



Comparative Study Of Use of Autologous Bone Grafts Vs. Artificial Beta TCP Bone Grafts In Cases of Non Union, Mal Union, Trauma, Arthrodesis Procedures

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ABSTRACT

Aim- compare the results of Artificial bone graft substitutes to autologous grafts for non union, mal-union, arthrodesis and other orthopaedic procedure at different sites and its rate of incorporation, in turn to bring out some useful results to potentially reduce or eliminate the need for autograft.

Material and methods- A prospective study was conducted on patients with various indications by using bone graft substitutes at civil hospital, Ahmedabad during the period of June 2010 to December 2012. We have evaluated results of Autologous Bone grafts Vs Beta TCP bone grafts in various forms. Assessment of results with standard outcome measures was carried out through standard Performa.

Results- 1. Non union, Mal union, trauma:

→Beta Tricalcium phosphate -All patients got fractures united at a period comparable to autogenous bone grafts. Two patients with proximal tibia # with articular depression showed good results for maintenance of joint surface congruity treated with B TCP blocks.

→Autologous Bone Grafts –. All showed good results in union, and skin condition. Almost desired fusion occurred at about 2.5 months in all patients.

2 . Arthrodesis procedures

→Beta Tricalcium phosphate - Patients got Fusion Arthrodesis at a period comparable to autogenous bone grafts.

→Autologous Bone Grafts –12 patients showed good results in union, and skin condition. Almost desired fusion occurred at about 2 months in all patients.

Conclusions- Autologous Bone Grafts are the age old gold standard method for any fusion procedures. Combination of autogenous cancellous bone grafts and bone graft substitutes are the next best available option. Bone graft substitutes alone can be helpful when only osteoconductivity property is needed for which careful patient selection is required.

Keywords : Non union, Arthrodesis, autologous bone grafts, artificial Beta TCP bone grafts

INTRODUCTION

Greater than 5.5 million fractures are sustained by Americans each year, accounting for more than 500,000 bone graft surgeries. Over 2 million bone graft procedures are performed annually worldwide to repair defects caused by trauma or removal of tumors, or to fuse spinal vertebrae

These traditional approaches to bone repair are currently being integrated with innovative tissue engineering techniques, as researchers and clinicians shift their treatment focus towards regenerating functional tissue rather than just filling a defect to provide structural support

Bone grafts are the second most transplanted material, surpassed only by blood.

The current "gold standard" for bone grafting involves harvesting bone material from the patient's iliac crest, due to its osteoinductive properties.

Unfortunately, the surgery required to harvest material from the iliac crest causes additional pain for the patient, relies on a limited amount of available bone tissue, and results in, on average, a 30% rate of donor site morbidity. And some of major complications include deep infection, prolonged wound drainage, large haematoma, reoperation, sensory loss, pain greater than 6 months, herniation of abdominal contents through massive bone graft donor sites, vascular injuries, iliac wing fractures and minor complications include superficial infections, minor wound problems, temporary sensory loss, mild or resolving pain, minor haematomas.

Alternatives to autografts are allograft taken from donors or cadavers, allografts circumvent some of the short comings of autografts by eliminating donor site morbidity and issues of limited supply. However, allografts present risks and limitations as well. (Risk of disease transmission of HIV, hepatitis B, hepatitis C, infection, immunogenecity). Loss of biologic and mechanical. Properties due to its processing increase cost and non availability world wide due to financial and religious concerns.

Despite the benefits of autografts and allografts, the limitations of each have necessitated the pursuit of alternatives. Using the two basic criteria of a successful graft, osteoconduction and osteoinduction, investigators have developed several alternatives. Both natural and synthetic substitutes have been developed .

The aim of this study is to compare the results of these Artificial bone graft substitutes to autologous grafts for non-union, malunion, fusion and other orthopaedic procedure at different sites and its rate of incorporation, in turn to bring out some useful results to potentially reduce or eliminate the need for autograft.

Materials and Methods

A prospective study was conducted on patients with various indications by using bone graft substitutes at civil hospital, Ahmedabad during the period of June 2010 to December 2012.

We evaluate results of Autologous Bone grafts Vs Beta Tricalcium Phosphate in various forms

Autologous Bone Graft:

Autologous bone grafts have osteogenic, osteoconductive, and osteoinductive properties. Available autologous bone grafts include cancellous, vascularized cortical, nonvascularized cortical, and autologous bone marrow grafts (Table I).

Bone formation from autologous grafts is believed to occur in two phases. During the first phase, which lasts approximately four weeks, the main contribution to bone formation is from the cells of the graft. During the second phase, cells from the host begin to contribute to the process.

The endosteal lining cells and marrow stroma produce more than half of the new bone, whereas osteocytes make a small (10%) contribution. Free hematopoietic cells of the marrow make a minimal contribution.

Autologous cancellous bone is easily revascularized and is rapidly incorporated into the recipient site. Cancellous graft is good space filler, but it does not provide substantial structural support. Because only the osteoblasts and endosteal lining cells on the surface of the graft survive the transplant, a cancellous graft acts mainly as an osteoconductive substrate, which effectively supports the ingrowth of new blood vessels and the infiltration of new osteoblasts and osteoblast precursors

Osteoinductive factors released from the graft during the resorptive process as well as cytokines released during the inflammatory phase may also contribute to healing of the graft, although this is only a prevailing theory based on circumstantial evidence; it has not yet been substantiated by scientific documentation.

Although cancellous graft does not provide immediate structural support, it incorporates quickly and ultimately achieves strength equivalent to that of a cortical graft after six to twelve months.

Autologous cancellous bone is commonly harvested from the iliac crest, which can provide a large supply of bone (especially the posterior iliac crest). Other sources are Gerdy's tubercle, the distal part of the radius, and the distal part of the tibia.

Autologous cancellous bone graft is an excellent choice for non-unions with <5 to 6 cm of bone loss and that do not require structural integrity from the graft. It can also be used to fill bone cysts or bone voids after reduction of depressed articular surfaces such as in a tibial plateau fracture.

However, bone-graft substitutes may be preferable in these cases to avoid donor site morbidity.

Stable internal or external fixation is also required, to provide the optimum environment for graft consolidation and successful fracture-healing.

Sources of autologous cortical grafts include the fibula, ribs, and iliac crest. These grafts can be transplanted with or without their vascular pedicle. Autologous cortical grafts have little or no osteoinductive properties and are mostly osteoconductive, but the surviving osteoblasts do provide some osteogenic properties as well.

Autologous cortical grafts provide excellent structural support at the recipient site as well. Although nonvascularized cortical grafts provide immediate structural support, they become weaker than vascularized cortical grafts during the initial six weeks after transplantation as a result of resorption and revascularization.

However, by six to twelve months there is little difference in strength between vascularized and nonvascularized cortical grafts.

Vascularized cortical grafts heal rapidly at the host-graft interface, and their remodeling is similar to that of normal bone. Unlike nonvascularized grafts, these grafts do not undergo resorption and revascularization and, therefore, they provide superior strength during the first six weeks¹². Despite their initial strength, cortical grafts still must be supported by internal or external fixation to protect them from fracture while they hypertrophy in response to Wolff's law and mechanical loading.

Autologous cortical bone grafts are good choices for segmental defects of bone of >5 to 6 cm, which require immediate structural support. For defects of >12 cm, vascularized grafts are superior to nonvascularized grafts.

Beta Tricalcium Phosphate

Chemical composition: - It is a Beta Tricalcium Phosphate.

Beta Ca3 (PO4)₂

Bio Compatible: - Bio compatibility is well established.

Porosity: -

Granules- 60%

Performs- 70%

B –TCP standardized pores (100-500microns) are within the range identified as ideal for bone in growth.

The size of pores allow the material to be infiltrated by blood vessels and bone cells to act as a scaffold for new bone-formation

Mechanical Strength: - The compressive strength of B –TCP (dry) is approximately 7 (Mega Pascal), which is very similar to cancellous bone.

Placement: -

Prepare host bone to attain bleeding bone

Ensure adequate contact with viable bleeding bone for vascular supply to the graft material.

Simultaneous Resorption and new bone formation

It is designed to be resorbed and replaced with new bone during the healing process, 6-18 months.

B –TCP is easy to handle and retains its structural integrity during preparation and placement.

Results

Indications ↓			
Types of → grafts	Autologous Bone Grafts	Artificial Beta –TCP Grafts	Total
Non-union Mal-Union Trauma Group	66	21	87
Arthrodesis Procedures Group	12	1	13
Total	78	22	100

Our study is probably first of its kind where various bone graft substitutes are used for different indications in patients and their results are compared with the similar uses of Autologous Bone graft .

So, our discussion of the study will be on the basis of indications for which the artificial bone graft substitutes are used and their comparison with the use of Autologous Bone Grafts

1. Non union, Mal union, trauma :

→Beta Tricalcium phosphate -

- One patient got infected who had uncontrolled diabetes mellitus and very long surgery time- three and half hours for non union femur, interlocking nailing and bone grafting. Serous discharge and wound gap- signs of infection were present. Infection subsided by regular dressing, injectable antibiotics and control of diabetes mellitus by insulin.
- 25 patients got fractures united at a period comparable to autogenous bone grafts.
- Two patients with Proximal tibia # with Articular depression showed good results for maintenance of joint surface congruity treated with B TCP blocks.

→Autologous Bone Grafts –

- Two patient who had done autologous bone grafts developed implantation site infection. Followed by revision surgery and debriment
- 14 patients developed complications related to donor site. In terms of chronic pain, neuralgias, tingling numbness, or hyposthesia.
- One patient developed donor site infection.
- Apart from this rest of all showed good results in union, and skin condition.
- Almost desired fusion occurred at about 2.5 months in all patients.
- Structural fibula graft patients showed good results in incorporation of graft and solid structural support.
- 2 . Arthrodesis procedures

→Beta Tricalcium phosphate -

- 2 patients got Fusion Arthrodesis at a period comparable to autogenous bone grafts.

→Autologous Bone Grafts –

- One patient who had done autologous bone grafts developed implantation site infection. Followed by revision surgery and debriment
- One patient developed donor site infection.
- 12 patients showed good results in union, and skin condition.
- Almost desired fusion occurred at about 2 months in all patients.

Conclusion

Looking to the overall results,

→ Beta TCP grafts are good alternatives when structural support needed. Its due to their chemical property.

Beta Tricalcium phosphate don't have any osteoinductive property, so it cannot be used where osteoinduction is required.

When mixed with Autologous Bone Marrow they showed excellent fusion outcomes.

They are freely available and cost effective grafts.

Infection rates are very minimal compared to Hydroxyapatite.

Thus careful patient selection and indication for use are keys to get success with use of beta Tricalcium phosphate.

→Autologous Bone Grafts

Are the age old gold standard method for any fusion procedures. They are harvested in any forms such as cancellous or cortical or strut. They have all properties of osteoinduction, osteoconduction, osteogenesis. They show excellent results for fusion.

The problems with auto grafts are

1. limited availability.
2. Donor site complications.
3. Chances of infection.
4. Host morbidity.

However on accounting the morbidity and other problems with autogenous bone grafts, the combination of autogenous cancellous bone grafts and bone graft substitutes are the next best available option. Bone graft substitutes alone can be helpful when only osteoconductivity property is needed for which careful patient selection is required. But still the future modification in the preparations and future research for valid indications for use of various artificial bone graft substitutes are required to use bone graft substitutes in place of autogenous cancellous bone grafts.

REFERENCES

1. Hirata M et al, Use of purified beta – tri calcium phosphate for filling defects after curettage of benign bone tumours, , Int Orthop 2006 May 31. | 2. Michael Muschik et al, Beta Tricalcium phosphate as a bone substitute for dorsal spinal fusion in adolescent idiopathic scoliosis: preliminary results of a prospective clinical study, European spine journal, 2001 Oct, Volume 10, Supplement 2. | 3. Bilkay U et al, Comparing the osteogenic capacities of bone substitutes: HA, high density porous PE and bone collagen; a biochemical and histological analysis, J Craniofac Surg. Jul 2004, 45(4); 585-93. | 4. Bohner M et al, Synthesis and characterization of porous beta Tricalcium phosphate blocks, Biomaterials, Nov 2005, 26(31); 6099-105. |