



Histological Observation of Effect of Collagen Cross-Link Deficiency on Bone Augmentation

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Introduction

Under the concept of prosthodontically driven implant placement, bone augmentation would be sometimes required for the success of implant therapy. Current gold standard of the augmentation is auto bone transplantation and the bone could be collected from several sites ¹⁾. However, fate of the transplanted bone is reportedly not so optimistic in some cases. There should be several factors that might affect the long time prognosis of transplanted bone and bone quality could be the major one. Grafted bone harvested from different sites could have different bone qualities and therefore, the fate of transplanted bone might be influenced by the site where the bone collected.

Collagen cross link is a key factor of bone quality. There has been few studies reporting the relationship of collagen cross link of transplanted bone and its fate. Thus, the purpose of this study was to investigate the influences of collagen cross-link on bone augmentation.

Materials and methods

Animal: Three weeks old male SD rats (n = 28) were divided into four groups (n = 7 each)(Table 1).

Donor	Normal (Control)	BAPN (Test)
Recipient		
Normal (Control)	N-N	N-B
BAPN (Test)	B-N	B-B

Table 1

Collagen cross link deficiency : 0.2% beta-aminopropionitrile (BAPN) as collagen cross link inhibitor in drinking water was fed for 4 weeks ²⁾ to the animals(Fig. 1).

Surgical procedure : Total thickness flap was created in rat calvarias and 5mm diameter calvarial bone chips were harvested from the donor rats(Fig. 2a). Then the chips were transplanted on recipient calvarias(Fig. 2b) and the flap was sutured. We used link pin to fix the bone chips(Fig. 2c). 1, 2 and 4 weeks after surgery, rats were sacrificed.

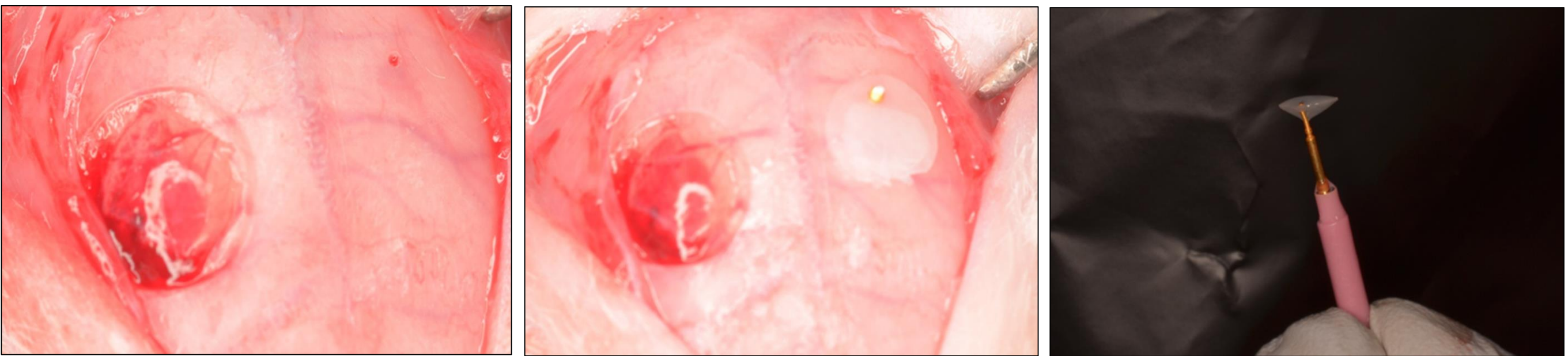


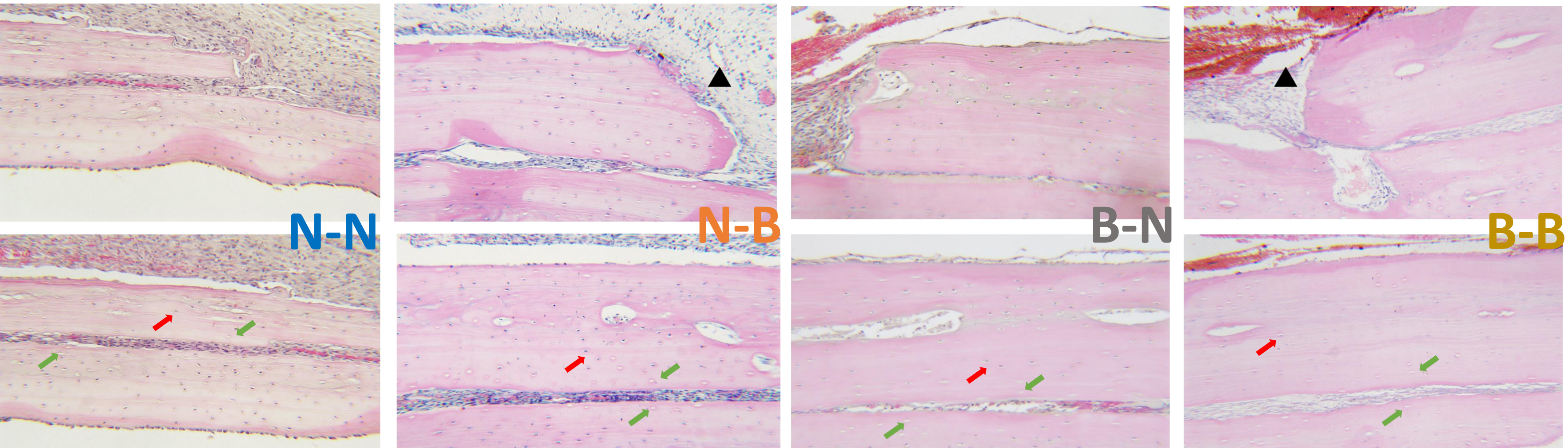
Fig. 2

Histological observation: The specimens were prepared for decalcified histological sections and observed under light microscopy and H&E. Histomorphometric analysis was carried out Adobe Photoshop CS4.

Histomorphometric analysis: The ratio of newly formed bone area to total area in the gap between the transplanted bone and recipient bone was calculated.

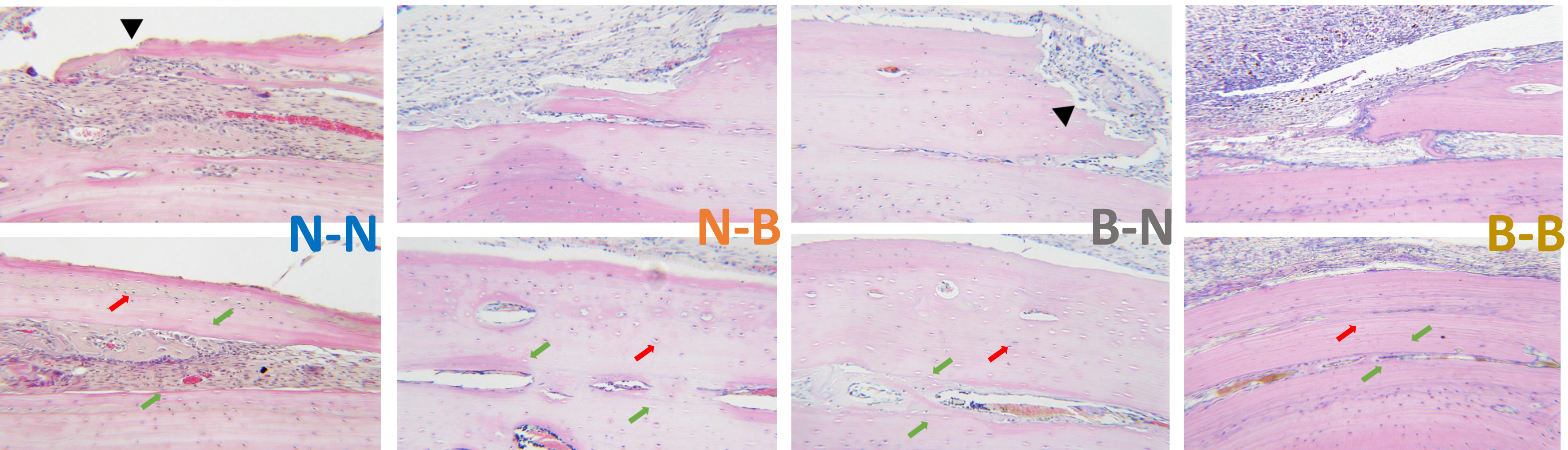
Results

1 W



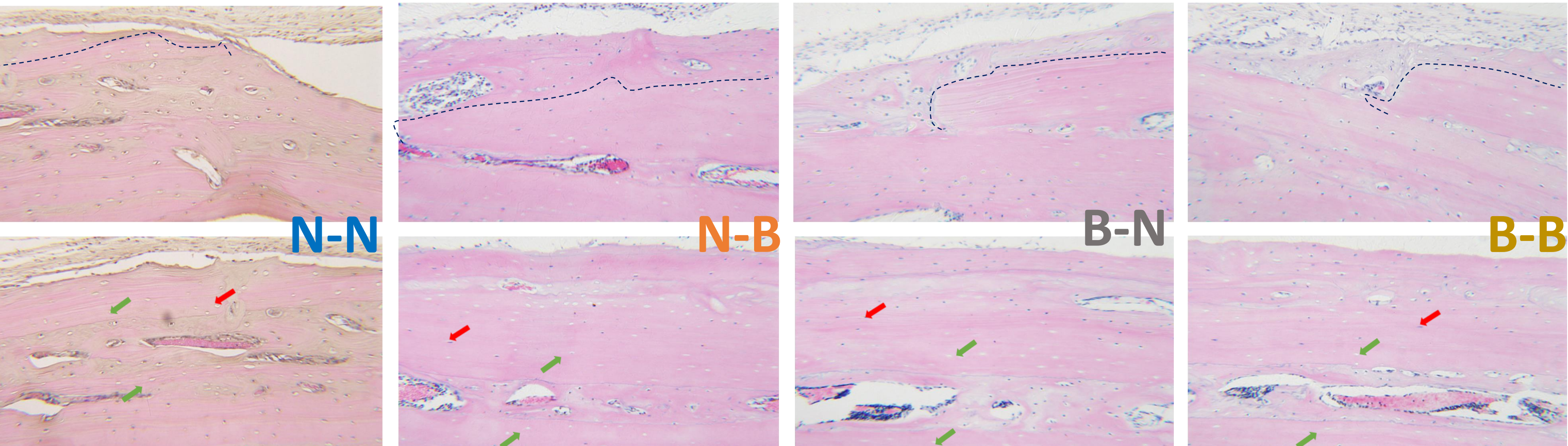
- New bone formation was observed in the limited area of the gap between transplanted bone and recipient bone in all groups.
- There was not a clear difference of newly formed bone area among all groups.
- The majority of the tissue in the gap was soft tissue mainly consisted of fibroblastic cells in all groups.
- Osteocyte of the transplanted bone was vital (red arrows), but not vital in the face of the gap(green arrow) in all groups.
- Bone resorption was observed at the edge of transplanted bone in N-B and B-B group(▲).

2 W

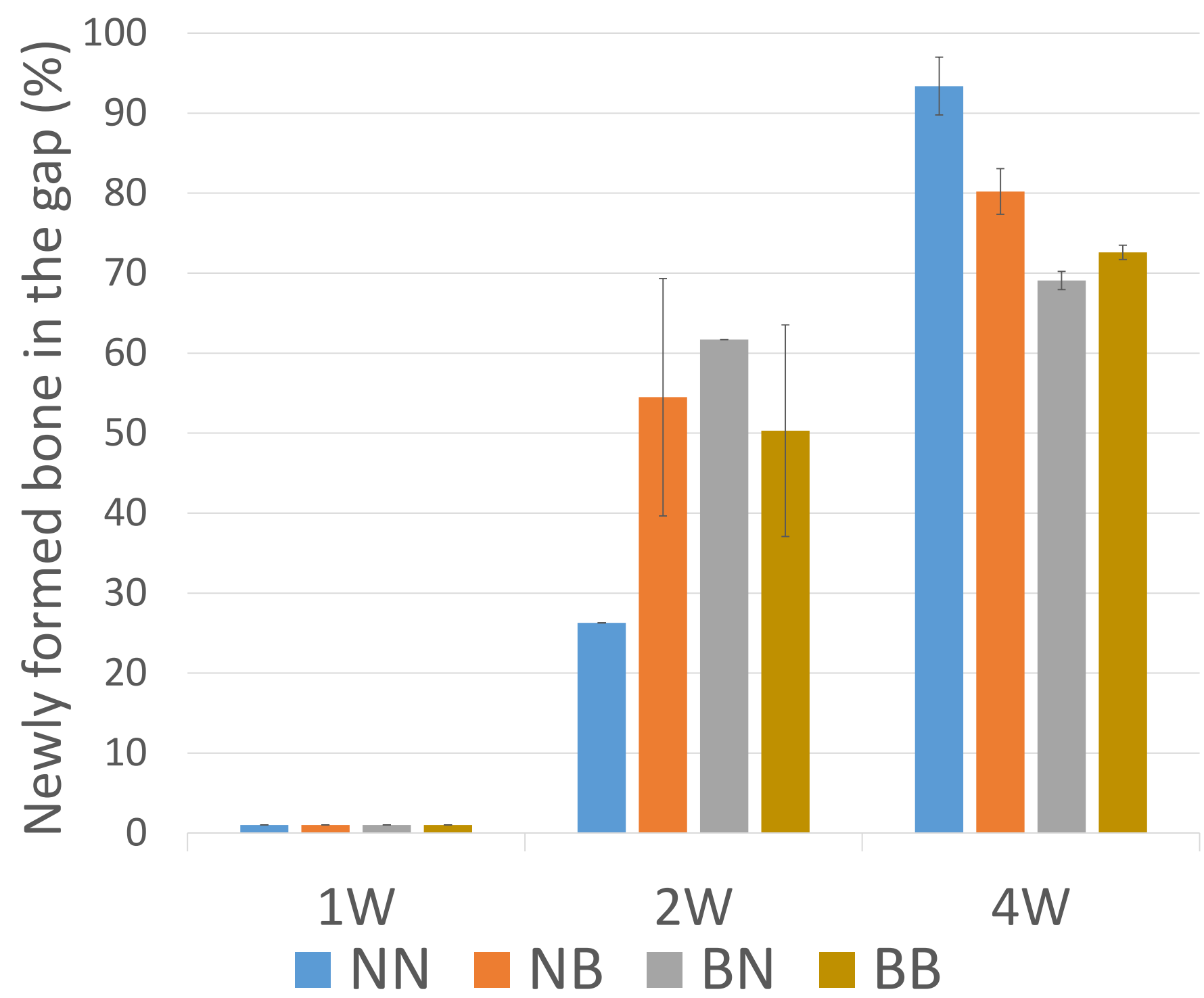


- The area of newly formed bone in the gap of BAPN recipient groups was larger than normal recipient groups.
- Bone resorption was observed at the edge of transplanted bone mainly in N-N and B-N group(▲).
- Osteocyte of the transplanted bone was vital (red arrows), but not vital in the face of the gap(green arrow) in all groups.
- Osteoblast-like cell in the gap was observed in all groups.
- Bone formation was observed not only in the gap but also at the surface of transplanted bone in BAPN recipient groups.

4 W



- The area of newly formed bone in the gap of normal recipient groups was larger than BAPN recipient groups.
- The edge and the top surface of the bone chips were covered with newly formed bone in all groups (dotted lines).
- Osteocyte of the transplanted bone was vital (red arrows), but not vital in the face of the gap(green arrow) in all groups.
- Bone resorption was rarely observed in all groups.



Results of histomorphometry

Discussion

New bone formation in the gap was observed in all conditions. However, within the experimental period, BAPN recipient groups showed more bone formation than normal recipient groups at 2 weeks, while less bone formation at 4 weeks. Since it is thought to be clinically important to stabilize the transplanted bone earlier, rapid bone formation in the gap might be of benefit in case of low quality bone transplantation. Nonetheless, final bone area in the gap was larger in case of normal conditions and longer experimental period is required.

Conclusion

Collagen cross link deficiency of transplanted bone clearly affect the connection of the bone to recipient site in any conditions. Further long time observation is required.

References

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2) Ida, T.; Id, M.K.; Kitami, M.; Terajima, M.; Rocabado, M.R.; Akiba, Y.; Nagasawa, M.; Yamauchi, M.; Uoshima, K. Extracellular matrix with defective collagen cross-linking affects the differentiation of bone cells. **2018**, *13*, 1–18.