Osteobiologics for spine fusion: A continuing dilemma

Spine fusions are being performed exorbitantly and remain gold standard for several pathologies of spine. The orthobiologics available for spine fusion vary from iliac crest bone graft to bone morphogenic protein and gene and cell therapy. Yet there is no unanimous consensus regarding choice of osteobiologics. Clinical evidences regarding choice of bone graft or bone graft extenders are lacking and so is the persisting dilemma among surgeons.

The physiological basis of spinal fusion remains same and requires three essential characteristics: osteogenicity, osteoinductivity, and osteoconductivity. Autolgous bone graft has all the property and provides excellent physiological environment for the spine fusion. It also acts as a bony scaffold, which enhance the mechanical construct of the spine. The fusion rate is more than 90% with use of iliac crest bone graft.[1] However, it is associated with significant donor site morbidity, limited quantity of graft and reduced acceptability on behalf of patients. Local bone graft taken from lamina, spinous process, facets while decompressing spine, open transforaminal lumbar interbody fusion (TLIF) can also be used and has shown excellent fusion rates.[2]

Recently, emphases have been shifted on improving the efficacy of bone grafts or other scaffolds by incorporating bone progenitor cells and growth factors to stimulate cells, which can enhance bone repair, bone regeneration and subsequent vascularization.[3]

In current practice, some of these autograft substitutes, which have predominantly osteconduction property, are available such as allografts, ceramics, and demineralized bone matrix (DBM). Allograft bone is harvested from cadaveric donors and has been used widely. Various forms including freeze-dried, fresh-frozen, cancellous chips, structural, and DBM are available. Fusion rates are not encouraging using freeze-dried allograft, frozen allograft alone. However, fusion rate increases tremendously when allografts were used in combination with iliac crest bone graft or local autologus graft.[4]

Presently, DBM has shown promising fusion rates and could be a potential graft extender or substitute. DBM has excellent osteoconduction and osteoinduction property as it contains type I collagen and non-collagenous proteins and small concentration of growth factors. However, it shows highly variable osteoinductive property.[5] Synthetic bone substitutes e.g., bioceramics, hydroxyapatite and tricalcium phosphate have also been proposed as alternative options based on osteoconductive/osteoinductive property as it can generate a microenvironment for the cellular growth and conscript bone precursor cells.[6]

Bone Morphogenic Protien (BMP) belongs to the transforming growth factor beta (TGF-β) superfamily of growth factors. BMP induces osteoblast and new bone formation by activating mesenchymal stem cells through a complex signaling pathway to stimulate osteoblasts to produce bone. Despite revolutionary fusion rates and outcome, spine surgeon fraternity keeps divided opinion on use of BMP in current clinical practice regardless of cost effectiveness.[7] In recent years, cell and gene therapies, collagen-based matrices, autogenous growth factors, platelet concentrate and bone marrow aspirate have attracted great interest from the scientific community and have shown to have promising approaches to achieve spine fusion. However, so far researches have failed to prove convincing and consistent results to suggest effective methods of fusion and as effective osteobiologics.

The wide variety of bone graft substitutes and extenders are being utilized currently, yet the researches and supporting evidences which can help in choosing the appropriate bone graft are sparse. A spine fusion registry ought to be promoted by various organizations in order to provide sufficient information to deliver high level researches. However, with the current lack of level-I studies supporting the use of many of the bone graft expenders and substitutes, future research will be decisive to further study and clinical trial will evaluate merits of bone graft substitute.

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