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Evaluation of curettage, synthetic bone grafting and fixation with implant in benign osteolytic and cystic lesions of long bones in children and young adults

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ABSTRACT

Background: Curettage is one of the most common treatment options for benign lytic bone tumors and cystic lesions. In children and young adults, the resultant defect is usually filled with synthetic bone graft, which is a natural calcium phosphate hydroxyappatite (HA) in crystalline ceramic form.
Methods: Sixteen cases of benign lytic and cystic lesions of bone were managed by simple curettage and grafting using hydroxyappatite blocks. Displaced pathological fractures or impending peritrochanteric fractures were fixed by implant. Commercially available HA was used for this purpose. Mean duration of follow up was 17.5 months (range 12 –30 months). Mean patient age was 11.2 years (range 6–20 years). Radiological staging of graft incorporation was done as per criteria of Irwin et al.
Results: Among 16 cases, 2 patients presented with non-ossifying fibroma and 2 patients with simple bone cyst, 12 cases were aneurysmal bone cyst. 5 patients had pathological fracture. Healing of lesion and graft incorporation is seen in all of the cases. At 6 months of follow up 3 cases were in Irwin stage III, 9 cases were in Irwin stage II and 4 cases were in Irwin stage I. At final follow up 10 cases were in Irwin stage III and rest was in Irwin stage II. No recurrence seen till date.
Conclusions: We conclude that meticulous curettage and filling of bone cavity by calcium phosphate hydroxyappatite and fixation with implant in displaced pathological fracture or impending fracture is the procedure of choice of management of benign lytic lesions of bone.

Keywords: Curettage, Calcium phosphate hydroxyappatite, Benign lytic, Cystic lesions

INTRODUCTION

Tumor like bone lesions can be latent like non ossifying fibroma or active like simple bone cyst or aggressive like aneurysmal bone cysts.[1,2] Most patients with aneurysmal bone cysts complain of mild to moderate pain that has been present for weeks to several months. Pathological fractures are detected incidentally or after trivial trauma in aneurysmal bone cysts in children.[3] Primary aneurysmal bone cyst (ABC) most commonly is diagnosed in the first two decades of life and may be slightly more common in females. Secondary ABC occurs in the age range of the underlying primary tumor. In unicameral bone cysts, boys outnumber girls by ~2:1, and most patients are under the age of 20 years. In contrast to a random finding of a juvenile or aneurysmal bone cyst, a pathological fracture often needs an

immediate treatment due to pain and (more rarely) due to instability of the fracture.

The most common treatment has been curettage with bone grafting which has substantial rate of recurrence.[4-6]

In young adults bone cavities have been reinforced with cortisone injection, autologous bone grafts, allograft, demineralized bone matrix and bone graft substitutes. Owing to its osteoconductive, osteoinductive and osteogenic potential, the autologous bone graft is considered as the gold standard. The scope of getting ample autologous bone graft in skeletally immature patients is limited. Calcium hydroxyappatite (HA) can be obtained from natural sources as well as from a synthetic process. Natural HA may be coral based, obtained from exoskeleton of marine species goniospora or can be of bovine origin. Synthetic HA is formed by the precipitation of calcium nitrate and ammonium-dihydrogen phosphate. Displaced fractures of upper/ lower limb or impending fractures of lower limb specially peritrochanteric fracture often need stabilization of fracture with implant. This procedure is combined with curettage, different kinds of bone substitute and individual or combined application of growth factors.[7]

The aim of the study is to monitor radiological incorporation of synthetic graft, time taken for graft incorporation to host bone, recurrence of lesion, follow up and functional status of limb after healing.

METHODS

This study was performed in the Department of Orthopaedics, North Bengal Medical College and Hospital from September 2015 to March 2018. 16 cases of benign osteolytic and cystic lesions of bone were included in the study. Provisional diagnosis was made with X-ray, CT scan and MRI.

Cystic lesions of different long bones of children and young adults were curetted and filled with hydroxyappatite synthetic bone grafts. In young adults impending fractures and displaced pathological fractures of lower and upper limbs were fixed with implants.

In proximal femoral cystic lesions with pathological fracture of young adults, the site is accessed by standard lateral exposure, the fracture site is exposed and with the help of curette the pathological material is scooped out until inner surface of cortex is felt by the end of curette. In case of aneurysmal bone cyst, membrane like material is taken out from the lesion. The fracture is reduced and fixed with proximal femoral nail and the cavity is packed with synthetic bone grafts.

In femoral cystic lesions of young adults with impending fracture, cortical window is made in the lateral femoral cortex. Scoop is used to curette out the tissue within the cystic lesion meticulously and cavity filled with hydroxyappatite blocks and prophylactic fixation done with dynamic hip screw barrel plate.

Cases of benign osteolytic and cystic lesions of distal radius, lateral malleolus, proximal tibia, proximal humerus and shaft tibia of children and young adults were exposed by proper approach and the pathological material is scooped out after cortical window and resultant bony cavity is filled with synthetic bone grafts.

Extra articular pathological distal humerus fracture was exposed by Campbell`s approach and fracture was fixed after freshening the bone ends curetting the cystic lesion. Pre-contoured plates were applied in both medial and lateral column and bony defect grafted with synthetic hydroxyappatite crystals.

All curetted material sent for histopathological examination.

Post-operatively upper limb lesions immobilized with plaster for 6 weeks and lower limbs for 8 weeks except proximal femoral lesions. Distal humeral pathological fracture was kept in plaster for 3 weeks post-operatively.

In upper limb (except elbow lesion) range of movement exercises were started after 6 weeks. Proximal tibia and shaft tibia lesions active movements were allowed in 8 weeks post-op after plaster removal. Lateral malleolus aneurysmal bone cyst was mobilized after 2 months since below knee cast was removed.

In proximal femoral cystic lesions, active hip and knee mobilizing exercises started in 7 days after operation.

In upper limb involvement, unrestricted activity was allowed in 8-12 weeks. All the patients with lower limb osteolytic lesions were protected from weight bearing for 12–20 weeks. Radiological evaluation of graft incorporation was done according to the criterion of Irwin et al.[8] Radiological stages of graft incorporation were as follows: stage I: obvious margins, stage II: hazy margin and stage III: obvious incorporation.

Periodic follow up was done in 2 month, 6 month,12 month,18 months and 30 month to assess bone formation, incorporation of graft, recurrence of lesion infection, healing of pathological fracture etc.

Statistical analysis was done with the help of computer using statistical package for social sciences (SPSS Inc., Chicago, IL, version 22.0 for Windows).

RESULTS

16 cases with benign cystic lesions of long bone were included in the study. The mean age was 11.2 years (range 6-20 years). There were 10 female and 6 male. 5 cases had pathological fracture.

Among 16 cases, two patients presented with non-ossifying fibroma and 2 patients with simple bone cyst, 12 cases were aneurysmal bone cyst (Table 1). Proximal femur (5 cases) was most common site involved followed by proximal tibia (3 cases) and distal radius (3 cases). Proximal humerus was the 4th common site with 2 cases. Majority of our cases presented with pain and swelling. Pathological fracture was seen in 5 cases (31.25%).

Table 1: Cases depending on the location (n=16).

Location of bony lesion	Aneurysmal bone cyst (ABC) (n=12) (%)	Simple bone cyst (SBC) (n=2) (%)	Non-ossifying fibroma (NOF) (n=2) (%)	Number of lesion (%)
Proximal femur	5 (31.25)	0	0	5 (31.25)
Proximal tibia	2 (12.5)	1 (6.25)	0	3 (18.75)
Proximal humerus	1 (6.25)	1 (6.25)	0	2 (12.5)
Distal radius	3 (18.75)	0	0	3 (18.75)
Shaft tibia	0	0	1 (6.25)	1 (6.25)
Distal humerus	0	0	1 (6.25)	1 (6.25)
Lateral malleolus	1 (6.25)	0	0	1 (6.25)
Total	12 (75)	2 (12.5)	2 (12.5)	16

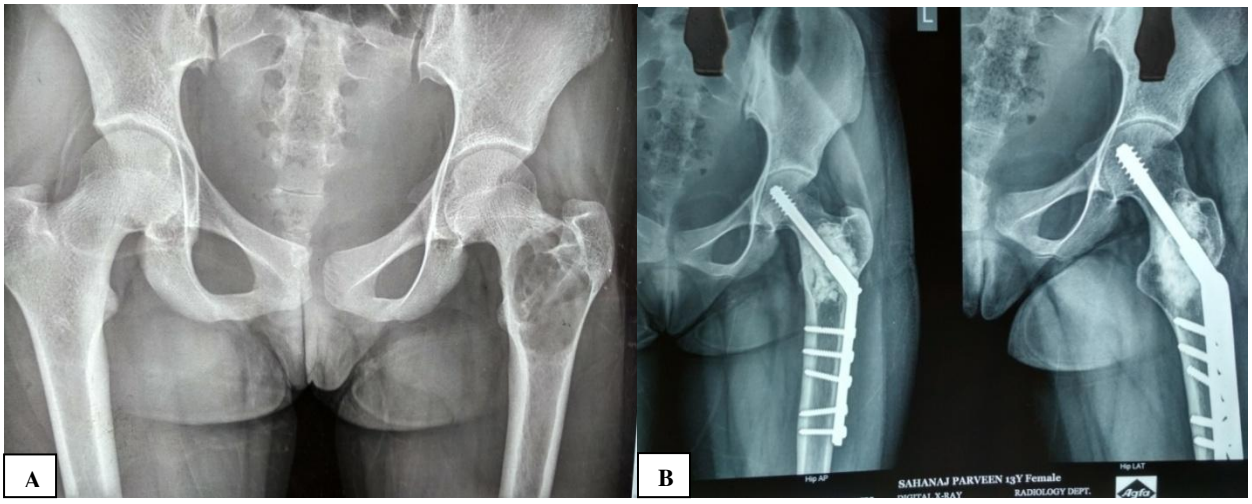

Figure 1: (A) Aneurysmal bone cyst (ABC) in proximal femur (left) in a 13 year old girl; (B) prophylactic fixation with paediatric dynamic hip screw and filling the cavity with synthetic bone graft leading to complete incorporation of graft within 12 months.

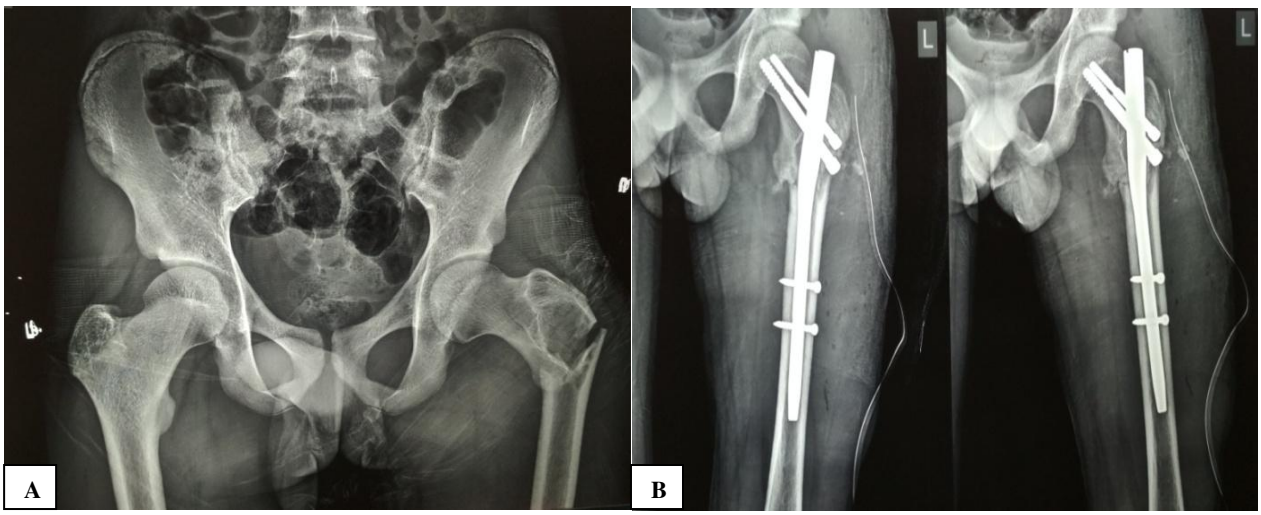

Figure 2: (A) Aneurysmal bone cyst with pathological fracture in left femur in a 16 year old boy; (B) fixation of pathological fracture with short PFN and packing the cavity with hydroxyappatite crystals.

Femoral lesions

Displaced femoral pathological fractures were fixed by proximal femoral nailing in 3 patients. Two cases with impending fracture of proximal femur were prophylactically fixed with dynamic hip screw. In all cases, curettage was followed by synthetic bone grafting (Figure 1 and 2). The patients were allowed full weight bearing in 4-5 months. Synthetic bone graft incorporated to host bone within 12 months except in one case taking longer time.

Distal humerus

One patient aged 14 year presented with distal humerus fracture due to non-ossifying fibroma. Distal humerus pathological fracture treated with curettage, fixed with precontoured plate and synthetic bone grafting. Post-op the patient was immobilized for 3 weeks and ROM exercises started. Unrestricted activity was allowed 3 months since operation and the lesion healed uneventfully in 6 months (Figure 3).

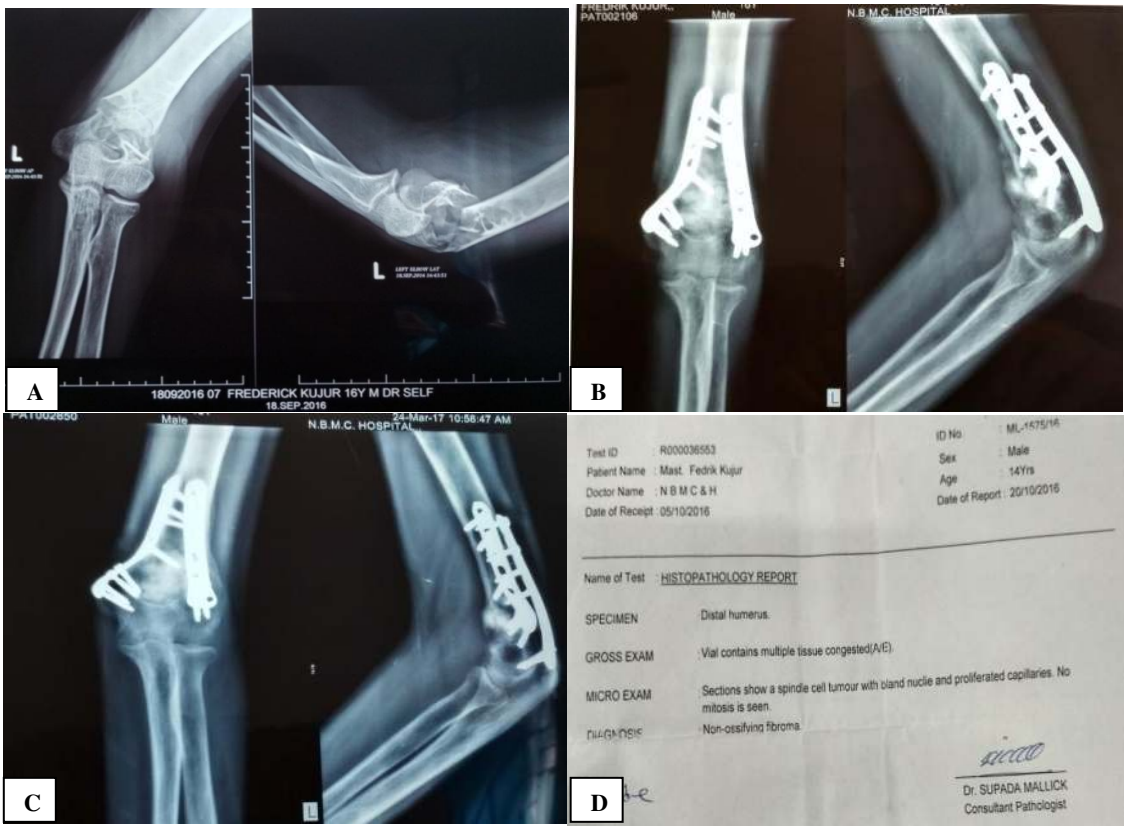

Figure 3: (A) Non-ossifying fibroma in distal humerus (left) with pathological fracture in 14 year old male patient; (B) fixation of pathological distal humeral fracture with precontoured plate and synthetic bone grafting; (C) follow up at 6 months showing fracture union and intake of graft; (D) HPE report of pathological fracture.

Proximal tibia

3 patients presented with proximal tibia cystic lesions. All underwent curettage and synthetic bone grafting. Full weight bearing was allowed in 4-6 months in these cases. In two cases radiological incorporation of bone graft was incomplete (Irwin stage II) in 12 months (Figure 4). However clinical recovery preceded radiological graft healing.

Shaft tibia

One patient presented with non-ossifying fibroma of proximal shaft tibia with pathological fracture. 6 months after curettage and bone grafting, grafts showed partial incorporation (Irwin grade II). However in 12 months the graft was incorporated completely (Irwin grade III).

Distal radius

All the three patients had aneurysmal bone cyst in distal radius. Following curettage and synthetic bone grafting in 12 month follow up showed one patient with Irwin grade III graft incorporation (Figure 5) , while in rest of the cases the healing were incomplete.

Proximal humerus

Two cystic lesions of proximal humerus were packed with copious amount of synthetic graft after thorough curettage. All healed completely (Irwin grade III) within 1 year.

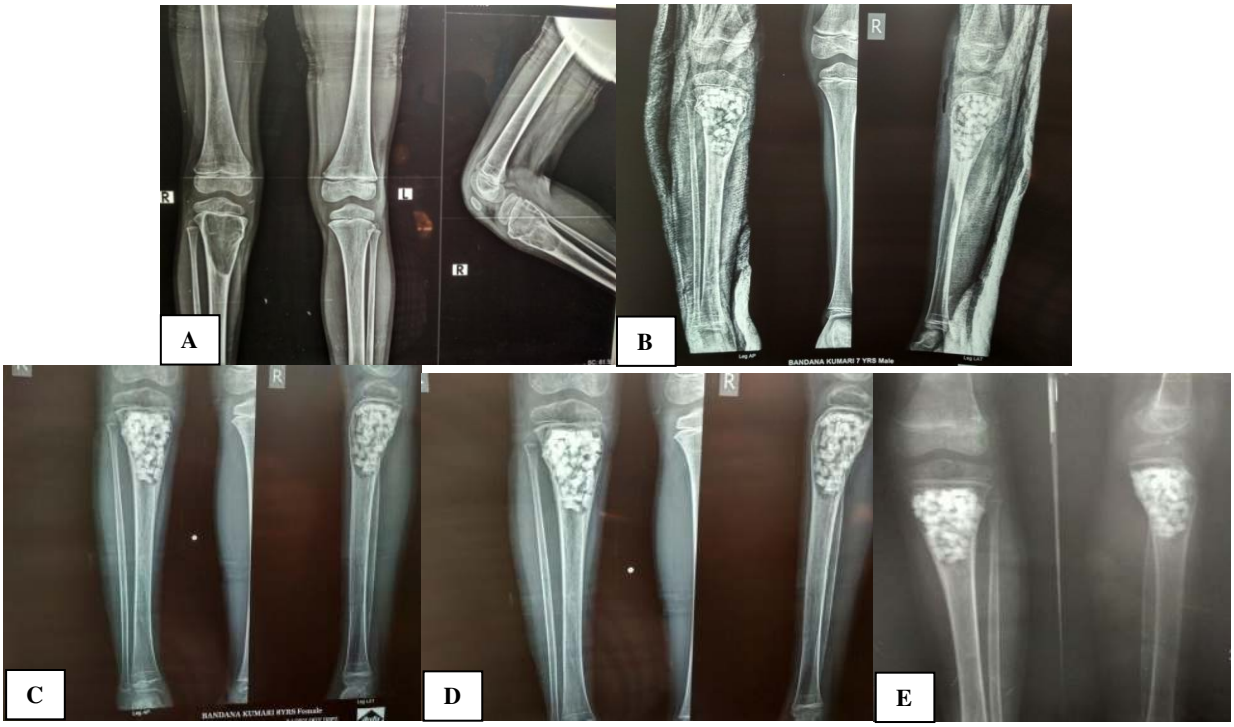

Figure 4: (A) Aneurysmal bone cyst with impending fracture in right proximal tibia in 8 year old girl; (B) post-op X-ray of curettage and bone grafting; (C) at 2 months follow up; (D) at 6 months follow up; (E) follow up at 12 months showing partial incorporation of graft (Irwin grade II).

Figure 5: (A) Aneurysmal bone cyst in distal radius (right) in a 6 year old girl; (B) curettage and synthetic bone grafting in distal radius; (C) follow up at 6 months showing complete graft incorporation; (D) follow up at 12 months; (E) HPE report.

Lateral malleolus

Aneurysmal bone cyst in lateral malleolus healed partially in 14 months post-op and graft showed partial incorporation.

During this study the average follow-up was 17.5 months (range 12-30 months). Upper limb osteolytic lesions immobilized about 6 weeks after curettage and bone grafting except elbow lesion. For tibia and fibula osteolytic lesions, plaster is kept for 2 months after operative intervention. In proximal femoral lesions, knee and hip mobilization started 7 days post operatively. Patients with upper limb involvement, unrestricted activity was allowed in 8-12 weeks. All the patients with lower limb osteolytic lesions were protected from weight bearing for 12–24 weeks.

Healing occurred in aneurysmal bone cyst cases at an average 10.3±2.93 months (range 6–12 months) while in other cases at an average 10±3.46 months (range 6–12 months). The clinical recovery observed before the radiological recovery in our series. Full weight bearing without support was allowed in all patients at 6 months follow up. Normal activity was allowed in mean duration of 15.38±4.42 weeks.

At 6 months of follow up 3 cases were in Irwin stage III, 9 cases were in Irwin stage II and 4 cases were in Irwin stage I (Table 2). At final follow up 10 cases were in Irwin stage III and rest of the cases was in Irwin stage II. All lesions healed in mean duration of 10.2±2.90 months (Table 3).

Table 2: Graft incorporation at 6 months and 12 months (n=16).

Location	Number (%)	Irwin grading in 6 months (%)			Irwin grading in 12 months (%)		
		Grade I	Grade II	Grade III	Grade I	Grade II	Grade III
Proximal femur	5 (31.25)	2 (12.5)	3 (18.75)	0	0	1 (6.25)	4 (25)
Proximal tibia	3 (18.75)	1 (6.25)	1 (6.25)	1 (6.25)	0	2 (12.5)	1 (6.25)
Proximal humerus	2 (12.5)	0	2 (12.5)	0	0	0	2 (12.5)
Distal humerus	1 (6.25)	0	0	1 (6.25)	0	0	1 (6.25)
Distal radius	3 (18.75)	1 (6.25)	1 (6.25)	1 (6.25)	0	2 (12.5)	1 (6.25)
Lateral malleolus	1 (6.25)	0	1 (6.25)	0	0	1 (6.25)	0
Shaft tibia	1 (6.25)	0	1 (6.25)	0	0	0	1 (6.25)
Total	16	4 (25)	9 (56.25)	3 (18.75)	0	6 (37.5)	10 (62.5)

Table 3: Mean and standard deviation of various parameters of patients having cystic and lytic lesions of bone.

Variables	Mean±SD (range)		
	Total (n=16)	Aneurysmal bone cyst [ABC] (n=12)	Other cystic and lytic lesions [SBC and NOF] (n=4)
Age (in years)	11.2±4.05 (6-20)	11.25±4.47 (6-20)	11±2.94 (8-14)
Follow up in months	17.5±5.78 (12-30)	17.67±6.15 (12-30)	17±5.29 (12-24)
Month taken for healing	10.2±2.90 (6-12*)	10.3±2.93 (6-12**)	10±3.46 (6-12***)
Movement started in weeks (post-op)	4.88±2.99 (1-8)	4.42±3.12 (1-8)	6.25±2.36 (3-8)
Normal activity allowed in weeks (post-op)	15.38±4.42 (10-24)	16±4.43 (10-24)	13.5±4.43 (10-20)

SD=Standard deviation; NOF=Non-ossifying fibroma; SBC=Simple bone cyst. * Within 12 months, 10 cases healed completely (Irwin grade III). In rest of the 6 cases healing was incomplete (Irwin grade II). ** In 12 months, graft incorporation was complete in 7 cases of ABC, rest of the cases (5) partial incorporation was seen. *** Other cystic and lytic lesions-- 3 cases healed within 12 month, in one cases healing was partial (radiologically).

Figure 6: Range of movement of left shoulder joint and operative scar mark at 18 months follow up of curettage and hydroxyappatite bone grafting in proximal humerus aneurysmal bone cyst (left).

In few cases like distal humerus pathological fracture terminal loss of joint movement was noted, there is no significant loss of joint movement in lesions involving other sites (Figure 6). Till date, no cases presented with recurrence of lesion.

DISCUSSION

Curettage is the commonest mode of the treatment of the benign bone tumors and the lytic lesions. Bone defect after curettage of benign bone tumors should be filled with bone grafts or substitutes such as hydroxyappatite, tricalcium phosphate and cement.[9] Autograft are free of disease transmission or immunological reactions and have properties of osteogenesis, osteoinduction and osteoconduction, but are associated with the donor site morbidity.

Poly (methyl methacrylate) (PMMA) is inert and non-bio-degradable so it persists within the bone cavity. PMMA provides instant stability and sufficient quantity for large tumor cavities; its exothermic reaction kills tumor cells and causes less recurrence.[10,11]

HA has low density ultraporous structure with osteoconductive properties. The three dimensional structure provides scaffolding for bone in-growth.

Holmes et al studied diaphyseal defects in dogs implanted with hydroxyapatite.[12] Histological study of animals demonstrated new bone formation layered upon hydroxyappatite. Mechanical testing reinforces the view that HA once incorporated into bone is stronger than the bone it replaced.

The nature of the filling material used or the type of adjuvant method or combination of both has failed to show any statistical impact on the recurrence risk or on bone remodeling and bone strength. Rather it is the adequate exposure, histological type and curettage/removal of complete tumor cells followed by cauterizing the wall that is more important predictive factor for the successful outcome of surgery.[13]

One study performed by AK Gupta et al 37 cases of benign bone tumour was curetted and filled with HA bone substitutes.[14] After 12 months of follow up five cases were in Irwin stage I, 13 were in Irwin stage II and 19 were in Irwin stage III. In the study of Reddy and Swamy bone formation was seen in all cases by 4–6 weeks.[15]

In our study, 16 cases were operated, two patients presented with non-ossifying fibroma and 2 patients with simple bone cyst (unicameral), 12 cases were aneurysmal bone cyst. Curettage of lesion and filling up with synthetic bone graft was done in all cases. Pathological displaced fractures were fixed with implants.

Healing of lesion and graft incorporation is seen in all of the cases. At final follow up, 10 cases were in Irwin stage III and rest of the cases was in Irwin stage II. No recurrence seen in till date.

CONCLUSION

Simple curettage and bone grafting of the resultant bony cavity is the most common surgical procedure adopted in the treatment of benign lytic and cystic lesions of bone despite high rate of recurrence.

Autologous bone graft provides the most rapid and most reliable healing rate because it is osteogenic, osteoinductive and osteoconductive, but it is associated with additional morbidity at the donor site, and it may not be available in sufficient quantity to fill a large cavity in children and skeletally immature individual.

The HA has excellent biocompatibility and provides right scaffolding for in-growth of bone forming tissue and thus ultimately gets well incorporated with the host bone. Artificial bone graft substitutes are easy to procure and are affordable.

Though less number of patients and short mean follow up are limitation of our study, curettage with filling of resultant bony cavity with HA and fixation with implant of displaced or impending peritrochanteric fracture and displaced periarticular fractures yielded good result in benign cystic/ lytic lesions of bone.

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