

무기인산염 함유 이상성 인산칼슘이 외방성 수직골 형성에 미치는 영향

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- 1.
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The effect of micro-macroporous biphasic calcium phosphate incorporated with polyphosphate on exophytic bone regeneration

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ABSTRACT

Purpose: In this study, the effect of micro-macroporous biphasic calcium phosphate(MBCP) incorporated with inorganic polyphosphate for bone regeneration in the calvaria of rabbit was evaluated.

Materials and Methods: The procedure of guided bone regeneration was performed with titanium reinforced expanded polytetrafluoroethylene(TR-ePTFE) membrane. Four animal groups were compared : 1) TR-ePTFE membrane for negative control group, 2) TR-ePTFE membrane filled with MBCP for positive control group, 3) TR-ePTFE membrane filled with MBCP soaked in 4% inorganic polyphosphate for experimental group I, and 4) TR-ePTFE membrane filled with MBCP soaked in 8% inorganic polyphosphate for experimental group II.

Results:

1. Negative control group showed the highest new bone formation at 16 weeks.
2. Positive control group showed the smallest new bone formation compared to other groups.
3. 8% inorganic polyphosphate induced more volume of bone formation, otherwise experimental group II did not show significant difference compared to negative control group.

Conclusion: These results suggest that inorganic polyphosphate has a promoting effect on bone regeneration, possibly by enhancing osteoconductivity of the carrier and by increasing osteoinductivity of the defected alveolar bone tissue.

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KEY WORDS: MBCP; polyphosphate; exophytic bone regeneration.

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2)
 3,4)

orthophosphate(Pi) residues가 phospho-
 anhydride 23,24)
 Schröder 25)
 Kawazoe 26)
 (Marker) osteopontin osteocalcin 가
 alkaline phosphatase polyphosphatase
 가
 Martin 27) (phosphorous) bisphosphonate
 가
 Porphyromonas
 gingivalis 28,29)
 10-16)
 17)
 Hydroxyapatite(HA) be-
 ta-tricalcium phosphate(-TCP)
 가 . HA
 가가 , -TCP
 가 18,19)
 가
 -TCP
 HA
 20)
 HA -TCP 가
 가 , HA -TCP
 collar
 3mm
 0.5~1mm
 (MBCP™, Biomatlante Sarl, France)
 Poly P75(Sodium polyphosphate, Sigma, St.
 Louis, MO)
 (TG)
 (TG)
 , 4% (4% polyP)
 20,21) Nery 20)
 -TCP 60% HA 40%
 가
 (micro-macroporous biphasic calcium phosphate,
 MBCP)
 22)
 (Inorganic polyphosphate, PolyP) (NaPO₃)n

Table 1.

			4%	8%
	○			
	○	○		
I	○	○	○	
II	○	○		○

(8% polyP)

I, 8% chromic cat gut, Ailee, Korea)

II (Table 1).

2) (Dong hwa pharm. Ind. Co., Korea) 0.5Mℓ 1% (Uni biotech, Korea) 0.2Mℓ

6 White Rabbit) 2 kg (New Zealand 16 (Virbac, France, 0.2 ml/Kg) 0.5~1Mℓ epinephrine (Kwangmyung Pharm., Korea) 1.8Mℓ #15 2 mm (HP long #6) 1~2 mm, 8 mm, 5 mm, 8 mm, 5 mm, 4 mm 4%, 8% mm 5 (4-0 (Fig. 1).

3) 8, 16 2

1) 2 70%, 80%, 90%, 95%, 100% technovit 7200VLC (Kultzer & Co., Germany) EXAKT cutting & grinding system machine(EXAKT Apparaturbau, Germany) 50 μm Hematoxylin & Eosin BX-51 Olympus DP 71 12.5 Tomoro Scope Eye (Techsan Co., Korea)

4) (New bone formation ; %)

$$\frac{\text{Total areas of newly formed bone (mm}^2\text{)}}{\text{Area of space created by the membrane (mm}^2\text{)}} \times 100$$

2) (Residual graft material ; %)

(Fig. 1).

$$\frac{\text{Total areas of graft materials (mm}^2\text{)}}{\text{Area of space created by the membrane (mm}^2\text{)}} \times 100$$

5.

Mann Whitney U test

8 , 16

Kruskal -Wallis test

SPSS ver 12.0

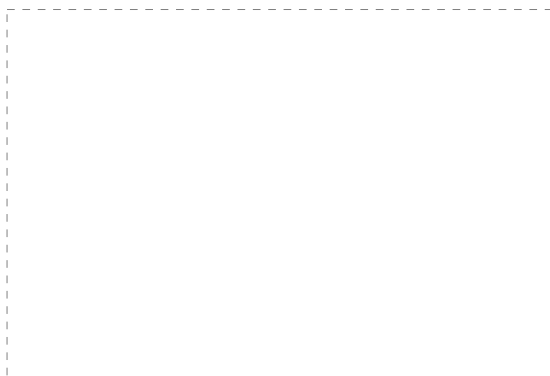


Figure 1. A schematic diagram used in histomorphologic analysis.

1.

1) (TG)

(1) 8

13.71 ± 0.18% (Table 2, Fig. 2).

(2) 16

8 가 ,

19.55 ± 0.44% (Table 2, Fig. 3).

2) (TG+MBCP)

(1) 8

5.78 ± 0.60%

27.24 ± 1.41% (Table 2, Fig. 4).

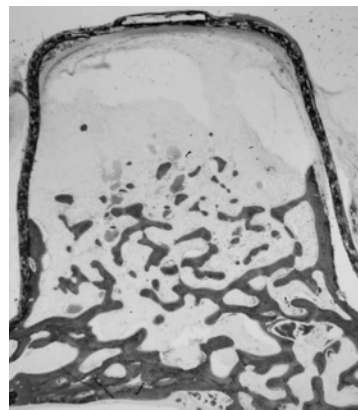


Figure 2. (TG 8 weeks)

Trabecular bone formation from the base. H&E Stain, Original magnification × 12.5

Figure 3. (TG 16 weeks)

More trabecular bone formation than that at 8 wks. H&E Stain, Original magnification × 12.5

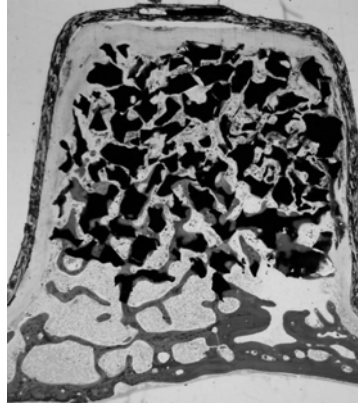
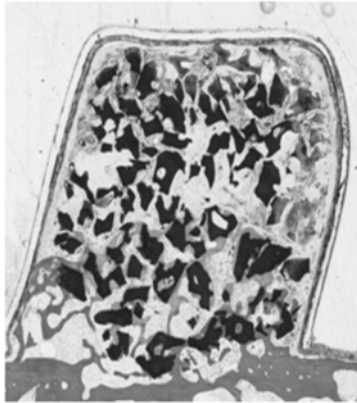


Figure 4. (TG+MBCP 8 weeks)
MBCP particles were surrounded by connective tissues.
A little newly formed tissue was detected in the bottom of the residual bone. H&E Stain, Original magnification $\times 12.5$

Figure 5. (TG+MBCP 16 weeks)
More trabecular bone formation than that at 8 wks. H&E Stain, Original magnification $\times 12.5$

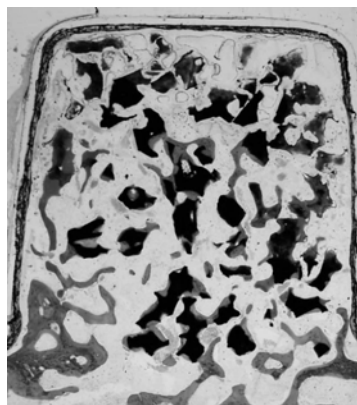
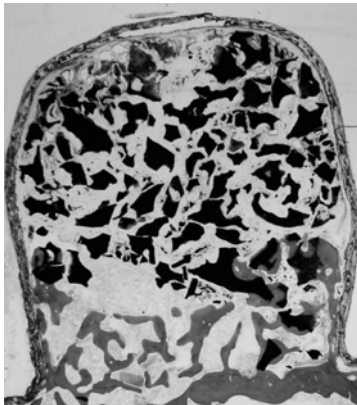


Figure 6. (TG+MBCP+4% polyP 8 weeks)
Slight trabecular bone formation. H&E Stain, Original magnification $\times 12.5$

Figure 7. (TG+MBCP+4% polyP 16 weeks)
Slight trabecular bone formation. H&E Stain, Original magnification $\times 12.5$

(2) 16
8

가

$11.05 \pm 1.03\%$

$32.80 \pm 2.27\%$ (Table 2, Fig. 5).

$11.62 \pm 0.32\%$

$20.68 \pm 0.58\%$ (Table 2, Fig. 7).

3) I(TG+MBCP+4% polyP)
(1) 8
8

$11.41 \pm 0.74\%$

$26.68 \pm 1.09\%$ (Table 2, Fig. 6).

4) II(TG+MBCP+8% polyP)

(1) 8
I 8 가 가

(2) 16
8

$18.05 \pm 0.23\%$

0.31% (Table 2, Fig. 8).

$33.50 \pm$

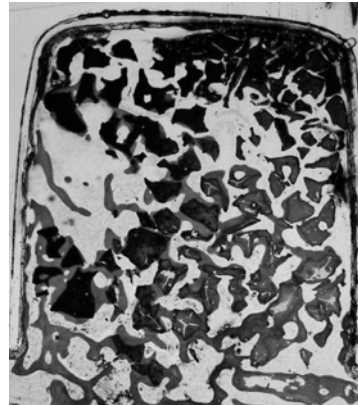
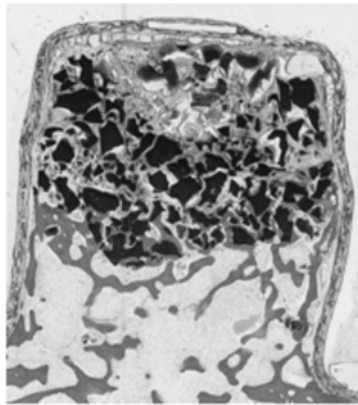


Figure 8. (TG+MBCP+8% polyP 8 weeks) Trabecular bone formation near the residual bone. MBCP particles were connected with trabecular bone from the residual bone surface. H&E Stain, Original magnification $\times 12.5$

Figure 9. (TG+MBCP+8% polyP 16 weeks) Trabecular bone formation near the residual bone. MBCP particles were connected with trabecular bone from the residual bone surface. H&E Stain, Original magnification $\times 12.5$

(2) 16
8

2.

8 16

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8 16

II

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16

(Table 2, Fig. 10).

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16.07 \pm 0.49% ,
23.48 \pm 0.09% (Table 2, Fig. 9).

Table 2. New Bone Formation and Residual Graft Material

	New bone formation(%)		Residual graft material(%)	
	8 weeks(n=4)	16 weeks(n=4)	8 weeks(n=4)	16 weeks(n=4)
Negative Control (TG)	13.71 \pm 0.18	19.55 \pm 0.44	0	0
Positive Control (TG+MBCP)	5.78 \pm 0.60	11.05 \pm 1.03	27.24 \pm 1.41	32.80 \pm 2.27
Test I (TG+MBCP+4% polyP)	11.41 \pm 0.74	11.62 \pm 0.32	26.68 \pm 1.09	20.68 \pm 0.58
Test II (TG+MBCP+8% polyP)	18.05 \pm 0.23	16.07 \pm 0.49	33.50 \pm 0.31	23.48 \pm 0.09

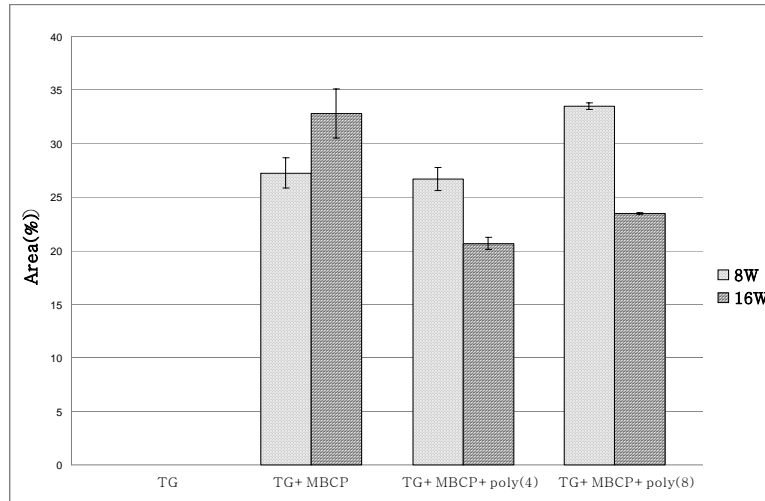


Figure 12. Residual graft material rate by period.
 TG(n=4), TG+MBCP(n=4), TG+MBCP+poly(4)(n=4), and TG+MBCP+poly(8)(n=4)
 * means statistically significant difference between 8 weeks and 16 weeks by Mann Whitney U test(p<0.05).

34) . 가 가

8, 16 1~2 mm

. Schenk 30) 33) 35)

8 16

8 , 16 31-33) 4, 14 31) , 36,37)

32) 10, 21, 42, 60 33) 4 ,

, 21

Simion 38) 4 mm

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 9 8, 16
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 tension
 가 , 가 가
 1 4 mm 가
 가 가 가
 가 , , polylactic acid³²⁾ . Schmid³²⁾
 . 1
 가 , 2
 (IGF), (TGF-), 가 가
 -2(BMP-2) 가 가
 가 가 가
 가 가 가
 가 가 가
 가 가 가
 가 (carrier) . Fleisch bisphosphonate가 HA
 가 HA
 가
 orthophosphate
 residue가
 (demineralized human bone powder)
 2% 가 가
 가
 1% 2% 2%
 가 6
 2 kg

- 4%
- I, 8%
- II 8, 16
1. 16 가
2. 8, 16 가
3. 11가 I 8, 16
- 4%
- 8%
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