

13 , 4 , 2000 10

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Vol.13, No.4, October, 2000

가 ; 가  
가

\*  $\frac{1}{2} \leq \frac{1}{2} \leq \frac{1}{2}$

\*

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가

$$\vdots$$

(2.0-2.5kg)

7mm7t

1mm

2 가  
(Osteoset , Wright r  
가

. 1 7

Lubboc 5mm<sup>2</sup>

DEXA(dual energy X-ray absorptiometry, Lunar )

1

16.9, 14, 15.4 가 가

16.9

가

: 가 가

가

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27† 50

Tel : (053) 420-5630

Fax : (053) 422-6605

\* 1999

\* ( )



가

7,8)

(distraction osteogenesis) (bone defect)

(limb shortening)

가

, Wagner<sup>19)</sup>

(consolidation) 가

(external fixator)

(bone graft substitutes)

(calcium sulfate)

(Fig. 1)

period) 1 5 (latency

1mm 2 7mm가

가

(calcium sulfate)

Osteoset (, Wright medical, USA)

98%  $\text{CaSO}_4 \cdot \text{H}_2\text{O}$ , 0.5%  $\text{CaCO}_3 \cdot \text{MgCO}_3$ ,

0.3%  $\text{CaCO}_3$

(xenograft) Lubbock (bovine)

(purified)

2.

7 1

가 (distraction callus)

100mg(1 ) 5mm<sup>2</sup>

, 7 ( )

1

가

2-2.5kg

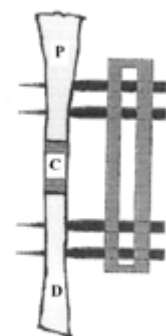
가 (New Zealand white rabbit) 14

, ketamine



**Fig 1.** Photographs and x-ray of rabbit that had osteotomy and external fixation(left and second), the inserted calcium sulfate(third), and inserted Lubbock(right side).

$$\text{BMD ratio} = (\text{C/P} + \text{C/D}) / 2$$



**Fig 2.** Calculation of bone-density ratio ; P and D are the values of bone mineral density in the proximal and distal area to osteotomy site, and C is the value of distraction area.



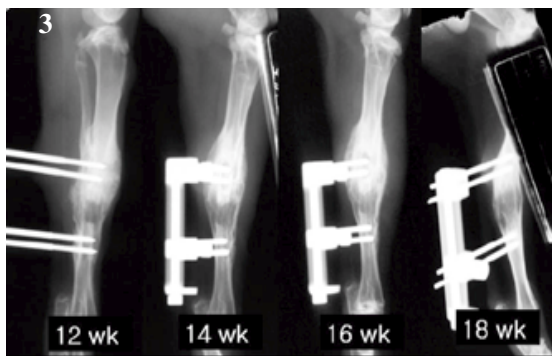
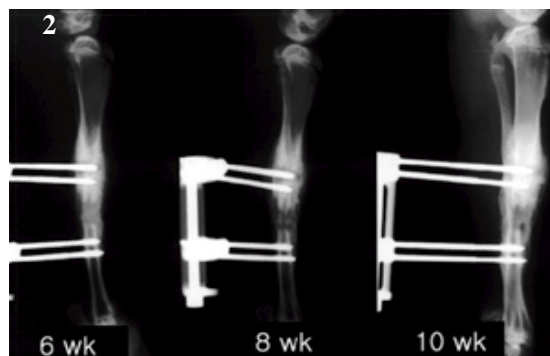
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가

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• 689

3 가 . 10.5 ,  
(DEXA, 13.2 , 16.9  
dual energy x-ray absorptiometry, Lunar )  
(marrow canalization)  
ketamine , 가  
1 1  
(Fig. 2),  
(modified bone density ratio)<sup>4)</sup> (Fig. 3), 가 4 , 2 가  
2 . 가 , 6 ,  
8.5 ,  
10.1 , 14 가  
1. 2  
( ) , , 4  
2 , 8  
, 4-5 가 , 10  
가  
6.2 , 15.4  
가 , 가



**Fig 3.** Serial changes of radiographs in control group

At 2 week, radio-opaque shadow was seen on distraction area(Fig3-1).The corticalization of distraction callus was seen at 10 week(Fig 3-2),and at 17 week the marrow of distraction callus was cleared and the cortex of that was obvious(Fig3-3).

**Table 1.** Bone density ratio in group of control group

	3 wk	5 wk	7 wk	9 wk	11 wk	13 wk	15 wk	17 wk
C-1	0.018	0.110	0.234	0.272	0.413	0.416	0.598	0.530
C-2	0.107	0.066	0.455	0.551	0.631	0.333	0.364	0.290
C-3	0.189	0.183	0.193	0.321	0.375	death	death	death
C-4	0.133	0.173	0.172	0.267	0.223	0.347	0.512	death
C-5	0.056	0.185	0.282	0.302	0.335	0.433	0.508	0.578
C-6	0.067	0.211	0.293	0.354	0.412	0.483	0.605	0.590
C-7	0.091	0.178	0.302	0.377	0.431	death	death	death
mean	0.094	0.158	0.275	0.349	0.403	0.402	0.517	0.497

**Table 2.** Bone density ratio in group of calcium-sulfate(Osteoset) insertion(1st experimental group).

	5 wk	7 wk	9 wk	11 wk	13 wk	15 wk	17 wk
O-1	0.127	0.237	0.612	0.534	0.604	0.485	0.466
O-2	0.123	0.341	0.596	0.362	0.545	0.471	0.455
O-3	0.079	0.120	0.259	0.481	0.502	death	death
O-4	0.217	0.478	0.577	0.472	0.522	0.466	death
O-5	0.194	0.341	0.589	0.421	0.482	0.573	death
O-6	0.109	0.151	0.196	0.188	death	death	death
O-7	0.072	0.142	0.287	0.625	0.862	0.764	0.719
mean	0.131	0.258	0.445	0.440	0.586	0.551	0.547

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15

(p=0.01).

2. 가

가

3

2

3

0.094, 5 0.158, 7 0.275, 9 0.349, 11

0.403 15 0.517

(limb lengthening)

(Table 1).

가

3),

(distraction

5

2

osteogenesis)

(bone defect)

(limb

shortening)

5

0.131,

7 0.258, 9 0.445 11 0.440, 13 0.586

15),  
2,6,12,21),

가

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(Table 2),

5

0.134, 7

가

0.253, 9 0.422, 11

0.431, 13

0.532

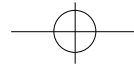
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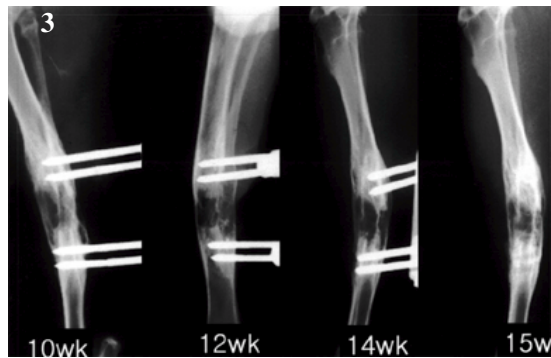
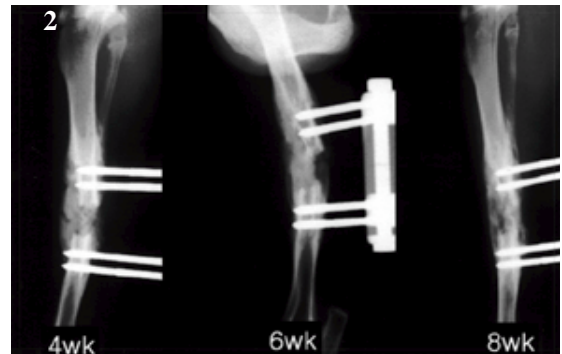
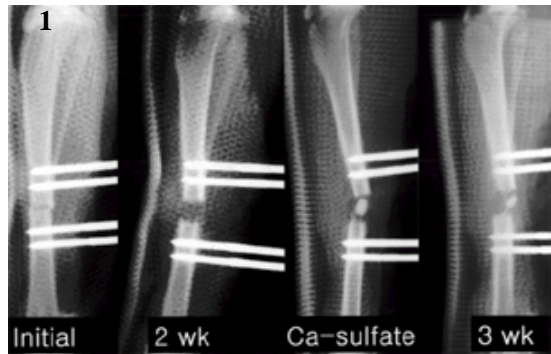


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**Fig 4.** Serial changes of radiographs in calcium-sulfate insertion group.

The calcium-sulfate was inserted at 1 week after lengthening, and at 2 week it was nearly absorbed(Fig4-1). At 4 week, whole of the distraction site was filled with radio-opaque shadow(Fig 4-2), and the cortical shadow of both sides was seen at 10 week, and at 13 week the marrow of distraction area was cleared and the cortex of that was obvious(Fig4-3).

가 (autogenous bone graft)<sup>5)</sup>

(autogenous bone marrow cells),  
(marrow-derived mesenchymal progenitor cells),  
demineralized bone matrix, bone morphogenic  
protein(BMPs), (allograft)  
가

4,13,17,20),

가

(osteoblast)가  
(osteoclast)가

10,18)

(hydroxyapatite)

3

(tricalcium phosphate)

9,14),

demineralized bone matrix

, Richards<sup>17)</sup>

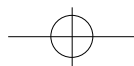
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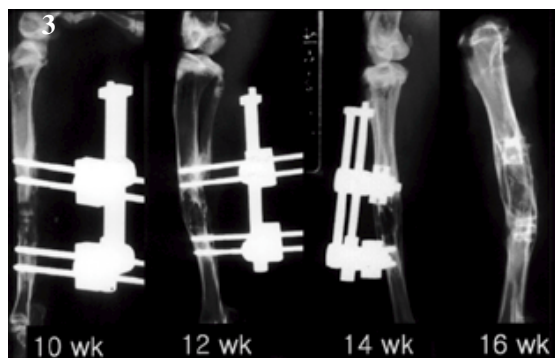
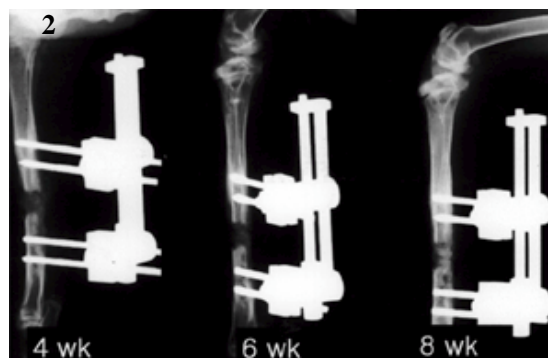
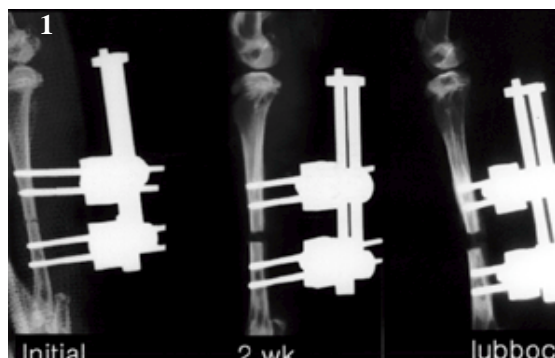
1.5

3 ,



**Table 3.** Bone density ratio in group of xenograft(Lubboc ,) insertion(2nd experimental group).

	5 wk	7 wk	9 wk	11 wk	13 wk	15 wk	17 wk
L-1	0.115	0.222	0.589	0.577	0.645	death	death
L-2	0.133	0.321	0.552	0.412	0.521	0.401	0.386
L-3	0.102	0.110	0.238	0.407	death	death	death
L-4	0.198	0.445	0.512	0.446	0.504	0.447	death
L-5	0.214	0.354	0.578	0.448	0.565	0.588	0.501
L-6	0.084	0.167	0.209	0.192	0.266	death	death
L-7	0.095	0.156	0.278	0.541	0.695	0.623	death
mean	0.134	0.253	0.422	0.431	0.532	0.514	0.443



**Fig 5.** Serial changes of radiographs in xenograft(Lubboc) insertion group. The xenograft was inserted at 1 week after lengthening, but we cannot know distinct shadow at 4 week (Fig 5-1). At 6 week, the distraction site was partially filled with radio-opaque shadow(Fig 5-2), and the cortical shadow of both sides was seen at 10 week, and at 12 week the marrow of distraction area was cleared and the cortex of that was obvious at 15week(Fig 5-3).

(micro-radiography)

,  
, Kojimoto <sup>11)</sup>

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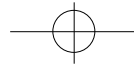
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Aronson <sup>1)</sup>

(quantitative computerized  
tomography)  
period) 가 가  
(consolidation period) 75% 가 ,

(fibrous interzone)

가



가

가

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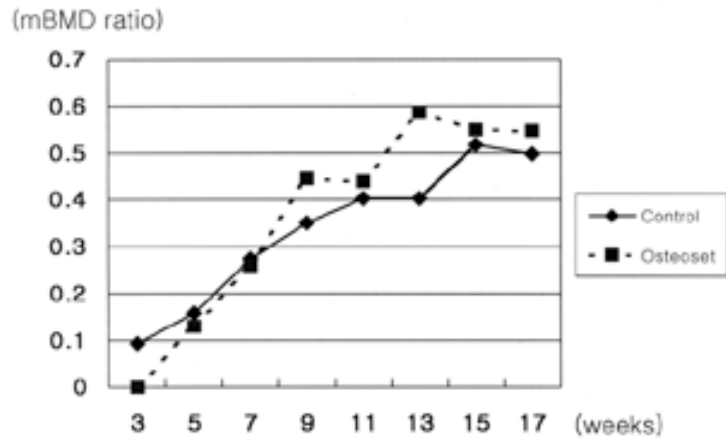


Fig 6-1

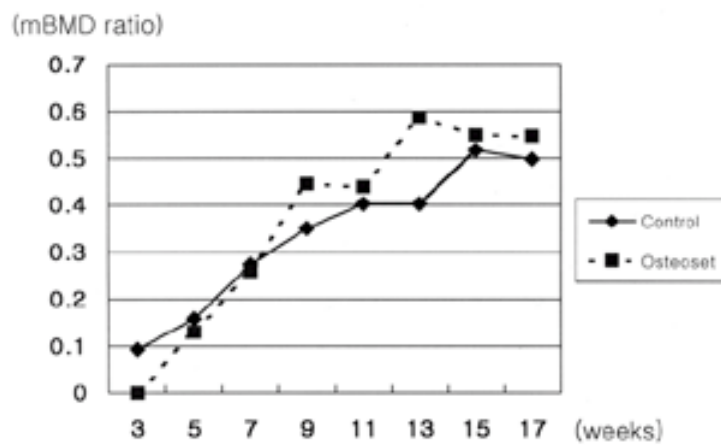


Fig 6-2

**Fig 6.** Changes of bone density ratio in control and experimental groups. The value of calcium-sulfate(Fig6-1) and xenograft group(Fig6-2) had superior to control group and the time to highest value was shorter than that of control group. (square dot line ; calcium-sulfate insertion group, triangle dot line ; xenograft insertion group, round straight line ; control group)

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60%

13-15

15

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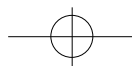
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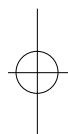
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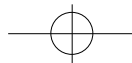


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## Abstract

**Effect of Insertion of Bone Graft Substitutes  
on Consolidation of Distracted Callus  
: Changes of Radiography & Bone Mineral Density in the Tibia  
of Rabbits**

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**Purpose** : This study was designed to know the effect of calcium-sulfate and xenograft on the distracted callus after lengthening.

**Materials & Methods** : We had operation of subperiosteal osteotomy and external fixation on the tibial diaphysis of young New Zealand White rabbits(2.0-2.5kg); after 5 days of latency period, 7 mm(1mm/day, 2 times/day) of tibial lengthening was reached in a week. At 1 week after lengthening, the 1st experimental group of 7 rabbits received a pellet of calcium sulfate(Osteoset, Wright medical, USA) in the distraction gap, and the 2nd experimental group of 7 rabbits received 5mm<sup>2</sup> of xenograft(Lubroc) in the distraction gap. But, the control group of 7 rabbits did not receive any of above materials. We compared three groups with the changes of radiographic findings at every week and bone mineral ratio(DEXA) at every two weeks.

**Results** : The time to complete consolidation of distraction callus of both experimental group(calcium sulfate;14 weeks, xenograft; 15.4 weeks) was shorter than that of control group(16.9 weeks) in radiographic findings. Maximum value of bone mineral ratio of distraction callus was higher and the time to reach the highest value was also shortened in the both experimental group compared to control group.

**Conclusion** : By use of bone substitutes as like calcium sulfate or xenograft in the distraction callus with external fixator, it may be possible to shorten the consolidation period and the fixator-wearing period.

**Key Words** : Lengthening, Calcium sulfate, Xenograft, Distraction callus, External fixator