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Editorial

The Arrival of Synthetic Bone Grafts with Osteoinductive Potential

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Bone grafting materials have played a pivotal role in modern dentistry. Used to fill bone defects and to augment missing or lost bone, a wide variety of bone grafts are now available including autogenous bone from the same donor, allografts harvested from human donors, xenografts harvested from an animal donor and a wide variety of synthetically fabricated bone grafts made from hydroxyappatite, tri-calcium phosphate, biphasic calcium phosphate and bioactive glasses. Bone grafts are typically characterized by their potential for osteoconduction, osteoinduction and osteogenesis. Osteoconduction refers to the grafts ability to serve as a 3-dimensional scaffold for cell proliferation and tissue in-growth. Osteoinductions refers to the ability for the graft to favour the recruitments of mesenchymal progenitor cells and spontaneously auto-induce their differentiation down the osteoblast lineage. Osteogenesis refers to the ability for the graft to contain living progenitor cells within its matrix. Not surprisingly autogenous bone is considered the gold standard for bone grafting procedures due to its excellent combination of these 3 properties.

More recently, numerous attempts have been conducted in order to avoid the drawbacks of harvesting autogenous bone which include donor site morbidity and additional surgical time and costs. While the majority of bone grafts are unable to repeat the predictable success of implanting autogenous bone to defect sites, recently the development of novel bone grafting materials sintered at low temperature fabricated from biphasic calcium phosphates (BCP) reveal some form of osteoinduction [1,2].

Most of the field of osteoinduction is credited to have been derived from Marschall Urist in the mid 1960s [3]. In his classic study in 1965, he defined the term 'autoinduction' after studying the ability for demineralised bone matrix to induce ectopic bone formation in extraskeletal locations in rabbits, dogs and rats [3]. He later described osteoinduction as "the mechanism of cellular differentiation towards bone of one tissue due to physicochemical effect or contact with another tissue" [4]. Other investigators were also quick to create a definition for what they were observing in their experimental protocols. A year later, Friedenstein redefined osteoinduction as the "induction of undifferentiated inducible osteoprogenitor cells that are not yet committed to the osteogenic lineage to form osteoprogenitor cells" following numerous studies in transitional epithelium [5]. Further research on osteoinduction by Urist and Reddi later revealed that low-molecular weight proteins extracted from demineralized bone matrix, termed bone morphogenetic proteins (BMPs), showed more osteogenic activity than DBM alone. As defined by Urist in 1970, osteoinduction is "the process of recruitment of mesenchymal-type cells into cartilage and bone under the influence of a diffusible bone morphogenetic protein" [6]. Today, nearly 30 BMPs have been identified and most date back to the 1970s when the field of osteoinductive research was at its peak.

Over the next 40 or so years, the field of osteoinductive bone grafts has progressed rather slowly. Autogenous bone has remained the gold standard and various commercially available demineralised bone matrix grafts with osteoinductive potential were originally characterized in the late 1960s and early 1970s. Only recently have synthetic bone grafts

fabricated from various calcium phosphate (CaP) ceramics sintered at low temperatures been reported to form ectopic bone formation [1,2]. Furthermore, when these grafts were implanted in bone defects created in dogs or sheep, the bone healing capabilities were comparable to autogenous bone [1,2]. Despite these positive results, the ability for novel basic calcium phosphate scaffolds to induce bone formation as effectively as autogenous bone remains questionable [7]. Two of the main material factors described to contribute to their bone formation properties are microporosity and dissolution rate [8]. While our laboratories have recently been extremely interested in these synthetic bone grafts, much research remains to unlock the mechanisms by which these grafts are able to promote bone formation versus previous versions of synthetically fabricated bone grafts [9]. Although the future field of bone grafting materials worldwide will face many upcoming challenges, these positive results demonstrate the potential for improved healthcare in the field of bone grafting due to the ability to fabricate in large quantities osteoinductive bone grafts that are 100% derived from synthetic materials.

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