



16 , 6 , 3  
 , 2 ,  
 1 . Enneking <sup>10)</sup>  
 IIA가 10 , IIB가 19 ,  
 가 7 , 가 6 ,  
 가 5 , 가 4  
 , 가 2 , 1 .

23

가 .

, 가 , 가 2.

가

18

가 29  
가

6

, 5 가 (deep freezing), 11  
 가 (autoclaving), 7  
 가 (pasteurization) 가  
 , 5 -  
 가

1.

-196℃

10 가 37℃

1990 2 2003 1 3 . 6 2

가 4

가 29 18 가 .

33 , 10 가 18 , 65 가 11 , . 11 132℃, 2 10  
 18 117 7

51.8 , 2

2 . 가 5 5 ( , 3~7 )  
 가  
 65℃  
 30 . 7 4 11 2 가  
 14 15  
 (Table. 1).

, 3

5 - 가 2.

, 2

가 1 .  
 가 , 3 가  
 가 K- 34 .

3. 가

가 가 15  
 가 가 25 .  
 가 가 3. 가

. , , 29 가 76.8%(  
 , 40~90%) 65.8%(  
 , 가 1993 40~85%), - 76.6%(  
 (International Symposium On 40~90%), 81.6%(  
 Limb Salvage; ISOLOS) , - 가

9).

83.4%(  
 가 , 75~90%) .  
 가 6

1.

, 가  
 가 , , ,  
 가  
 7.2  
 ( , 3~15 ) . 가

6 5.8 ( , 4~8 ), 4.  
 - 11 9.7  
 ( , 6~15 ), 7 29 4 ,  
 5.9 ( , 4~8 ) 2 , 1 ,  
 , - 1 . -

— : 가 —

가

14 15 ,

- 1 (Case No.1)

가

12 44 2

(Fig. 1A-B)

**Table 1.** Summary of patient data

Patient	Age	Sex	Diagnosis	Lesion	Type	Treatment	Complication	Union (Mo)	F/U (Mo)	Function (%)
1	44	M	OSA	P-Tibia	F	Fusion	Recurrence	8	34	46
2	22	M	Periosteal OSA	D-Femur	F	Fusion		6	47	40
3	13	M	OSA	D-Femur	F	Intercalary		4	76	85
4	30	M	MFH	D-Femur	F	Intercalary	Infection	8	18	74
5	17	M	OSA	P-Tibia	F	Intercalary		4	27	70
6	19	F	OSA	P-Tibia	F	Intercalary		5	76	80
7	48	M	SMP	P-Humerus	A	Fusion		9	49	40
8	26	M	OSA	P-Humerus	A	Bipolar	Nonunion	14	81	87
9	65	M	CS	Pelvis	A	THR		10	33	85
10	41	M	Parosteal OSA	P-Femur	A	Intercalary		9	61	83
11	35	M	MFH	Femur	A	TKR	Fracture	10	26	70
12	17	M	OSA	P-Tibia	A	TKR		6	95	90
13	49	F	CS	D-Femur	A	Intercalary		7	37	80
14	50	M	CS	P-Humerus	A	Bipolar		11	31	84
15	32	M	OSA	P-Humerus	A	Bipolar	Nonunion	15	75	75
16	33	M	OSA	D-Femur	A	Fusion		8	109	65
17	42	F	MFH	D-Femur	A	TKR		8	41	84
18	18	M	OSA	Tibia	P	Intercalary		4	117	90
19	15	F	OSA	Tibia	P	Intercalary		5	92	90
20	57	F	CS	P-Humerus	P	Bipolar		8	38	70
21	45	F	CS	P-Humerus	P	Bipolar		8	35	75
22	41	F	Parosteal OSA	Femur	P	TKR		5	56	81
23	25	M	OSA	Tibia	P	Intercalary		5	77	85
24	27	F	OSA	D-Femur	P	TKR	Metastasis	6	25	80
25	55	F	OSA	P-Femur	C	Onlay		7	23	80
26	10	F	OSA	Femur	C	Medullary		3	35	90
27	13	F	OSA	Femur	C	Medullary		4	27	85
28	15	M	OSA	Tibia	C	Medullary		4	42	87
29	49	M	CS	Tibia	C	Onlay		7	20	75

OSA, Osteosarcoma; MFH, Malignant Fibrous Histiocytoma; SMP, Solitary Malignant Plasmacytoma; CS, Chondrosarcoma; P, Proximal; D, Distal; F, Deep Freezing; A, Autoclaving; P, Pasteurization; C, Autoclaving and Vascularized Fibular Graft Composite; Bipolar, Bipolar Shoulder Hemiarthroplasty; TKR, Total Knee Arthroplasty; Mo, Months.

1C-D).

8

, 20

가

34

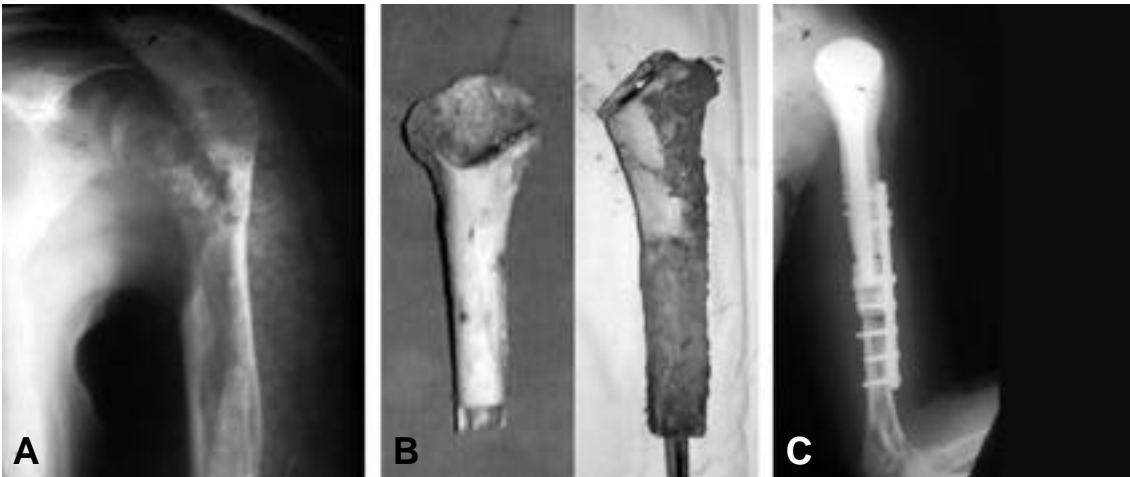
가 Huckstep nail  
(Fig.



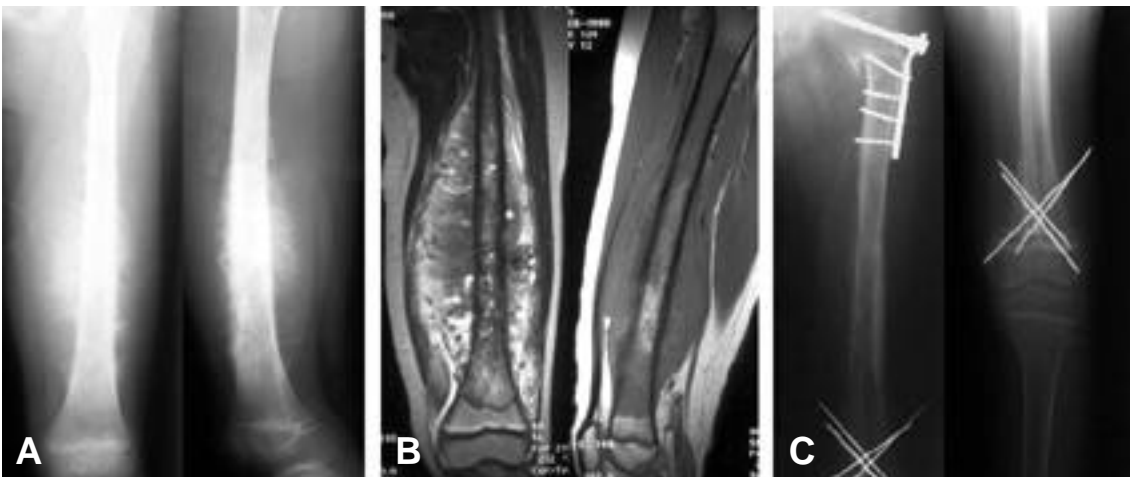
**Fig. 1.** Osteosarcoma of the right proximal tibia in a 44-year-old male. (A, B) Initial radiographs and MRI show pathologic changes of proximal tibia. (C) He underwent limb salvage operation with deep frozen autogenous bone graft. (D) The knee joint was fused by Huckstep nail. After 34 months, he expired due to multiple metastasis.

2 (Case No.8)

26 1 (Fig. 2B-C).  
 10 가  
 (Fig. , 14  
 2A) 81  
 가 87% .



**Fig. 2.** (A) Osteosarcoma of the left proximal humerus in a 26-year-old male. (B) After wide resection, soft tissue was peeled off and medullary canal was curetted. The bone was autoclaved and then, the bipolar shoulder prosthesis was inserted with bone cement. (C) The composite of autogenous bone and prosthesis was fixed with plate and screws.



**Fig. 3.** Osteosarcoma of the left femur shaft in a 10-year-old girl. (A, B) Initial radiographs and MRI show wide spread pathologic lesion at the femur shaft. (C) The femur shaft was re-inserted after autoclaving and the vascularized fibula was inserted in the medullary canal.



— : 가 —

가  
- Gallie<sup>11)</sup>가 90% , 80 ℃  
가 80% , 100 ℃

14,17,19)  
- , Chang <sup>4)</sup> 가

. Kohler <sup>19)</sup> 가  
가 20~25% 가  
, Nakanishi <sup>24)</sup> 가

가 가 가 , 가  
132℃ -

. Urist <sup>33,34)</sup> 가  
23,30)

가  
70℃ 가  
7

- 가 -  
가

11 2  
1 12  
. Kohler Kreicberg<sup>18)</sup>  
가

. 가  
21,27)

가 가 <sup>2,26)</sup> Taguchi

<sup>14,15,22)</sup> Dickson Calderwood<sup>8)</sup> <sup>31)</sup> 가  
(thermosensitivity)42℃ 44℃  
가

, 가 가 가 , 가  
(thermal death  
time) 50℃ 가 가  
30 5 - 가

. Manabe<sup>23)</sup> 가  
가

. Ohura<sup>25)</sup> 60℃



가  
가  
가  
가  
가

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**Abstract**

## **Limb Salvage Operation with Recycled Autogenous Bone Graft**

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**Purpose:** To determine the usefulness of limb salvage operation with recycled autogenous bone graft in musculoskeletal malignant tumors.

**Materials and Methods:** Twenty nine cases, who underwent limb salvage operation with recycled autogenous bone graft for the treatment of musculoskeletal malignant tumor between February 1990 and January 2003, were included. There were 18 males and 11 females and the mean age was 33 years (range, 10 to 65 years). The mean follow-up period was 51.8 months (range, 18 to 117 months). The Enneking stage was IIA in 10 cases and IIB in 19 cases. The recycling method of autogenous bone was deep freezing in 6 cases, autoclaving in 11 cases, pasteurization in 7 cases and the composite of autoclaving and vascularized fibular graft in 5 cases. The union of junctional site was evaluated radiologically and the functional results was analyzed by the grading systems of the International Symposium On Limb Salvages (ISOLS).

**Results:** The mean union time was 7.2 months (range, 3 to 15 months). The union took 5.8 months (range, 4 to 8 months) in deep freezing, 9.7 months (range, 6 to 15 months) in autoclaving, 5.9 months (range, 4 to 8 months) in pasteurization, and 5 months (range, 4 to 8 months) in the composite of autoclaving and vascularized fibular graft. The mean functional evaluation percentage was 76.8% (range, 40 to 90%). It was 65.8% (range, 40 to 85%) in deep freezing, 76.6% (range, 40 to 90%) in autoclaving, 81.6% (range, 70 to 90%) in pasteurization, and 83.4% (range, 75 to 90%) in the composite of autoclaving and vascularized fibular graft. There were 6 cases of complications including 1 case of local recurrence, lung metastasis, infection, fracture, respectively and 2 cases of nonunion.

**Conclusion:** The limb salvage operation with recycled autogenous bone graft is a useful treatment method for the musculoskeletal malignant tumors. Particularly, autoclaving is the most reliable sterilization method. The vascularized fibular graft can compensate decreased osteoinductivity and mechanical strength of recycled bone. So, the composite of autoclaving and vascularized bone graft seems to be a favorable treatment method for high grade malignant musculoskeletal tumors.

**Key Words:** Sarcoma, Limb salvage, Recycled autogenous bone graft, Vascularized fibular graft

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