Original Article

Assessment of Morselized Allograft Replacement in the Management of Bone Tumors

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Abstract

Background: Bone grafts, in their various forms and applications, represent one of the earliest devised for reconstructive surgeries of the musculoskeletal system and remain the most commonly used orthopedic procedures. **Materials and Methods:** Only ten patients who received elective surgery with fresh frozen bone allograft in the orthopaedic operation room met the inclusion and exclusion criteria for the study because of its short duration and minimal six-month post-operative follow-up. **Results:** Ten cases of the benign tumor out of which 3 were of Chondroblastoma (1 each in proximal ends of humerus and tibia and distal femur), 3 cases of Giant cell tumor (2 in the proximal tibia and 1 in the distal tibia), 2 cases of Osteoid osteoma (both in the neck of femur), 1 case of Simple bone cyst (proximal femur) and 1 case of Schwannoma of 5th lumbar nerve root causing erosion of L-5 body. Two (20%) and eight (80%) of the patients in this study had fair and bad preoperative grades, respectively. At six months, nine patients (90%) had great results, one patient (10%) had decent results, and none had clinical evaluation results that were rated as unsatisfactory. **Conclusion:** Large bone defects in cases of benign bone tumors with excellent results found in 90% and good results in the remaining 10% cases when bone allograft was made. Therefore, replacement of bony defects due to bone tumors has an excellent result with bone allograft.

Keywords: Fresh Frozen Bone allograft, Chondroblastoma, Giant cell tumor, Osteoid osteoma, Bone defects.

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Introduction

An ideal bone-graft substitute must provide scaffolding for osteoconduction, growth factors for osteoinduction, and progenitor cells for osteogenesis. The autogenous cancellous bone graft is considered the gold standard for bone grafting. It contains osteoblasts, endosteal osteoprogenitor cells, and a structural matrix that act as a scaffold.

However, due to the limited availability of autogenous cancellous bone graft and associated high donor-site morbidity, bone allograft now plays a major role in bone grafting procedures.[1]

Allografts have osteoconductive properties and can serve as substitutes for autografts. Allografts are frozen or freeze-dried not only to preserve them but also to reduce antigenicity and thus decrease the chances of rejection by the host.

Allografts can be classified as:

1) Fresh-frozen allograft
2) Freeze-dried bone allograft (FDBA)
3) Demineralized freeze-dried bone allograft (DFDBA)

The process of preparation and storage of fresh-frozen allograft in a bone bank deep freezer maintained at -70 ℃ is less cumbersome and more practical than demineralization or gamma irradiation stored grafts. When stored at a temperature of -70 ℃, the allograft loses its antigenicity and hence can be safely used for bone grafting.

Incorporation is the process of uniting the host tissue to the transplant material as well as the envelopment and admixture of necrotic and viable new bone. This is primarily the function of the recipient bed and depends on close contact with the viable donor tissue. It also depends on skeletal metabolism and the age of the recipient.

The donor criteria are used both for cadaveric as well as live donors.[2] Orthopedic surgeons are increasingly using femoral heads as bone grafts which can be easily stored by freezing without elaborate equipment and with minimum personnel involved. The case of storing femoral heads has encouraged orthopedic surgeons to consider establishing bone banks in their local hospitals, where local control of the stored bone, personal knowledge of the donors and easy access to the tissue are advantages.[3]

Materials and Methods

The prospective study including the use of bone bank frozen allograft in various orthopedic surgeries were conducted in 10 cases of bone tumors in the Department of Orthopaedic Surgery, Lok Nayak, and Associated Hospitals, New Delhi from October 2014 to April 2016. These instances were chosen for the study

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based on the following inclusion and exclusion criteria. Data regarding patients' demographics and laboratory test results before as well as after the intervention were recorded, after taking written informed consent form the patient. The details of the procedure, pre- and post-treatment, the patients' condition, and the healing of involved sites were recorded. At two weeks, six weeks, three months, and six months, patients were monitored.

Inclusion criteria of recipient patients:

a. Above 4 years age.
b. Bone grafting and curettage are used to treat benign bone tumours.

Exclusion criteria for recipient patients:

Infected non-union, non-union of long bone fractures, posterolateral spinal fusion in spondylolisthesis and spinal trauma, cervical laminoplasty, non-union because of pathological fracture, congenital pseudoarthrosis of the tibia, immunocompromised state (HIV, uncontrolled diabetes mellitus, cancer), patient on antibiotics for any other reason (endocarditis prophylaxis), destitute and homeless patients.

Criteria for donors of bone allograft:

a. Patients undergoing total hip replacement and hemiarthroplasty had their femoral heads removed.
b. Patients who had total knee replacements have their bones cut.

Inclusion criteria for bone graft donor: To make sure the donors were free of HIV, Hepatitis B or Hepatitis C, systemic, local, or sexually transmitted infections, blood dyscrasias or blood pathologies, and cancer, a thorough medical history was obtained from them.

Exclusion Criteria for bone graft donors: Harvested grafts that may have been contaminated or diseased.

Graft Harvesting and Storing Protocol: Donors were suitable for the harvest of bone graft as per the criteria. A swab culture was collected from the graft as soon as it was harvested. It was then cleaned with regular saline and kept in an autoclaved stainless steel container with a sterile rubber glove filled with a saline solution treated with gentamicin (320 mg in 100 ml). The graft was promptly placed in a deep freezer and frozen to -70 ℃. Only those grafts that showed no growth of bacteria on the swab culture were used.

Preoperative planning of Recipients for Prospective study: Every patient in the study underwent an intradermal cefazolin sensitivity test, a basic pre-anesthetic examination, and the following tests – Hemogram, ESR, CRP, liver function tests, Serum protein/albumin levels, Kidney function tests, Urine examination (routine and microscopy), Bone biopsy, Chest x-ray, Electrocardiography (ECG). Every patient who was scheduled for surgery provided written informed consent.

Intra-operative Protocol: Thirty minutes before the skin incision, Cefazolin 1gm I.V. was administered to all patients having bone grafting. Allograft to be used was procured from the bone bank freezer and thawed in a warm saline solution. In order to prepare the transplant for implantation, all cartilage and soft tissue were removed. The graft was morselized or sliced into the appropriate shape. Before being transplanted into the recipient location, the prepared graft was carefully cleaned with saline. Additionally, a lot of saline was used to cleanse the surgery site prior to implantation of allograft followed by a wound closure in layers over a suction drain if required. Blood loss and the duration of the surgery were noted.

Postoperative Protocol: Axillary temperature monitoring was done for all patients on a twice-daily basis and request in case of fever until the discharge of the patient from the hospital. Cefazolin was used as an antibiotic prophylactic till the second postoperative day. ESR and CRP were recorded on postoperative day 2. A suction drain was removed on postoperative day 2. Routine wound inspection was done only if there was a persistent fever on the 3rd postoperative day or in the event that the surgical location is discharged. Sensitivity tests, Gram staining, and culture were performed on the discharge sample. Patients were discharged from the hospital on the morning of postoperative day 3 unless otherwise indicated.

On the fourteenth day following surgery, patients were told to come in for suture removal. However, in case of fever, soakage of dressing, or any discharge from the surgical site, they were instructed to report immediately to the hospital.

Follow Up Protocol: All cases were followed up for wound inspection and suture removal on a post-operative Day 14 and the following parameters were assessed: 1) History of fever after the discharge of the patient from hospital. 2) Signs of inflammation around the surgical site at the time of suture removal - tenderness, erythema, edema or induration of skin. 3) Any discharge from the surgical site, investigations were done in these cases such as hemogram including total and differential leukocyte count, CRP, ESR, Swabs for C/S. Appropriate antibiotics were advised according to sensitivity.

In case the surgical site had healed completely at the time of suture removal, Only at six weeks, three months, and six months was the patient monitored. During these visits the following parameters were recorded: 1) Episodes of fever, if any, since the last visit. 2) Any sign of inflammation around the surgical site - tenderness, erythema or edema 3) leave the surgery site. 4) A simple radiograph shows the area that was operated on. 5) If necessary, a CT scan of the surgical site for graft integration (at six months). 6) Anti-HCV antibody (at six months), HBsAg, and HIV I and II (ELISA).

Results

There were 10 cases of the benign tumor out of which 3 were of chondroblastoma (1 each in proximal ends of humerus, tibia and distal femur), 3 cases of giant cell tumor (2 in the proximal tibia and 1 in the distal tibia),(Figure 1) 2 cases of osteoid osteoma (both in the neck of femur), 1 case of the simple bone cyst (proximal femur) (Figure 2) and 1 case of schwannoma of 5th lumbar nerve root causing erosion of L-5 body. [Table 1]

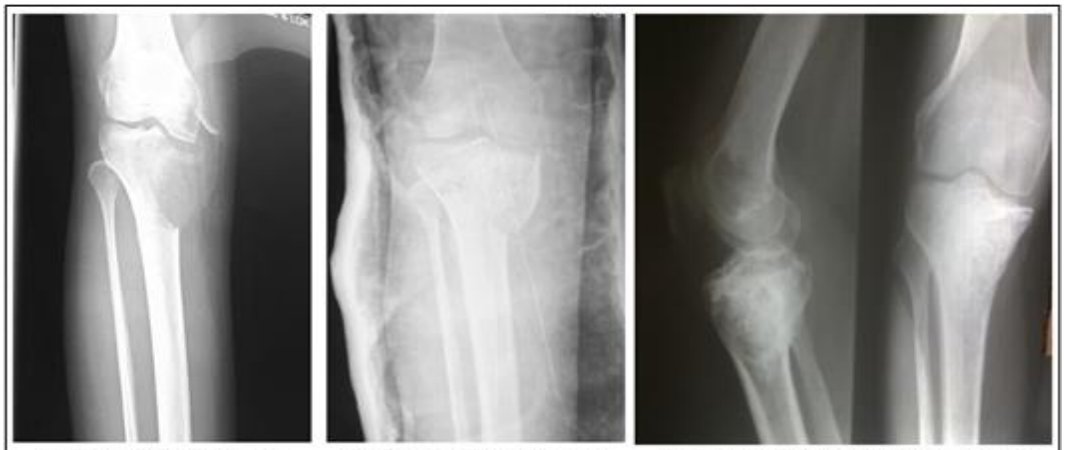
None of the ten individuals in this study experienced postoperative infection. The average ESR value for the cases in this study was 15.2 prior to surgery and 18.11 after six months. In a similar vein, the mean CRP was 11.52 prior to surgery and 5.44 after six months. [Table 2]

In this study, a total of 10 cases of benign tumors were operated by extended curettage and using a bone allograft. As per Mankin et al [4] functional scoring system excellent results were obtained in 9 cases (90%) and good result in one case (10%). [Table 3]

Four of the ten cases in the study demonstrated incorporation at four months, three at five months, and three at six months. Consolidation took an average of 4.9 months. [Table 4]

Excellent or good pain reduction was observed in 8 (80%) patients at 6 weeks, 10 (100%) patients at 3 months, and 10 (100%) patients at 6 months, according to the visual analogue score. [Table 5]

Two (20%) and eight (80%) of the patients in this study had fair and bad preoperative grades, respectively. At six months, nine patients (90%) had great results, one patient (10%) had decent results, and none had clinical evaluation results that were rated as unsatisfactory. [Table 6]

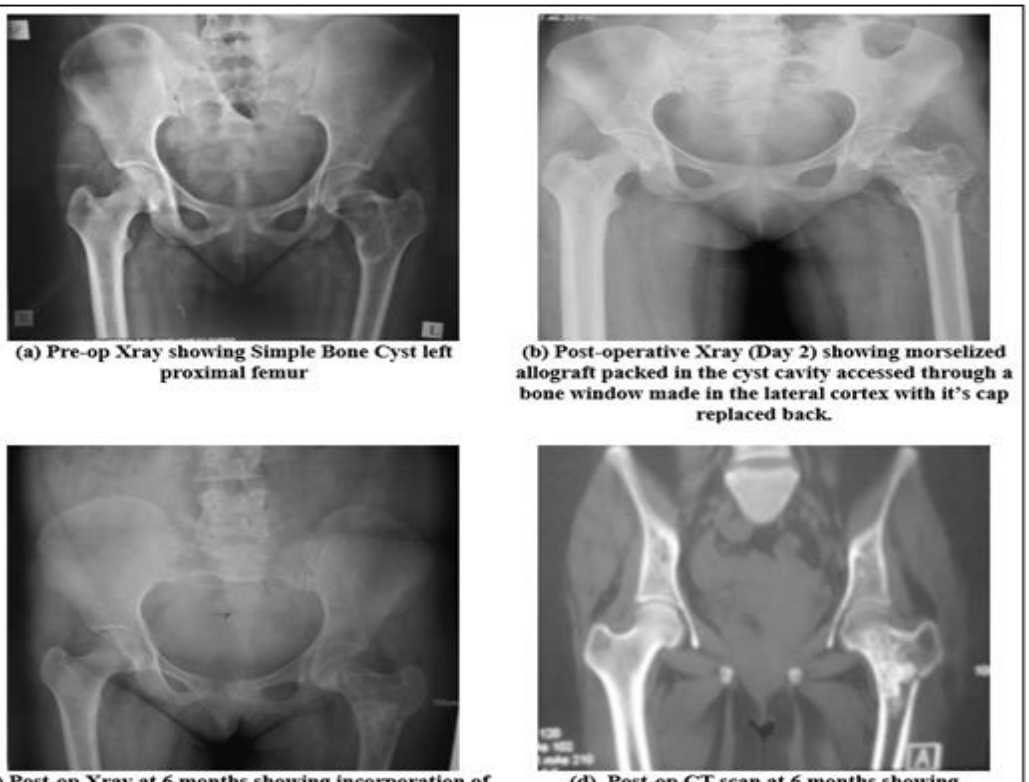


(a) Pre-op Xray showing large epiphyseal lytic area with loss of medial wall of the proximal tibia

(b) Post-op Xray showing morselized graft packed in the cavity with structural allograft at medial wall defect

(c) Post-op Xray at 6 months showing good incorporation of the graft

Figure 1: Giant cell tumor of the right proximal tibia of 26-year-old lady (a) Pre-op showing lytic area (b) Post-op with graft (c) Post-op with the incorporation



(a) Pre-op Xray showing Simple Bone Cyst left proximal femur

(b) Post-operative Xray (Day 2) showing morselized allograft packed in the cyst cavity accessed through a bone window made in the lateral cortex with it's cap replaced back.

(c) Post-op Xray at 6 months showing incorporation of the allograft and healing of lateral cortical window

(d) Post-op CT scan at 6 months showing incorporation of the allograft and healing of lateral cortical window

Figure 2: Simple Bone Cyst left proximal femur in a 22-year-old lady (a) Pre-op Xray (b) Post-operative Xray on 2nd Day (c) Post-op Xray at 6 months (d) Post-op CT scan at 6 months

Table 1: Bone allograft used in tumors

S. No.	Bone tumors	Number of cases
1.	Chondroblastoma	3
2.	Giant cell tumor	3
3.	Osteoid osteoma	2
4.	Simple bone cyst	1
5.	Schwannoma	1

Table 2: Mean ESR and Mean CRP

Period	Mean ESR of patients	Mean CRP of patients
Pre-op	15.2	11.52
Day-2	46.4	44.47
Day-14	31.5	18.09
6 weeks	28.2	13.32
3 months	23.4	10.89
6 months	18.11	5.44

Table 3: Functional Scoring System

S. No.	Grade	Follow-up at 6 months	Percentage
1.	Excellent	9	90%
2.	Good	1	10%
3.	Fair	0	0%
4.	Failure	0	0%

Table 4: Time taken for graft incorporation

S. No.	TIME TAKEN	Number
1.	4 months	4 (40%)
2.	5 months	3 (30%)
3.	6 months	3 (30%)

Table 5: Post-operative Pain Relief Score (VAS)

VAS score	6 Weeks	3 Months	6 Months
0 (EXCELLENT)	3 (30%)	5 (50%)	5 (50%)
1-2 (GOOD)	5 (50%)	5 (50%)	5 (50%)
3-4 (FAIR)	2 (20%)	0 (0%)	0 (0%)
>4 (POOR)	0 (0%)	0 (0%)	0 (0%)

Table 6: Clinical Grading

Grade	Functions	Pre-op	Post-op at 6 months
Excellent	Pain free, normal function of part	0 (0%)	9 (90%)
Good	Pain free, some functional impairment	0 (0%)	1 (10%)
Fair	Pain with or without disability, some functional impairment	2 (20%)	0 (0%)
Poor	Poor disability with severe complication	8 (80%)	0 (0%)

Discussion

In this prospective study, there were 10 cases of the benign tumor out of which 3 were of chondroblastoma (one each in proximal ends of humerus and tibia and distal femur), 3 cases of giant cell tumor (2 in the proximal tibia and 1 in the distal tibia), 2 cases of osteoid osteoma (both in the neck of femur), 1 case of the simple bone cyst (proximal femur) and 1 case of schwannoma of 5th lumbar nerve root causing erosion of L-5 body.

In a series of benign bone tumors requiring curettage, Kundu et al reported that giant cell tumor was the most common tumor followed by the simple bone cyst, aneurysmal bone cyst, enchondroma fibrous dysplasia, chondromyxoid fibroma, chondroblastoma, and giant cell reparative granuloma.[5]

Sethi et al in 1993 reported seventeen patients with benign cystic osseous lesions which were treated by curettage and grafting using allogenic decalcified bone. There were five cases of fibrous dysplasia, four cases of aneurysmal bone cysts, three cases of simple bone cysts, two cases of giant cell tumors, chondromyxoid fibroma, non-ossifying fibroma and fibrous cortical defect each.[6]

According to a study by Shukla et al., 26 out of 32 instances (81.25%) of the patients had complete consolidation.[7] Three cases (9.38%) of non-union were reported, and there was no evidence of disease transmission. In 2015, Roudbari et al. reported that after six months of surgery, 96.6% of their patients had the graft fully integrated into the host bone.[8] Between November 1971 and January 1993, Mankin et al. reported a 17% nonunion rate in the long-term outcomes of allograft substitution in the treatment of bone tumours.[4] Using demineralised bone, Goel et al. (1992) found that simple bone cysts consolidated in three months, aneurysmal bone cysts took four months, and giant cell tumours took six to nine months.[9]

With the main advantage of normal reconstruction of normal or nearly normal osseous architecture, bone allografts often get integrated into the host bone and, if successful, represent a

permanent implant rather than a transient spacer.[10]

Early postoperative CRP and ESR readings were significantly abnormal, according to the study report by Kong et al. According to their findings from anterior cervical fusion employing allograft, abnormal CRP and ESR readings in the early postoperative phase indicate acute inflammation rather than acute postoperative infection.[11] In addition to the typical course, an acute postoperative infection was indicated by a second rise in CRP and ESR or, more crucially, by the failure of these parameters to decline. Similar postoperative trends in ESR and CRP following elective orthopaedic procedures were reported in research by Larsson et al.[12]

The minimum storage period in the deep freezer for bone allograft was 2 weeks and the maximum storage period was 10 weeks. The donor grafts were not given an opportunity to be stored for long during the tenure of this study due to the large number of cases being operated frequently, many of whom required multiple grafts.

A study report by Aro HT the bone allograft was deep-frozen at -70 to -80°C and stored for a minimum of 2 weeks.[13]

Allograft, when stored at a temperature below -70°C in a fresh frozen state, have near normal biomechanical strength of the original bone, the longer shelf life of approximately 5 years due to inhibition of enzymatic destruction, reduced immunogenicity and are non-toxic. Therefore, allograft stored below -70°C can be used for transplant in cases of the bone tumor as they can act as filling bone defects.[10]

Conclusion

Large bone defects in cases of benign bone tumors with excellent results found in 90% and good results in the remaining 10% cases when bone allograft was made. Therefore, replacement of bony defects due to bone tumors has an excellent result with bone allograft that's why it can be used as a replacement procedure for filling defects due to tumors.

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Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Silber JS, Anderson DG, Daffner SD, Brislin BT, Leland JM, Hilibrand AS et al. Donor site morbidity after anterior iliac crest bone harvest for single-level anterior cervical discectomy and fusion. Spine (Phila Pa 1976) 2003; 28(2):134-9.
2. Tomford WW, Mankin HJ. Investigational approaches to articular cartilage preservation. Clin Orthop Relat Res 1983; 174:22-7.
3. Tomford WW, Ploetz JE, Mankin HJ. Bone allografts of Femoral heads – procurement and storage. J Bone Joint Surg Am 1986; 68(4):534-7.
4. Mankin HJ, Gebhardt MC, Jennings LC, Springfield DS, Tomford WW. Long term Results of Allograft replacement in the management of bone tumors. Clin Orthop 1996; 324:86-97.
5. Kundu ZS, Gupta V, Sangwan SS, Rana P. Curettage of benign bone tumors and tumor-like lesions: A retrospective analysis. Indian J Orthop 2013; 47:295-301.
6. Sethi A, Aggarwal K, Tulsi SM, Sethi S, Kumar S, Maurya SK. Allografts in treatment of Benign Cystic Lesions of Bone. Arch Orthop Trauma Surg 1993; 112(4):167-70.
7. Shukla S, Malhotra R, Bhan S. Results of fresh frozen bone allografts in orthopaedics. Indian J Orthop 2003; 37:8.
8. Roudbari S, Haji Aliloo Sami S, Roudbari M. The clinical results of benign bone tumor treatment with allograft or autograft. Arch Iran Med 2015; 18(2): 109-13.
9. Goel SC, Tuli SM, Singh HP, Sharma SV, Saraf SK, Srivastava TP. Allogenic decalcified Bone in Repair of Benign Cystic lesions of Bone. Int Orthop 1992; 16(2): 176-9.
10. Borja FJ, Mnaymneh W. Bone allografts in salvage of difficult hip arthroplasties. Clin Orthop1985; 197: 23.
11. Kong CG, Kim YY, Park JB. Postoperative changes of early-phase inflammatory indices after uncomplicated anterior cervical discectomy and fusion using allograft and demineralised bone matrix. Int Orthop 2012; 36(11): 2293-7.
12. Larsson S, Thelander U, Friberg S. C-reactive protein (CRP) levels after elective orthopedic surgery. Clin Orthop Relat Res1992; 275:237-42.
13. Aro HT, Aho AJ. Clinical use of bone allografts. Ann Med. 1993; 25: 403-12.