滋阴补肾中药通过巨噬细胞和骨髓间充质干细胞的交互作用促进腱骨愈合的研究进展Δ

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摘　要　巨噬细胞和骨髓间充质干细胞（BMSCs）的交互作用在调节腱骨愈合过程中发挥着重要作用。基于“肾在体合骨，生髓”的中医理论，现代药理学研究发现滋阴补肾中药可促进BMSCs向成骨细胞分化、巨噬细胞由M1型向M2型极化，进而促进腱骨愈合。多种滋阴补肾的中药单体（如薯蓣皂苷、齐墩果酸等）、中药提取物/有效部位（如人工虎骨粉、骨碎补总黄酮等）和中药复方（如六味地黄丸、续筋接骨液、独活寄生汤等）可通过调控Wnt/β-连环蛋白信号通路、核因子κB信号通路、磷脂酰肌醇3激酶/蛋白激酶B/雷帕霉素靶蛋白信号通路、转化生长因子β/Smad信号通路等诱导巨噬细胞和BMSCs的交互作用，并进一步发挥抗炎、抗氧化和促进骨形成等作用，从而有效促进腱骨愈合。但目前证据限于多为动物实验，存在模型与临床损伤类型适配性不足、单一通路研究为主、活性成分不清等局限。未来学者可通过完善动物模型及大样本随机对照试验，解析多通路之间的交叉网络并分离滋阴补肾中药的核心活性物质，以推动中药精准化应用。

关键词　腱骨愈合；滋阴补肾；巨噬细胞；骨髓间充质干细胞；交互作用；信号通路

Research progress on the regulation of macrophage-bone marrow mesenchymal stem cell interactions by yin-nourishing and kidney-tonifying Chinese herbal medicines to promote tendon-bone healing

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ABSTRACT　The crosstalk between macrophages and bone marrow mesenchymal stem cells (BMSCs) plays a vital role in regulating tendon-bone healing. Based on the traditional Chinese medicine (TCM) theory that the kidney governs the bones and generates marrow, yin-nourishing and kidney-tonifying Chinese medicines can promote the osteogenic differentiation of BMSCs and the M1-to-M2 polarization of macrophages, thereby facilitating tendon-bone healing. A variety of related medicinal monomers (such as diosgenin and oleanolic acid), extracts and effective fractions (such as artificial tiger bone powder and total flavonoids of *Drynaria fortunei*), as well as compound prescriptions (such as Liuwei dihuang pill, Xujin jiegu decoction and Duhuo jisheng decoction), can modulate the crosstalk between macrophages and BMSCs by regulating the Wnt/β-catenin, nuclear factor kappa-B, phosphatidylinositol 3-kinase/protein kinase B/mammalian target of rapamycin and transforming growth factor-β/Smad signaling pathways. They further exert anti-inflammatory, antioxidant and osteogenic effects to effectively accelerate tendon-bone healing. However, current evidence

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