Bone Morphogenetic Proteins: Promising Molecules for Bone Healing, Bioengineering, and Regenerative Medicine

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Bone morphogenetic proteins (BMPs), glycoproteins secreted by some cells, are members of the TGF-β superfamily that have been implicated in a wide variety of roles. Currently, about 20 different BMPs have been identified and grouped into subfamilies, according to similarities with respect to their amino acid sequences. It has been shown that BMPs are secreted growth factors involved in mesenchymal stem cell differentiation, also being reported to control the differentiation of cancer stem cells. BMPs initiate signaling from the cell surface by binding to two different receptors (R: Type I and II). The heterodimeric formation of type I R and II R may occur before or after BMP binding, inducing signal transduction pathways through SMADs. BMPs may also signal through SMAD-independent pathways via mitogen-activated protein kinases (ERK, p38MAPKs, JNK). BMPs may act in an autocrine or paracrine manner, being regulated by specific antagonists, namely: noggin and chordin. Genetic engineering allows the production of large amounts of BMPs for clinical use, and clinical trials have shown the benefits of FDA-approved recombinant human BMPs 2 and 7. Several materials from synthetic to natural sources have been tested as BMP carriers, ranging from hydroxyapatite, and organic polymers to collagen. Bioactive membranes doped with BMPs are promising options, acting to accelerate and enhance osteointegration. The development of smart materials, mainly based on biopolymers and bone-like calcium phosphates, appears to provide an attractive alternative for delivering BMPs in an adequately controlled fashion. BMPs have revealed a promising future for the fields of Bioengineering and Regenerative Medicine. In this chapter, we review and discuss the data on BMP structure, mechanisms of action, and possible clinical applications.