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Clinical outcome of reconstruction using a frozen autograft for a humeral bone tumor

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Background

We developed a frozen autograft technique in which a tumor-bearing bone was treated with liquid nitrogen. For humeral reconstruction after bone tumor resection, we used frozen autografts to acquire good function and preserve bone stock. The purpose of this study was to evaluate the functional outcomes and complications of patients treated with frozen autograft after resection of malignant or aggressive benign humeral bone tumors and describe our current strategy based on the results.

Methods

Nine patients who underwent a minimum of 2 year of follow-up after surgery were included in this study. The histological diagnoses were 6 osteosarcomas, 1 chondrosarcoma, 1 multiple myeloma, 1 aggressive osteoblastoma, and 1 phosphaturic mesenchymal tumor (fibroblast growth factor 23–producing tumor). The mean follow-up period was 52.8 months (range, 25–153 months).

For the freezing procedure, we performed free freezing in the first 2 cases and pedicle freezing, in which anatomical continuity on one side was maintained, in the other 7 cases. Freezing range was classified into 2 groups depending on whether the joint surface of the humeral head was frozen. The joint freezing group included 4 patients, whereas the joint preservation group included 5 patients. We evaluated the reconstruction methods, range of motion (ROM) of the shoulder joint, function of the upper extremities using the International Society of Limb Salvage/Musculoskeletal Tumor Society (ISOLS/MSTS) scoring system, bone union at the osteotomy site, bone absorption of the frozen bone, and complications in each group.

Results

In the joint freezing group, the first 2 patients underwent reconstruction with an osteoarticular graft fixed with intramedullary nailing and bone cement. Because severe bone absorption of the humeral head occurred in these 2 cases, the latter 2 patients underwent reconstruction with frozen autograft prosthesis composite. The mean active shoulder abduction and flexion were 43° and 55°, respectively, and the mean ISOLS/MSTS score was 70.8%.

In the joint preservation group, fixation with intramedullary nailing and bone cement was performed in 2 cases, whereas fixation with double plating was performed in 3 cases. Mean active shoulder abduction and flexion were 140° and 142°, respectively, and the mean ISOLS/MSTS score was 92.7%.

Seven patients who had at least one osteotomy site underwent bone union evaluation. Final bone union was achieved in 6 of 7 (85.7%) cases. The mean union period was 12.7 months (range, 4–24 months).

Bone absorption of the frozen autograft was observed in 7 of 9 cases. Progressive and massive bone absorption was seen in 3 cases with an osteoarticular frozen autograft, free freezing procedure, or freezing range >20 cm. In the other 4 cases, slight bone absorption that stopped within 12 months was seen.

Regarding the other complications, infection occurred in one case and periprosthetic fracture occurred at the distal end of the prosthesis in one case. There was only one failure due to progressive bone absorption that required construct removal.

Discussion

Our results indicated that the freezing method that involved the humeral head joint surface resulted in loss of ROM and unfavorable upper limb function because the entire rotator cuff had to be mutilated once. Recently, reverse shoulder arthroplasty (RSA) has been reported to improve the function of shoulder with rotator cuff deficiency. RSA-frozen graft composite may potentially become popular option in transarticular proximal humeral resection.

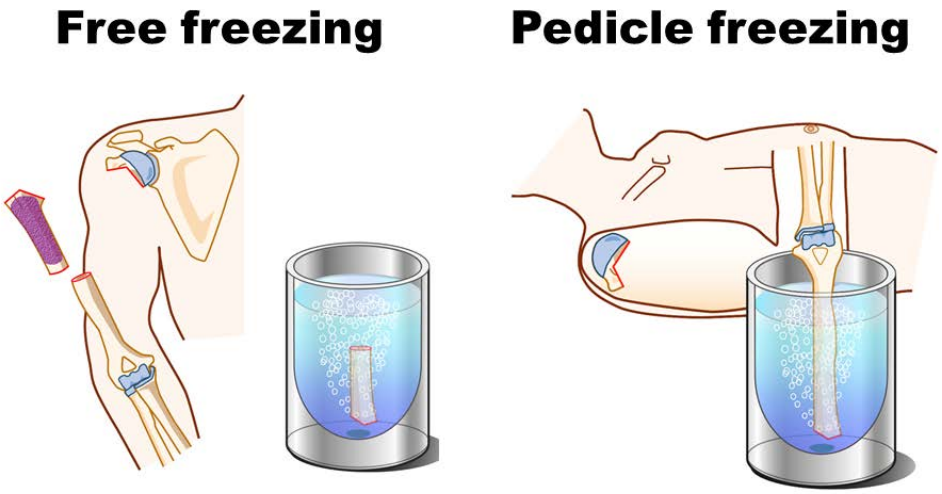
Progressive bone abruption was associated with long frozen bone range (>20 cm), use of the free freezing method, and use of osteoarticular grafts.

Based on these results, our current strategy for reconstruction with frozen autograft after resection of humeral bone tumor is as follows:

1. Pedicle freezing whenever possible
2. Combination with vascularized fibula graft only if freezing range is >20 cm
3. Frozen autograft prosthesis composite is preferred to osteoarticular graft after transarticular resection.

Conclusions

Reconstruction using a frozen autograft after resection of malignant or aggressive benign tumors of the humerus is a good option associated with good function and acceptable complications. Functional outcome is strongly influenced regardless of whether the joint surface of the humeral head is treated. Absorption of frozen bone is associated with long frozen bone range (>20 cm), use of the free freezing method, and use of osteoarticular grafts.



	Reconstruction	ROM abduction	ROM flexion	ISOLS score
Joint freezing N=4	Osteoarticular N=2 Composite N=2	43 (0-60)	55 (0-80)	70.8% (53.3 – 80.0)
Joint preservation N=5	IM nail with bone cement N=2 Double plate N=3	140 (100-180)	142 (100-180)	92.7% (83.3 – 100)