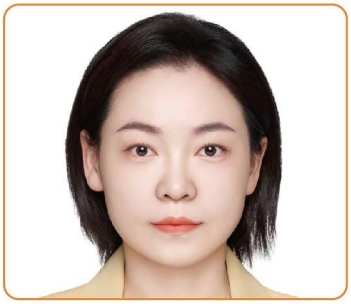
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Fibrin-konjac glucomannan-black phosphorus hydrogel scaffolds loaded with nasal ectodermal mesenchymal stem cells accelerated alveolar bone regeneration

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Abstract:

Background Effective treatments for the alveolar bone defect remain a major concern in dental therapy. The objectives of this study were to develop a fibrin and konjac glucomannan (KGM) composite hydrogel as scaffolds for the osteogenesis of nasal mucosa-derived ectodermal mesenchymal stem cells (EMSCs) for the regeneration of alveolar bone defect, and to investigate the osteogenesis-accelerating effects of black phosphorus nanoparticles (BPNs) embedded in the hydrogels.

Methods Primary EMSCs were isolated from rat nasal mucosa and used for the alveolar bone recovery. Fibrin and KGM were prepared in different ratios for osteomimetic hydrogel scaffolds, and the optimal ratio was determined by mechanical properties and biocompatibility analysis. Then, the optimal hydrogels were integrated with BPNs to obtain BPNs/fibrin-KGM hydrogels, and the effects on osteogenic EMSCs in vitro were evaluated. To explore the osteogenesis-enhancing effects of hydrogels in vivo, the BPNs/fibrin-KGM scaffolds combined with EMSCs were implanted to a rat model of alveolar bone defect. Micro-computed tomography (CT), histological examination, real-time quantitative polymerase chain reaction (RT-qPCR) and western blot were conducted to evaluate the bone morphology and expression of osteogenesis-related genes of the bone regeneration.

Results The addition of KGM improved the mechanical properties and biodegradation characteristics of the fibrin hydrogels. In vitro, the BPNs-containing compound hydrogel was proved to be biocompatible and capable of enhancing the osteogenesis of EMSCs by upregulating the mineralization and the activity of alkaline phosphatase. In vivo, the micro-CT analysis and histological evaluation demonstrated that rats implanted EMSCs-BPNs/fibrin-KGM hydrogels exhibited the best bone reconstruction. And compared to the model group, the expression of osteogenesis genes including osteopontin (Opn, $p < 0.0001$), osteocalcin (Ocn, $p < 0.0001$), type collagen (Col , $p < 0.0001$), bone morphogenetic protein-2 (Bmp2, $p < 0.0001$), Smad1 ($p = 0.0006$), and runt related transcription factor 2 (Runx2, $p < 0.0001$) were all significantly upregulated.

Conclusions EMSCs/BPNs-containing fibrin-KGM hydrogels accelerated the recovery of the alveolar bone defect in rats by effectively up-regulating the expression of osteogenesis-related genes, promoting the formation and mineralisation of bone matrix.

Keywords Fibrin, Konjac glucomannan, Black phosphorus, Ectodermal mesenchymal stem cells, Alveolar bone defect

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Biography

Ms. Yin Zou, MDS, graduated from Nanjing Medical University in2012, has been working at Wuxi Children's Hospital for over ten years. She has also undergone a one-year advanced training at the Ninth People's Hospital affiliated to Shanghai Jiao Tong University School of Medicine. Her main professional focus is on orthodontics and pediatric dentistry, and she collaborates with Jiangnan University on research into the functional regulation of stem cells.

About Research Topic

Our previous study showed that bone-like grafts loaded with EMSCs presented good repair effects for cranial defects. However, it remains unknown whether nasal mucosa derived EMSCs can be used as seed cells to effectively repair alveolar bone damage. Therefore, nasal mucosa derived EMSCs were applied to alveolar bone defects to verify the repair potential. In addition to seed cells, bone substitutes required bioactive scaffolds to realise their osteogenic potential. Fibrin scaffolds carrying MSCs possessed considerable potential for application in bone repair and regeneration, and the addition of KGM may slow down the degradation of fibrin hydrogels and form an appropriate extracellular environment for the growth and proliferation of stem cells.

About Institution:

Wuxi Children's Hospital, also known as Affiliated Children's Hospital of Jiangnan University, is a tertiary-level children's hospital located in Wuxi City, Jiangsu Province, China. Established in June 2000, it integrates medical treatment, teaching, research, prevention, and health care. The hospital is recognized as a provincial-level "Baby-Friendly Hospital," one of the first pediatric drug clinical trial institutions in Jiangsu Province, and a provincial base for the early development of children aged 0-6. It serves as the core unit of the Wuxi Pediatric Medical Alliance and undertakes clinical teaching and postgraduate training for pediatrics at Jiangnan University and Nanjing Medical University.

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