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Comparative study of use of autologous bone grafts vs. artificial Beta TCP bone grafts in cases of spine fusion, lytic lesions, and other orthopaedic procedures

DR SAMIR PATEL	M. S. Othopaedics, senior resident, B. J. Medical College Ahmadabad, Gujarat, India
DR MUKUND M PRABHAKAR	M. S. Othopaedics, Head of department ,orthopaedics, Director of GOVT spine institute,ahmedabad, Medical supretendant,civil hospital ahmedabad.
DR HIMANSHU PANCHAL	M. S. Othopaedics, associate professor, B. J. Medical College Ahmadabad, Gujarat, India.
DR DIPAK A SHAH	M. S. Othopaedics, assistant professor, M. P. SHAH Medical college Jamnagar, Gujarat, India.

ABSTRACT

Aim- compare the results of Artificial bone graft substitutes to autologous grafts for of spine fusion, lytic lesions, other orthopaedic procedures 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 Proforma.

Results- Spine Group: →Beta Tricalcium phosphate - patients got fusion at a period comparable to autogenous bone grafts.

→Autologous Bone Grafts –Massive number of 95 patients undergone fusion done by Autologous bone grafts. All showed good results in union, and skin condition.Almost desired fusion occurred at about 2 months in all patients

Lytic lesions and other procedures: →Beta Tricalcium phosphate –patients got lesion united at a period comparable to autogenous bone grafts.B- TCP proved good substitute for filling these lytic cavaties.Where massive bone grafting needed B-TCP provided good alternative ,when mixed with autologous bone marrow.

→Autologous Bone Grafts –Cancellous Autlogous bone grafts proved to be excellent in cavity filling in lytic lesion.Almost desired fusion occurred at about 2.5 months in all patients. All showed good results in union, and skin condition.

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 : Spine fusion, Lytic lesions, autologous bone grafts, artificial Beta TCP bone grafts

INTRODUCTION

As the life expectancy of humans continues to grow, people are staying active longer. Since the 1960s there have been two main approaches toward the repair of damaged or diseased tissue that is unable to heal by natural means: (1) tissue transplantation and (2) device implantation.

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

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

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 worldwide 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.

Bone tissue engineering solutions combine scaffold materials with viable stem cells or bone cells in products that can be implanted into bony defects. Incorporating cells and growth factors within a bone graft prior to implantation improves upon its ability to induce bone formation and decreases the time needed for native tissue to proliferation.

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

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 MPa, 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

From the above table can be concluded that the most common indication for using bone graft substitutes is as fusion procedures in Spine. The next indication is for lytic lesions and other procedure. It is also used for articular elevation after depressed intra articular fractures. And the least is for joint Fusion.

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 Autologouos 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 comparision with the use of Autologous Bone Grafts.

Indications ↓ / → Types of grafts	Autologous Bone Grafts	Artificial Beta –TCP Grafts	***Total***
Spine Group	95	6	101
Lytic lesions and Others Group	13	10	23
Total	108	16	124

Spine –

At our set up, spine is the most common indication for use of any bone graft.

Mostly used for fusion procedures after anterior decompression or correction of Angular deformities.

The usual indicatons are:

- Anterior decompression and fusion in TB spine
- Anterior decompression and fusion in traumatic spine
- Fusion in scoliosis or kyphoscoliosis
- Cv junction anomalies
- ACDF in Cervical compressive Myelopathies
- Fusion and fixation in Lytic - Lysthesis spine

→Beta Tricalcium phosphate -

- Out of 6 patients no patient got infected
- 6 patients got fusion at a period comparable to autogenous bone grafts.
- 1 patient fusion done by ALIF, developed displacement of the graft. Fusion took longer time in this patient.

→Autologous Bone Grafts –

- Massive number of 95 patients undergone fusion done by Autologous bone grafts.
- Mostly cortico-cancellous graft harvested from iliac crest
- In few patient fibula graft used.
- No patient who had done autologous bone grafts developed implantation site infection.
- 22 patients developed complications related to donor site. In terms of chronic pain, neuralgias, tingling numbness, or hyposthesia.
- 6 patients 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 months in all patients.
- Structural fibula graft patients showed good results in incorporation of graft and solid structural
- Almost all spine patients showed excellent fusion results.

Lytic lesions and other procedures

The lesion which were treated:

1. Giant cell tumor
2. Aneursymal bone Cysts
3. Pathological #
4. Fibrous Dysplasia
5. lysis SI Joint
6. Congenital pseudo-arthrosis Tibia
7. Meyers Procedure

→Beta Tricalcium phosphate -

- No patient got infection.
- 10 patients got lesion united at a period comparable to autogenous bone grafts.
- B- TCP proved good substitute for filling these lytic cavaties.
- Patients were treated with curettage and Bone graft and beta Tricalcium phosphate preparation.
- Where massive bone grafting needed B-TCP provided good alternative, when mixed with autologous bone marrow.

→Autologous Bone Grafts

- No patient who had done autologous bone grafts developed implantation site infection.
- 4 patients developed complications related to donor site. In terms of chronic pain, neuralgias, tingling numbness, or hyposthesia.
- Cancellous Autlogous bone grafts proved to be excellent in cavity filling in lytic lesion.
- Almost desired fusion occurred at about 2.5 months in all patients.
- Quadratus femoris muscle pedicle graft with cancellous bone showed excellent results when used in Meyer's procedure.All patients showed salvage of femur Head in these ICNF cases.
- Structural fibula graft patients showed good results in incorporation of graft and solid structural support in those cases with Fibrous Dysplasia
- Apart from this rest of all showed good results in union, and skin condition.
- Autologous bone grafts are the only option should be used in cases of Congenital Pseudo-arthrosis Tibia
- Autologous Grafts when used for fusion at Lysis at SI joint proved good results clinically and Radiologically.

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.

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 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.

ABBREVIATIONS

MPa : mega pascal
TB : Tuberculosis
CV : Cranio Vertebral
ACDF : Anterior Cervical Decompression Fusion
ALIF : Antrrior Lumbar InterBody Fusion
ICNF : Intra Capsular Neck Femur Fracture
SI : Sacro Illiac

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.