Iliac crest graft site reconstruction using Chitra - HABG bone blocks: A Prospective study

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Abstract
Study Design: Prospective study.

Objective: To prospectively study the hypothesis that structural reconstruction of iliac crest graft site significantly reduces donor site morbidity. The study also evaluates the efficacy of Chitra hydroxyapatitebioactive glass ceramic composite (Chitra-HABG) as a material for reconstructing the iliac crest.

Summary of Background Data: Significant donor site following tricortical iliac crest bone graft harvesting varies from 3% to 61%. Several studies suggest that this morbidity is predominantly due to structural issue and reconstructing the defect effectively reduces morbidity.

Study setting: Government Medical College, Thrissur during the period March 2011 to March 2012

Methods: Seven patients in whom Chitra HABG was used for filling up the iliac crest defect after graft harvesting were followed up to duration of 1 year. Both clinical and radiologic assessments were done and outcome measured.

Results: At the end of one year all seven patients have no pain. Two had full incorporation, at the end of six months. No one had infection, dissolution, migration or absorption.

Conclusion: This study validates our hypothesis that donor site morbidity after iliac crest biopsy can be significantly reduced by structural reconstruction. Chitra HABG blocks have satisfactory incorporation rates by the end of one year. As this is an ongoing study the radiologic outcome is expected to improve and to be at par with similar studies.

Key words: Bone graft, Iliac crest, Chitra-HABG, Hydroxy apetite

Introduction

Since the introduction of ilium as a bone graft reserve in 1942 by Abbott, it has been widely preferred for reconstructive surgeries as a graft source. This is because they are osteoinductive, osteoconductive and free from disease transmission with no immunogenic problems.

More than 1,00,000 bone graft procedures are performed in United States each year; the figures in India are not exactly known. Probably iliac crest might be the second most commonly used autogenous transplant after blood.

Donor site morbidity after iliac crest bone graft harvesting, as per various studies, can be very significant, varying from 3% to 61% and this is a serious postoperative concern for both the surgeon and the patient. Specific problems like postoperative hematoma, donor site stress fracture, donor site pain or altered sensation, visceral prolapse and delayed or non union of graft site has been reported. To reduce these complications, graft site reconstruction using a synthetic material is suggested. A study in this direction in our country is very crucial as iliac crest is usually left unattended without any repair.

Our hypothesis is that the morbidity is probably due to surface defect, filling which may give significant symptomatic effect. Various reconstructive options have been used with variable results. The material used in this study is Chitra – HABG block, which is a composite mixture of hydroxyapatite and bioactive glass. The study was conducted at Government Medical College, Thrissur, during the period between March 2010 to March 2011.
Aims and objectives

This study aims to prospectively:
1. Validate the hypothesis that, iliac crest donor site morbidity may be a structural issue and by reconstructing the crest the incidence of this complication might be reduced.
2. Evaluate in terms of radiologic and clinical outcomes, the efficacy of Chitra hydroxyapatite-bioactive glass ceramic composite (Chitra-HABG) blocks as a reconstructive material.

Materials and methods

A consecutive series of 7 patients who underwent Anterior iliac crest graft harvesting for various orthopaedic procedures were included in this prospective study. Ethical committee clearance was obtained. Subsequent to orthopaedic procedures, those patients needing bone grafting were selected. An informed consent was taken and the exclusion criteria were pregnancy, lactation and those having allergic response to medications.

A tricortical iliac bone was harvested for bone grafting in the usual manner and the gap is filled with appropriate bone block, which was fitted snugly and the graft is covered by periosteum. All patients were subjected to a clinical and radiologic evaluation on third day, third, sixth and 12th months postoperatively. Clinically patients were assessed for pain, surgical site complications and cosmesis. An iliac oblique view is taken for radiological assessment.

The study had 2 outcome measures:
1. Donor site morbidity: pain, wound hematoma, infection, iliac fracture, visceral prolapse, cosmetic deformity and instability. Pain was assessed by a simple scoring system proposed by a similar study as severe (intolerable) pain, moderate pain (requiring analgesics), mild pain (tolerable without analgesics) and no pain.
2. Radiologic assessment for ceramic incorporation, dissolution, fragmentation and migration.

As per definitions proposed by a similar study “complete incorporation means there was gradual blurring of sharp margins of the block, loss of radio-opacity and establishment of trabeculae across the block and “partial” if they were present, but only on one surface of contact. Ceramic dissolution meant disappearance of the block with no visible bony replacement, whereas partial dissolution meant thinning or reduction in size of the block with or without incorporation. Fragmentation was defined as breakage with dispersion into the surrounding tissue and migration as displacement from implanted site. Bioceramics are defined as “specially designed ceramics for the repair, reconstruction and replacement of diseased or damaged parts of the body”. They have been applied for repair of almost all parts of body. The basic compounds are oxides, nitrides or carbides of metals, phosphate minerals, silicates and/or their combinations. These compounds go through various processing techniques and the resultant material can be single crystal/ polycrystalline, dense/porous, coating, composite or set cement mass.

The Chitra-HABG, prepared by Sree Chitra Tirunal Institute for Medical Sciences and Technology, Trivandrum, India is a composite of hydroxyapatite (HAP) and a bioactive glass ceramic. This material is highly porous, safe, machinable and available in varies sizes. Both the individual components and the composite have been extensively studied in terms of phase purity crystalline, chemical and trace element analysis and toxicologic screening. The blocks were produced at laboratory scale per the specification of the international standard ASTM–F1538 and biocompatibility and safety has been investigated following the international standard ISO10993. They have also been subjected to animal experimentation and human clinical trials with appropriate ethical committee approval according to internationally recommended protocols.

Results

Of the seven patients done, clinically no one had pain or post operative infection at graft site. No patients complained of any cosmetic symptoms. None developed problems like hematoma, infection, visceral prolapse or neuroma formation. Radiologically two patients had complete incorporation and one patient had partial incorporation, attained around six months post operatively. No absorption, dissolution or migration was noted till date. The HABG blocks were seen with discrete borders in the immediate postoperative radiographs. In the serial follow ups, the borders became progressively indistinguishable. The reduction in size was noticed mainly on the crest side. Trabecular continuity developed was found to be indistinguishable from the surrounding bone.

Discussion

Autogenous bone grafts remain the gold standard in reconstructive surgery as they match closest to the host bone biologically, possess osteoinductive and osteoconductive properties and are free from immunogenic or disease transmission risks.

Often, full thickness iliac crest grafts are taken for reconstruction leaving large defects, which can precipitate very bothersome complications at the donor site. Iliac crest bone graft harvesting is associated with significant donor site

morbidity, which could persist months to years after the surgery. These include chronic pain, numbness, hypersensitivity or irritability of local tissue, cosmetic complaints, visceral herniations, pelvic instability and deformity. Donor site morbidity increases patient recovery time and the chance of disability in an otherwise successful surgical procedure. Postoperative complications are more with grafting from posterior iliac crest.

A few reports have suggested that if the iliac crest is maintained / restored, the morbidity of the procedure is reduced. Hence we made our hypothesis that donor site morbidity is predominantly a structural issue. Reconstruction of the defect with a solid spacer should restore the support and prevent scarring, thus reducing the morbidity. Many reconstructive materials like polymethylmethacrylate, proplast, polylactic acid mesh, etc have been tried, with variable results. Autologous rib has been shown to be effective and safe when available, but poses the disadvantage of an additional incision and rib graft complications. Ceramic substitutes have proven to be safe, effective and readily available. Graft site reconstruction is not necessary in cases like children, small graft sizes and in those cases where anatomic closure has been done.

The ideal reconstructive material should integrate with surrounding bone (bioactive and biodegradable), have optimum mechanical strength, be safe, economical and easily available. One such product, developed at the Sree Chitra Tirunal Institute for Medical Sciences and Technology (SCTIMST), Trivandrum, India, the Chitra-HABG. This composite of HAP and bioactive glass ceramic has shown to retain optimal beneficial properties of both components. Porous HAP integrates with the surrounding bone (40 to 60%) because new bone grows into the interconnecting pores and forms a micro lock type of interface. The strength of new bone formation depends on extent of fibrous tissue formation. In the clinical setting, such bony in-

![Figure. 1. Photograph showing the bone block](image1)

![Figure. 2. Peroperative photograph showing the block being measured.](image2)

![Figure. 3. Peroperative photograph showing the bone block being placed in the defect](image3)

![Figure. 4. Immediate post op X-ray showing the bone block in situ.](image4)
growth takes between 3 to 12 months to develop fully. Despite its better integration potential porous HAP is structurally weaker than dense HAP. It has good compressive strengths and modulus of elasticity. The bioactive glass, belonging to calcium-phospho-silicates, was also proved as a good graft material for reconstruction with excellent bonding properties not only to bone but also with soft tissues. The tissue bonding properties is based on the availability of silanol radicals on its surface, which promotes precipitation of hydroxyl carbonate apatite on its surface. Tissue adhesion starts almost immediately after application and attains optimum interface strength in weeks. The strength of this interface bond is stronger than that provided by pure HAP blocks. Their disadvantage is that they are mechanically weaker compounds.

The R & D lab at SCTIMST, has made pioneering efforts to develop a successful synthetic bone substitute based on HAP and bioactive glass (Chitra-HABG). The biologic activity, efficacy, biocompatibility and safety have been ensured through toxicologic tests and animal implantation, following relevant international standards and guidelines.

The limitations of this study are
1. Relatively small sample size
2. Short follow-up period
3. Need of multicentricity

This study shows that reconstruction of iliac crest graft is reasonable as it prevents postoperative pain, local hematoma, subsequent fracture and cosmetic problems. The implantation technique is reliable, safe and easy.

**Conclusion**

Iliac crest graft site morbidity following graft reconstruction can be effectively controlled by surface reconstruction and this is effectively attained by using CHITHRA–HABG blocks, but leaves with two questions which needs further studies:

1. Histopathologic analysis to prove bone incorporation
2. Can bone graft be reharvested from the same site? If so what is the time frame? What is the quality of the graft so obtained?

**References**


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