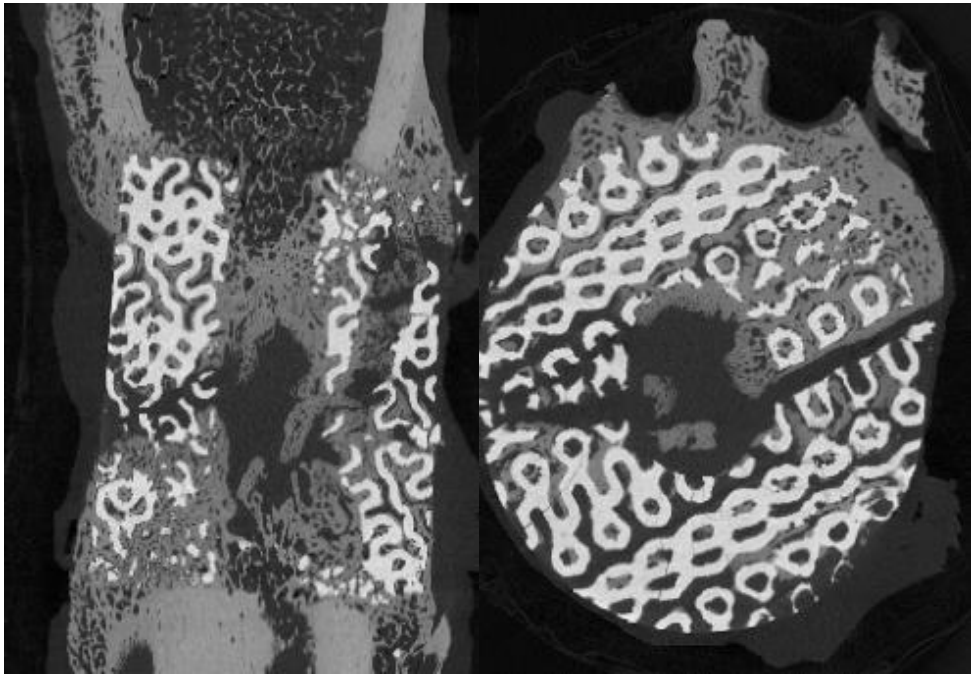
Type I collagen expression



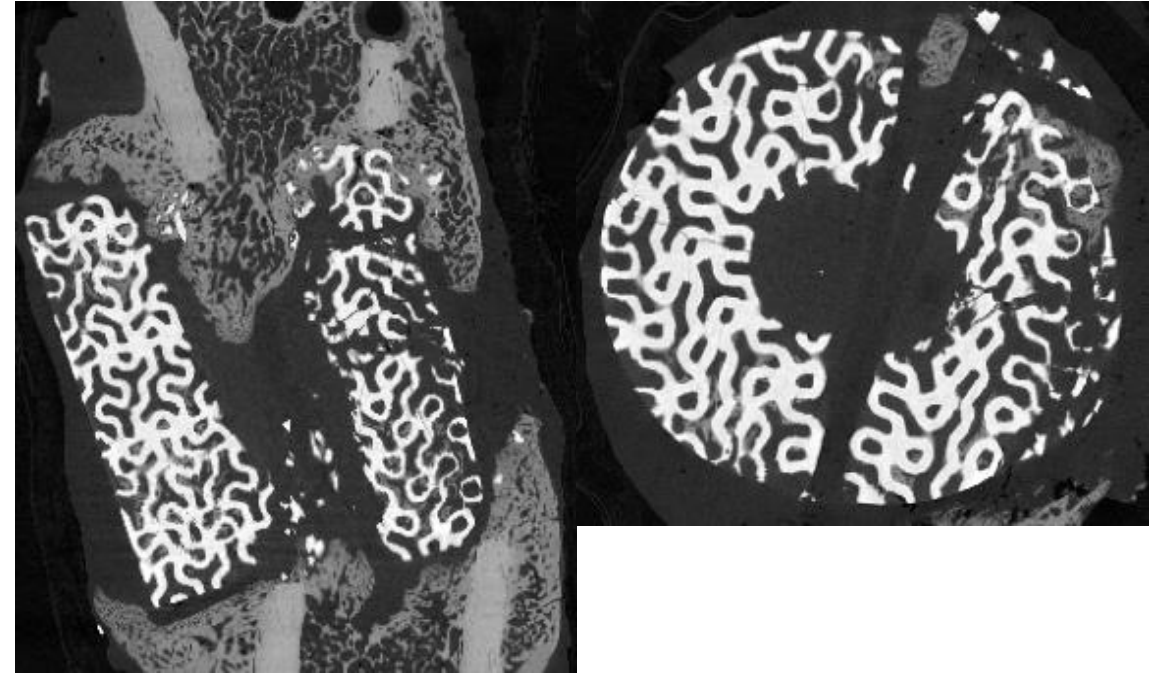
RESULTS

► In vivo

- Surgery pig 1 : Ex-vivo analysis (microscan)



- Left femur (scaffold + BMP2)



- Right femur (scaffold alone)

CONCLUSIONS

BMP2-impregnated bone graft is a promising patient-personalized 3D-printed solutions for bone defect regeneration

- ▶ Promoting neighboring host cells recruitment
- ▶ Solid new bone formation

REFERENCES

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