Session: Biomaterials and Implants

28. EFFECT OF NOTOGINSENOSIDE R1 ON OSTEOBLASTOGENESIS IN VITRO
Yi Liu a, Zhen Linb, Jing Guoc, Jianzhi Chend, Gang Wua
aDepartment of Oral Implantology and Prosthetic Dentistry, Academic Center for Dentistry (ACTA), Research Institute MOVE, VU University and University of Amsterdam, The Netherlands
bDepartment of Spinal Surgery, Nanfang Hospital, Southern Medical University, Guangzhou, China
cDepartment of Oral Cell Biology, Academic Center for Dentistry (ACTA), Research Institute MOVE, VU University and University of Amsterdam, The Netherlands
dSchool of Stomatology/Hangzhou Dental Hospital, Zhejiang Chinese Medical University, Hangzhou, China

Introduction: Notoginsenoside R1 (NGR1), one of the main effective components of Panax notoginseng (PNS) [1]. PNS could improve the development of osteoblasts [2,3]. These findings suggested that some effective components in PNS possess an application potential in clinic to promote osteogenesis. Notoginsenoside R1 (NGR1) is one of the main constituents of PNS. Unlike other pharmacologically active saponins in both PNS and other ginsengs, NGR1 existed only in PNS [4,5]. However, hitherto, whether NGR1 can directly affect osteoblastogenesis remains to be elucidated.

Materials and Methods: We hereby assessed the effects of NGR1 (Nanjing Jiancheng Company, China) on the osteoblastogenesis of a pre-osteoblast cell line (MC3T3-E1 cell line, subclone 14, ATCC Cell Bank, Shanghai) in an in-vitro time-course and dose-dependent study. We applied 5 μg/ml, 50 μg/ml, 100 μg/ml, 200 μg/ml, 1000 μg/ml NGR1 to evaluate the efficacy by assessing cell viability (indicator for proliferation), alkaline phosphatase (ALP) activity (a marker for an early osteoblastic differentiation), osteocalcin (a marker for a late osteoblastic differentiation), calcium deposition (a marker for final mineralization) and the expression of a series of osteoblastogenic genes (such as Collagen Iα, Runx2, ALP and osteocalcin).

Results: The effect of NGR1 on cell proliferation exhibited a bell-shape dose-dependent pattern. A significant increase in the cell numbers was detected under the treatment of 50 μg/ml NGR1. Similar to its effect on cell proliferation, NGR1 also exhibited a bell-shape dose-dependent pattern in modulating ALP activity. NGR1 ranging from 5 μg/ml to 200 μg/ml could significantly enhance ALP activity with a peak occurring at 50 μg/ml, while 1000 μg/ml NGR1 did show significant modulating effect in comparison with control. However, NGR1 showed a dose-dependent increasing pattern in promoting OCN expression. Cell matrix mineralization and expression of OCN mRNA, 1000 μg/ml NGR1 showed a highest efficiency. Furthermore, 1000 μg/ml NGR1 resulted in the highest mineralization 4.3 folds and 5.9 folds on the 21st and 28th day respectively compared with the control group.

Conclusion: NGR1 exhibited a bell-shape dose pattern in promoting the proliferation and ALP activity of pre-osteoblasts. NGR1 could markedly increase the expression of osteocalcin and mineralization in a dose-dependent pattern. In conclusion, NGR1 could significantly promote the osteoblastogenesis of pre-osteoblasts, which suggested a promising application potential for bone regeneration.

References:

44. BIODEGRADABLE MAGNESIUM INTERFERENCE SCREWS ACCELERATE MINERALIZATION OF FIBROUS TISSUE AT THE TENDON–BONE INSERTION IN ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION MODEL OF RABBIT
Jia-li Wang, Jian-kun Xu, Patrick Shu-hang Yung, Kai-ming Chan, Ling Qin
Department of Orthopaedics and Traumatology, The Chinese University of Hong Kong, Hong Kong, China

Background: The incorporation of tendon graft into bone tunnel is one of the most challenging clinical issues in anterior cruciate ligament (ACL) reconstruction. As a biodegradable metal, magnesium (Mg) has appropriate mechanical strength and shows osteoinductive effects, thus may be a promising alternative to currently commercialized products used for fixation and improving graft healing quality. We hypothesized that the use of Mg-based interference screws would promote tendon graft–bone junction healing when compared to commercial titanium (Ti) screws.

Methods: This was a controlled laboratory study. A total of 96 rabbits were used for ACL reconstruction surgery using Mg or Ti interference screws and suture for fixation of long digital extensor tendon autograft in femoral and tibial tunnels, respectively. Animals were sacrificed at 3, 6, 12 and 16 weeks postoperatively to harvest femur–tendon graft–tibia complex (FTGTC) for histological analysis and mechanical tests. High resolution peripheral quantitative computed tomography (HR-pQCT) was applied to measure changes in peri-tunnel bone volume/density and tunnel area at femoral side and the apparent volume of Mg screws during the entire experimental period. Eight randomly selected animals from either the Mg or Ti group were used for histological examination at each time point and the remaining 32 FTGTC samples in both Mg and Ti groups assigned at week 12 and 16 underwent tensile tests.

Results and Discussion: Compared to the Ti group, more fibrous tissue was present in the interface bridging tendon graft and bone tunnel surface in the Mg group after surgery. The semi-quantitative scoring evaluation for graft healing quality indicated that tendon graft–bone junction healing may last over 12 weeks. The mineralization in fibrous tissue at graft enthesis was initiated earlier in the Mg group (12 weeks vs. 16 weeks in Ti group). Importantly, the mineralized fibrous tissue area was significantly increased after the use of Mg screws at 16 weeks postoperatively (27.1 ± 10.4 mm²/µm vs. 12.1 ± 3.9 mm²/µm, p < 0.05). Approximately 10% loss in the apparent volume was detected in biodegradable Mg screws after 16 weeks. However, the degradation of Mg screws did not induce significant changes in bone tunnel diameter during the entire experimental period via CT imaging. The peri-tunnel bone volume decreased over 25% in both Mg and Ti groups at week 16 after reconstruction. In tensile testing, the failure mode was at the midsubstance close to the tibial tunnel’s entrance while the maximal load to failure, stress, stiffness and energy of FTGTC showed no significant differences between Mg and Ti groups at both 12 and 16 weeks after surgery.