Hydroxyapatite (HA), HA/Berberine, and HA/Moghat Nano- composites promote the bone regeneration of stressed bone defect area enforced by Cellulose Acetate fibers in rabbit model.

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Abstract

There are numerous cases involving extended periods of bone repair and healing due to several factors, including foreign bodies, infection, continuous stress at the trauma site, or systemic disorders. Nowadays, various biomaterials are available to promote and accelerate bone healing and its regeneration for defected bone areas and osteoplastic surgery, such as hydroxyapatite. **The purpose of this study** was to evaluate preclinically the efficacy and effectiveness of nanocomposites of hydroxyapatite alone or mixed with Berberine or Moghat on bone defected areas suffering from malfunctioning bone closure due to the presence of cellulose acetate (CA) mass as a foreign body in a rabbit animal model. **Methodology**: Thirty-five New Zealand male rabbits with an average weight of 3 kg were utilized. The rabbits were divided into 5 groups, each consisting of 7 rabbits. The first group had a bone defect (tibial bone defect with an average diameter of 2mm). The second group had a bone defect and was exposed to a CA mass, where the CA mass was embedded in the defective area entirely as a stress factor to prevent cell migration and the healing process. From the third group to the fifth one, the stressed bone defect rabbits were treated with HA, HA/Berberine, or HA/Moghat nanocomposites for 10 weeks. Defected bone healing was evaluated at the 6th and 10th week by X-ray. CT scanning was used to measure the bone intensity at the end of the experiment. Bone remodeling markers were measured at biochemical and molecular levels, including osteocalcin, TRAcP, calcium, alkaline phosphatase, MAPK p38, PARP-gamma, PTH, CD90, ADPH, Runx2, Wnt1, Wnt5, Beta-catenin, Cola1, OPG, RANKl, Osterix, and SOST. Finally, histopathological sections were evaluated at the end of the experiment using H&E stain. **The obtained results** showed that at the 10th week, the CA mass retarded the bone healing process as it prevented complete healing under normal conditions. While the treatment with scaffolds containing HA, HA/Berberine, and HA/Moghat showed different behavior in the bone healing process and bone defect closure, which was evident in the X-ray and CT scanning results. Both HA/Berberine and HA/Moghat showed higher bone intensity for the newly formed bone at the defected area when compared with HA alone. The histopathological findings, biochemical, and molecular investigations proved the efficacy of both combined composites as effective bone healing scaffolds and supported the X-Ray and CT scan results. Therefore, we can **conclude** that HA/Berberin and HA/Moghat nano-composites are considered alternative biomaterial composites with a potential role for biomedical applications in the field of bone tissue engineering.

Image

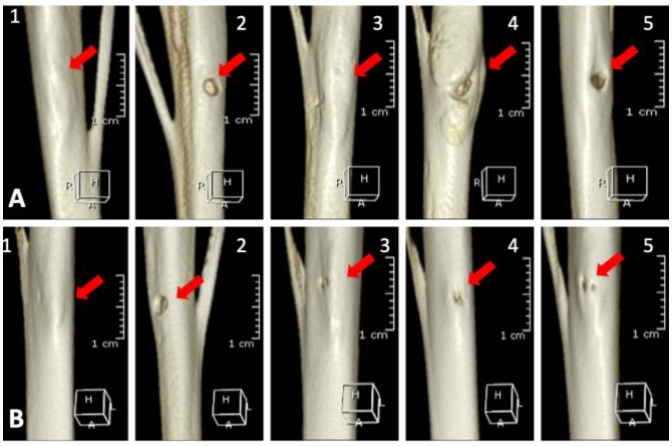


Fig.1: CT scan for defected bone area at A) 6th week post operative showed callus size and formation while B) 10th week showed bone healing and defect closure at 1) normal defect without stress, 2) CA stress factor, 3) CA/ HA , 4) CA/HA/BB , and 5) CA/HA/MO

Recent Publications

1. Shaban, N. Z., Kenawy, M. Y., Taha, N. A., Abd El-Latif, M. M., & Ghareeb, D. A. (2021). Cellulose acetate nanofibers: Incorporating hydroxyapatite (HA), HA/berberine or HA/moghat composites, as scaffolds to enhance in vitro osteoporotic bone regeneration. Polymers, 13(23), 4140.
2. Gimenes, R., Zaghete, M. A., Espanhol, M., Sachs, D., & Silva, M. R. A. (2019). Promotion of bone repair of rabbit tibia defects induced by scaffolds of P (VDF-TrFE)/BaTiO 3 composites. Bulletin of Materials Science, 42(5), 235.
3. Seman, C. N. Z. C., Zakaria, Z., Sharifudin, M. A., Ahmad, A. C., Awang, M. S., Yusof, N. M., & Buyong, Z. (2018). Model of a critical size defect in the new zealand white rabbit's tibia. IIUM Medical Journal Malaysia, 17(1).
4. Abedi, G., Jahanshahi, A., Fathi, M. H., Haghdost, I. S., & Veshkini, A. (2014). Study of nano-hydroxyapatite/zirconia stabilized with yttria in bone healing: histopathological study in rabbit model. Polish Journal of Pathology, 65(1), 40-47.



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