

The Effect of Platelet-Enriched Fibrin Glue on Bone
Regeneration in Autogenous Bone Grafts

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The Effect of Platelet-Enriched Fibrin Glue on Bone Regeneration in Autogenous Bone Grafts

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Abstract

The Effect of Platelet-Enriched Fibrin Glue on Bone Regeneration in Autogenous Bone Grafts

Objective :

The aim of this study was to examine the ability of platelet-enriched fibrin glue to enhance bone formation in critically sized defects in the dog mandible. For a start, to perform the above study I determined the critical size defect in a canine mandible model.

Methods :

Critical size defect in the canine mandible : Eighteen adult mongrel dogs underwent continuity resection on both sides of the mandible to create bilateral defects. In six dogs, mandibular defects ranging from 5 to 20 mm were created with periosteal resection. In the other twelve dogs, mandibular defects ranging from 15 to 60 mm were created preserving the periosteum. The dogs were then killed at 12 weeks and the defects examined using radiographs and by histologic analysis.

The Effect of Platelet-Enriched Fibrin Glue on Bone Regeneration in Autogenous Bone Grafts : Seven adult female mongrel dogs underwent continuity resections on both sides of the mandible; one defect was reconstructed with the original particulate bone mixed with platelet-enriched fibrin glue, and as a control, the contralateral defect was reconstructed with the original particulate bone alone.

Results :

Critical size defect in the canine mandible : When the periosteum was removed, mandibular defects greater than 15 mm failed to heal across the entire defects. When the periosteum was preserved, mandibular defects greater than 50 mm failed to heal. Thus, the critical size defect in a canine mandible model is 15 mm when the periosteum is removed and 50 mm when the periosteum is preserved.

The Effect of Platelet-Enriched Fibrin Glue on Bone Regeneration in Autogenous Bone Grafts : Biopsies after six weeks showed that the addition of platelet-enriched fibrin glue enhanced new bone formation in the autogenous bone grafts.

Conclusion :

The results suggest that fibrin nets formed by fibrinogen, in combination with growth factors present in platelet-enriched fibrin glue, might effectively promote bone healing at bone graft sites.

Key words: Fibrin glue; PRP; bone regeneration; bone graft; critical size defect; dog mandible

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I. INTRODUCTION

There is currently a great deal of interest in oral and maxillofacial bone grafting procedures, which involve the use of platelet-enriched fibrin glue to enhance bone formation and, in particular, increase the rate of bone graft healing. The use of platelet-enriched fibrin glue is based on the fact that the fibrin glue acts as a fluid tightness agent to hold particulate bone in a required configuration¹. In addition to the physical benefits, the glue also accelerates the bone graft healing process by incorporating blood platelets into the fibrin glue^{1,2}, as numerous different growth factors are released from the platelets upon activation with thrombin³. Previous studies^{1,2} have shown that a combination of platelet-enriched fibrin glue and autogenous bone grafting can increase the rate of osteogenesis and enhance bone formation. However, these results are reported as clinical observations without a well-defined set of success parameters or a control group. In an attempt to provide additional data on a more controlled scientific level, this study was undertaken to examine the ability of platelet-enriched fibrin glue to enhance bone formation in critically sized defects in the dog mandible.

A critical size defect is a bone defect, described in a particular bone and animal species, that will not heal spontaneously during the animal's lifetime⁴. Various osteogenic materials are available for repairing mandibular defects in reconstructive surgery, and

critical size defect presents a suitable model for evaluating the usefulness of treatments⁴, as bone regeneration in a critical size defect only occurs in the presence of osteogenic materials. However, in a review of the current literature, it is apparent that investigators have been anything but consistent in their choices of appropriate defect size in the dog mandible, in studies of the effects of osteogenic materials on mandibular bone regeneration^{6,7,8,9,10}. The absence of a well-documented critical size defect in the dog mandible makes experimental results questionable. Thus for a start, I decided to determine the critical size defects in the dog mandibles.

II. MATERIALS AND METHODS

Critical size defect in the canine mandible

Eighteen adult mongrel dogs, each weighing more than 15 kg (15–20 kg body weight), were used in this experiment. Animal selection and management, surgical protocol, and preparation were approved by the Animal Care and Use Committee, Yonsei Medical Center, Seoul, Korea. All surgical procedures were performed under systemic (ketamine, 5 mg/kg and xylazine, 2 mg/kg i.m.) and local (2 % lidocaine with 1:80,000 epinephrine) anesthesia. The mandibular premolar and molar teeth of each dog had been bilaterally extracted previously, and the ridges had been allowed to heal for 3 months. The mandible was then exposed using an extraoral approach. Prior to creating bone defects, two miniplates (Martin Medizin Technik, Tuttlingen, Germany) were adapted in order to maintain the mandible in the correct position, and the neurovascular bundle entering the mandible was ligated in order to control bleeding after resection. The animals were divided into two groups. In six animals, segments, measuring 5 mm, 10 mm, 15 mm, and 20 mm were excised with the surrounding periosteum. In the remaining twelve dogs, segments, measuring 15 mm, 20 mm, 30 mm, 35 mm, 40 mm, 45 mm, 50 mm, and 60 mm, were excised preserving the periosteum. Defects were created in each animal in pairs, bilaterally. Each defect size was created in triplicate. After resecting the segment, the mandible was stabilized by fitting two miniplates with bicortical screws. During the above procedure, special care was taken to avoid intraoral perforations.

Occlusal radiographs were taken from each dog 2 weeks postoperatively and before euthanasia to verify and document the proper position of fixation devices and bone formation. The animals were killed at 12 weeks postoperatively and mandibles were removed. The specimens were fixed in 10 % neutral buffered formalin for 1 week and decalcified. They were then embedded in paraffin, sectioned along the sagittal axis, and observed under a light microscope after staining with hematoxylin–eosin.

The Effect of Platelet–Enriched Fibrin Glue on Bone Regeneration in Autogenous Bone Grafts

Seven adult female mongrel dogs, each weighing more than 15 kg, were used in this experiment. All surgical procedures were performed under systemic (ketamine, 5

mg/kg and xylazine, 2 mg/kg i.m.) and local (2% lidocaine with 1:80,000 epinephrine) anesthesia. The mandibular premolar teeth of each dog had been previously bilaterally extracted, and the ridges had been allowed to heal for 3 months. After this period, segments measuring 15 mm were excised with the surrounding periosteum on both sides of the mandible. These defects were large enough to be critically sized¹¹, and could not heal naturally, without some form of treatment or intervention. Before resection, two miniplates (Jeil Medical Co., Korea) were adapted in order to maintain the mandible in the correct position, and the neurovascular bundle entering the mandible was ligated in order to control bleeding after the resection. After resecting the segment, the mandible was stabilized by fitting the two miniplates with bicortical screws. During the above procedure, special care was taken to avoid intraoral perforations. Each resected segment was then ground in a bone mill (Leibinger, Germany) to a uniform particle size. This particulate bone was then used for the reconstruction of the defect site from which the bone had been obtained. On one side of the mandible, the particulate bone alone was implanted into the bone defect (control group). On the contralateral side of the mandible, an identical defect was reconstructed with the particulate bone mixed with platelet-enriched fibrin glue (fibrin group). In order to prepare the platelet-enriched fibrin glue, 50 ml of autologous blood was withdrawn prior to surgery and treated using a previously described technique². Briefly, the blood was centrifuged for 15 min at 327 x g to separate the platelet rich plasma (PRP) from the blood. The platelet counts were determined on each dog's PRP to confirm the platelet concentrations. The mean platelet count of the PRP was 1520000/ μ l ranging from 1120000 to 2300000/ μ l. Subsequently, a fibrinogen solution was prepared using the PRP. To 15 ml of the PRP, 450 μ l of tranexamic acid and 1600 μ l of ethanol were added, and the mixture was then incubated in an ice-water bath for 20-30 min at a temperature of approximately 0°C. The precipitated fibrinogen was separated by centrifugation at 3000 x g for 8 min at 0-4°C. After discarding the supernatant, the fibrinogen precipitate was re-dissolved by incubation at 37°C and diluted to 50% with 0.9% NaCl. A thrombin solution was then prepared using the remaining PRP. To 5 ml of the remaining PRP, 45 ml of citric acid was added, and then the mixture was centrifuged at 3000 x g for 5 min at 4°C. After discarding the supernatant, the precipitate was dissolved in 300 μ l CaCl₂ (0.1M). The pH was adjusted to pH 7 by the addition of 200 μ l of NaHCO₃. After clot formation, the thrombin solution was collected and diluted to 50% with a 0.05 M CaCl₂. The fibrin glue was formed by mixing the two separate fibrinogen and thrombin solutions in a 3:1 (vol/vol) ratio. Thorn et al.² reported that the fibrin glue prepared using this technique

contained a high platelet and fibrinogen concentration.

Bone formation was labeled using a sequence of fluorescent dyes, i.e., at 2 weeks after the operation with tetracycline (12 mg/kg body weight, Bayer, Korea), at 3 weeks with alizarin red (30 mg/kg body weight, Sigma) and at 4 weeks with calcein green (20 mg/kg body weight, Sigma). The animals were sacrificed 6 weeks after surgery. The mandibles were harvested for radiographic and histologic evaluations. Radiographs of the reconstructed sites were taken with a mobile X-ray machine (Dong-Seo Med. Co., South Korea), using a long-cone technique, from a distance of 70 cm (40 kV, 28 mA). Two independent examiners, blinded as to which side was treated with platelet-enriched fibrin glue, assessed the radiographs. They were asked to score using a checklist developed by Fennis et al¹²(Table 1).

Table 1. Scoring system used for radiographic evaluation

Score	
1	Completely visible bone gaps
2	Partial obliteration of bone gaps
3	> 90% obliteration of bone gaps
4	Radio-opacity around obliterated gap

From the harvested mandibles the defects and the adjacent host bone were obtained en bloc, fixed in 70% alcohol and embedded in methylmethacrylate. Undecalcified sections of approximately 10 μ m were then taken along the sagittal axis of the grafts. Subsequently, the sections were either stained using the Masson-Goldner trichrome method for light microscopy or not stained for fluorescence microscopy. Computer-assisted histomorphometric measurements of newly formed bone were obtained, using an image analysis system (IBAS, Contron, Erching, Germany), by an anatomist who had no knowledge of the methods used in the study. The regenerated bone was distinguished by its histologic features, i.e., by chroma staining and from the morphologies of the bone cells and matrix. The perimeter of the newly formed bone was traced, and the enclosed area was determined in mm² using image analysis software. The percentage of newly formed bone within the former bone defect outline was calculated. The fluorochrome labeling was evaluated from the unstained sections. A grid divided into 3x3 subsquares was superimposed on the sections, and the occurrence of each of the three fluorochrome stains was recorded in nine evaluation

units. The frequency of the three labels was determined for each section. The quantitative results were tested for statistical significance using Wilcoxon's test at a significance level of 5%.

III. RESULTS

Critical size defect in the canine mandible

It was found to be possible to create defects of up to 60 mm in length in the mandibles of adult mongrel dogs. Healing was uneventful in all defects. At the time of harvesting, no plate fractures were noted. However, two loose screws were found in the each one of 2 defects, yet the plate was intact and appeared to be fixed to the bone with the remaining screws.

Radiographs taken 3 months postoperatively, showed that bone formation in mandibular defects with periosteum preservation, as manifested by the obliteration of the bone defects, originated predominantly from the periosteum and to a less extent from the bone edges. Defects of 15 mm, 20 mm, 30 mm, 35 mm, 40 mm, and 45 mm showed gap obliteration (Figs. 3 and 4), whereas radiolucency persisted in defects longer than 50 mm (Fig. 5). In mandibular defects where the periosteum was excised, bone formation occurred from the bone edges only. All of the 5-mm defects showed gap obliteration, but the 10-mm defects showed complete gap closure in only one of the three defects (Fig. 1). Defects longer than 15 mm showed no gap obliteration (Fig. 2).

These findings were confirmed histologically. Histological studies revealed that the radiolucency observed in the radiographic examinations represented fibrous connective tissue. In mandibles where segments were excised with surrounding periosteum, all 5-mm defect specimens exhibited complete solid bone healing across the entire defect, whereas only one in three 10-mm defects showed bony union. In all defects longer than 15 mm bone bridging was incomplete and a fibrous band was noted. In the mandibles where the periosteum was preserved, the 15-mm, 20-mm, 30-mm, 35-mm, 40-mm, and 45-mm defects exhibited complete bony union, whereas the 50-mm and 60-mm defects showed fibrous union without solid bone bridging.

The Effect of Platelet-Enriched Fibrin Glue on Bone Regeneration in Autogenous Bone Grafts

Healing was uneventful in all animals with the exception of one, in which intraoral dehiscence appeared on both sides during the second postoperative week. This condition continued through the sixth week, with intraoral exposure of the bone graft. The graft had healed with excellent solidification on the fibrin glue side, whereas the control side showed a partial resorption of the grafted bone and a fibrous union. Radiographs taken 6 weeks postoperatively showed that no screws had become loosened, and that the plates had no fractures in all cases (Figs. 6 and 7). All of the bone defects showed gap obliteration, with the exception of the above-mentioned case. The results of the radiographic evaluation scoring are presented in Table 2. The mean score of the fibrin group was significantly higher than that of the control group, indicating that bone healing, as manifested by the obliteration of the bone gaps at the osteotomy sites, was increased on the fibrin glue side.

Table 2. Results of the scoring of the radiographic evaluation

Dog number	Fibrin group	Control group	<i>p</i> value
1	2	1	
2	3	1	
3	2	1	
4	3	1	
5	3	2	
6	3	2	
7	2	2	
mean	2.7	1.7	0.023

These findings were confirmed by histological studies, which revealed that in the control group, more of the grafted bone was seen to be non-vital (i.e. lacking osteocytes), as compared to the fibrin group. Figures 6 and 7 show examples of sagittal sections of the defect, and the results of the histomorphometric analysis are shown in Table 3. The calculated percentages of the areas showing bone regeneration within the former outlined defects were 41.7% and 30.8% for the fibrin and control groups, respectively. The difference between these two groups was statistically significant, and indicated significantly better results on the fibrin side. In both the

fibrin and control groups, the surface of the new bone was lined with osteoids and osteoblasts, indicating active bone formation.

Table 3. Percentages of newly formed bone within the bone defects

Dog number	Fibrin group	Control group	<i>p</i> value
1	42.7	34.1	
2	42.2	38.8	
3	33.7	23.7	
4	43.6	24.6	
5	46.2	36.5	
6	45.1	33.4	
7	38.1	36.3	
mean	41.7	30.8	0.018

Fluorescence microscopy showed deposition of fluorochrome stains in their order of application (Fig 8). The 2-week label (tetracycline) was more frequently found in the fibrin group than in the control group. This label was present across the whole sagittal-section of the graft in areas adjacent to the recipient bone, but decreased gradually in the center of the graft where it was replaced by the subsequently administered fluorochrome stains, i.e., alizarin red (the 3-week label) or calcein green (the 4-week label). The frequency of appearance of the 2-week label was statistically different between the fibrin and control groups, while the frequencies of the later labels did not differ significantly between the two groups.

IV. DISCUSSION

Defects of a size that will not heal during an animal's lifetime have been defined as critical size defects⁴. Such defects when left untreated fill with fibrous connective tissue¹³, although limited bone regeneration can be seen at the margins of the defect. When this incomplete bone healing occurs in the mandible it results in bony nonunion, a frequent complication in oral and maxillofacial surgery¹⁴. Minimally sized defects leading to bony nonunion in the mandible are called critical size defects⁴. Thus for a start we decided to determine the minimal size of defect at which nonunion occurs in the dog mandibles.

The results show that the critical size defect depends on the presence of the periosteum. When the periosteum was preserved, bone formation occurred both from the periosteum and from the bone edges and the bone formation was sufficient to allow bone bridging across defects < 50 mm. However, defects > 50 mm exceeded the body's ability to regenerate bone. These results suggest that the critical size defect is 50 mm in the dog mandibles when the periosteum is preserved. Other authors have used bone defects of diverse dimensions in mandibular models with preserved periosteum. Leake and Rappoport¹⁵ used a 30 mm long defect in the mandibles of mongrel dogs as the critical size defect. Schmitz et al.⁴ reported that the critical size defect for adult mongrel dogs is probably between 20 mm and 40 mm. In other studies 40-mm defects were used as the critical size defect in the dog mandibles^{7,9}. Result discrepancies between these studies and the present investigation may be due to different appliance fixation, as they placed titanium mesh trays to fix the proximal and distal fragments. One might expect that a tray fixed with wire would not provide adequate stability. Accordingly, if the proximal and distal fragments are rigidly secured, the critical size defect might be increased. In the present study, two miniplates were placed at the superior and inferior borders of the mandible with 6 bicortical screws per plate to stabilize mandibles with discontinuity defects. Radiographs and clinical examinations revealed no plate fractures and little screw loosening. This suggests that the two-miniplate system successfully held the fragments. Further investigations on the results of clinical series using two miniplates with bicortical screws in human mandibular defects are needed to determine whether the results of the present study are in accord with clinical findings.

In the mandibular model in which periosteum was absent, bone formation originating

from the periosteum was absent. An interesting finding in this model was that a minimal amount of bone (3-6 mm in length) was formed from the bone edges of the defects so that it was insufficient to allow bone bridging across the 15-mm defects. Consequently, 15-mm defects devoid of periosteum met the criteria of the critical size bone defect. It has been reported that bone regeneration in discontinuity defects in the mandible is almost entirely dependent upon periosteum with minor contributions from the bone edges⁸. The present findings strongly support this contention. These findings indicate that the removal of the periosteum overlying a bone defect is more closely associated with nonunions than the actual size of the bone defect. In view of the fact that the creation of a large bone defect results in some inconvenience, I suggest that the smaller defect (15-mm defect) with periosteal resection should be considered as a defect size in the dog mandibles.

The creation of discontinuity defects in the mandibles of small animals (mouse, rat, rabbit, and guinea pig) is difficult because of limited surgical access. As a result, through-and-through defects of the mandible may be possible only in the mandibular ramus area of small animals. However, the adult dog offers a near ideal animal model for the study of mandibular discontinuity defects. In the present study, it was possible to create defects of up to 60 mm long in the mandibles of adult mongrel dogs. This animal has the advantage of allowing the creation of such large bone defects bilaterally and of permitting pair-design experiments.

Fibrin glues were first used to establish hemostasis at the beginning of the last century. In 1940, Young and Medawar¹⁶ mixed bovine thrombin with plasma fibrinogen to produce the first biological adhesive, which was applied in microsurgery for the suture of peripheral nerves in an animal model. In 1944, Tidrick and Warner¹⁷ applied biological adhesives to anchor human skin grafts. However, their products had suboptimal adhesive properties, due to the absence of fractionation technologies for providing concentrated fibrinogen. A significant improvement in the development of efficient fibrin glue was made when industrial plasma fractionation methods were implemented, which made it possible to develop concentrated fibrinogen preparations¹⁸. By this technique, significant progress was achieved in the rheological properties (elasticity, tensile strength and adhesiveness). However, the method of isolation used at that time did not give a high platelet concentration. Finally, further progress in plasma fractionation produced a fibrin glue with high concentrations of both platelets and fibrinogen². Therefore, fibrin glue offers significant additional benefits in

accelerating postoperative wound healing, which is bestowed by the presence of high concentrations of growth factors in the platelets^{19,20,21}. A complete list of the factors released by platelets is beyond the scope of this article, but the most important are the platelet-derived growth factor and the transforming growth factor- β 1. Both of these factors potentiate wound healing as they promote granulation tissue formation²², and, working synergistically, have been documented to increase the rate of collagen laydown, angiogenesis, fibroblast proliferation, extracellular matrix synthesis and overall wound healing. Thorn et al.² reported that the concentration of fibrinogen in the fibrin glue was approximately 12 times that found in PRP, and the concentration of growth factors, as measured by PDGF, was approximately eight times that in the PRP. In this study, autologous fibrin glue, with high concentrations of platelets and fibrinogen, was prepared using the technique described by Thorn et al.². This study demonstrated that the use of autologous fibrin glue resulted in enhanced bone healing, which was consistent with previous reports^{1,2} where autologous fibrin glue was found to help the remodeling process in bone grafts to begin earlier. However, further studies are needed to verify the effect of platelet-derived growth factors on bone regeneration in vivo. These findings are derived from comparing the autologous alveolar bone grafts with or without the platelet-enriched fibrin glue. Therefore, further studies with fibrin glue alone, in the absence of platelet enrichment, within a similar autologous alveolar bone graft in the dog may be necessary to determine whether the observed effect was the result of the concentrated platelet growth factors or of the vehicle.

Autologous fibrin glue mimics the final steps in the coagulation process, with the conversion of fibrinogen to fibrin, aided by thrombin and calcium, helping to cross-link the fibrin into a stable clot²³. The autologous fibrin glue prepared in this study produced a dense fibrin clot, with sufficient adhesive strength to hold particulate bone in a required configuration, due to its high concentrations of fibrinogen. It is known that multiplication of bacteria in a fibrin clot is significantly slower than in a comparable blood clot¹. These findings may explain the uneventful healing of the autologous fibrin glue treated bone graft in one dog, even with the occurrence of oral perforation and dehiscence.

V. CONCLUSION

For a start, I determined the critical size defect in the mandibles of 18 mongrel dogs. My study shows that the critical size defect depends upon the presence of the periosteum. When the periosteum is present, the critical size defect is 50 mm, and when absent, the critical size defect is 15 mm. Thus the study identifies the need to differentiate critical size defects according to whether the periosteum is present.

Then I examined the ability of platelet-enriched fibrin glue to enhance bone formation in critically sized defects in the mandibles of 7 dogs. Based on the results presented in this study, it can be concluded that when autologous fibrin glue, with high concentrations of platelets and fibrinogen, was prepared using the technique described by Thorn et al, the fibrin nets formed by fibrinogen, in combination with the growth factors present in the autologous fibrin glue, might effectively promote bone healing at bone graft sites.

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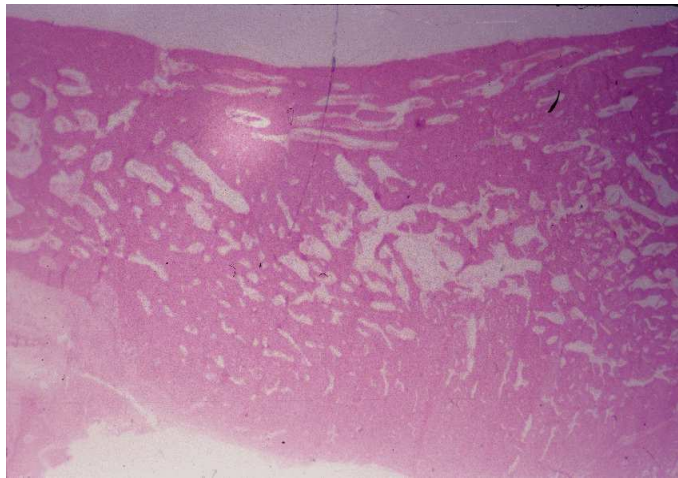
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Fig. 1. A mandible in which 5 mm- and 10 mm-defects with periosteal resection were created. A: photograph of specimen. B: histological appearance showing bone bridging. C: occlusal radiograph taken 2 weeks postoperatively. D: occlusal radiograph taken 12 weeks postoperatively.

A.



B.



C.



D.

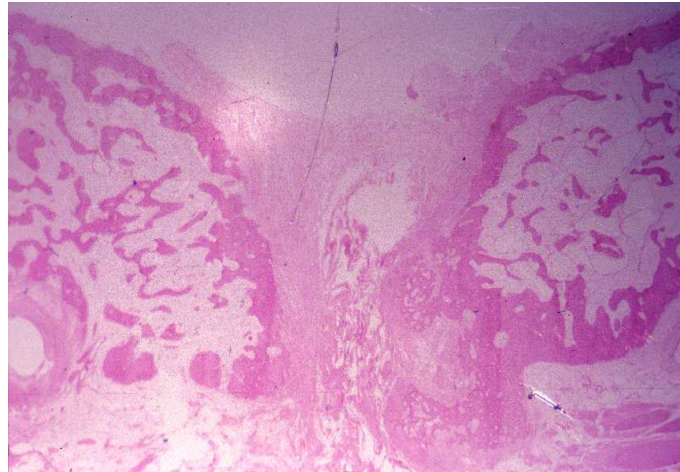


Fig. 2. A mandible in which 15 mm- and 20 mm-defects with periosteal resection were created. A: photograph of specimen. B: histological appearance showing nonunion. C: occlusal radiograph taken 2 weeks postoperatively. D: occlusal radiograph taken 12 weeks postoperatively.

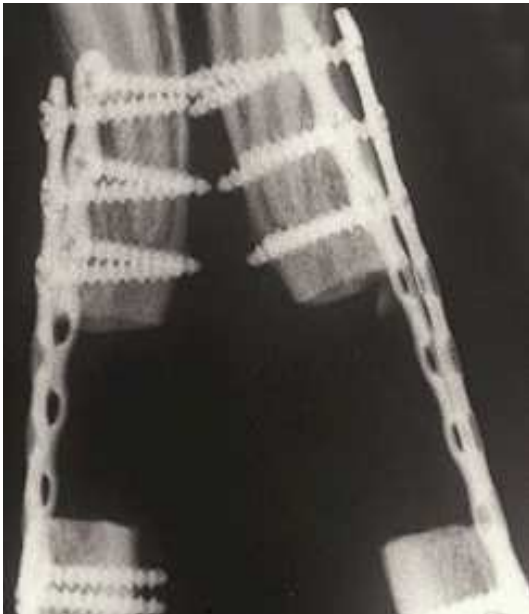
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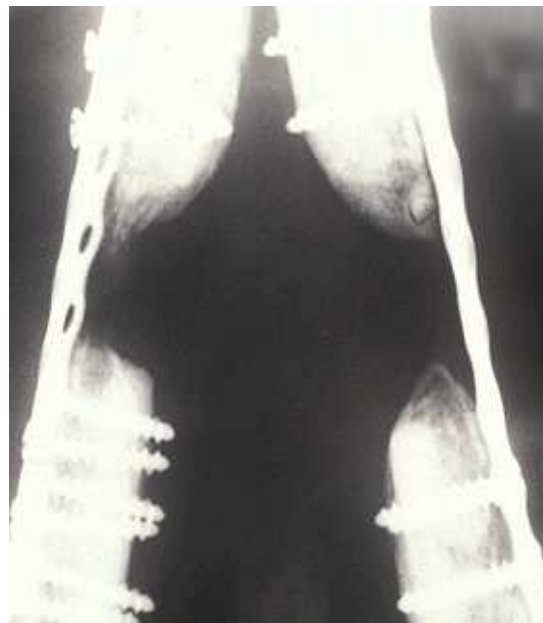
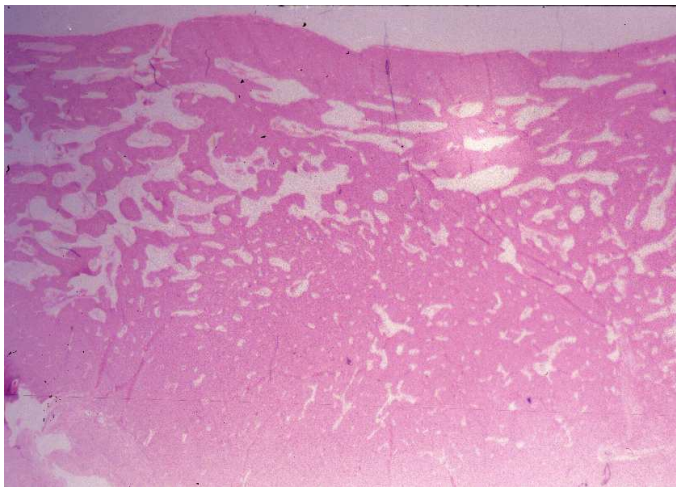


Fig. 3. A mandible in which 15 mm- and 20 mm-defects were created preserving periosteum. A: photograph of specimen. B: histological appearance showing bone bridging. C: occlusal radiograph taken 2 weeks postoperatively. D: occlusal radiograph taken 12 weeks postoperatively.

A.



B.



C.



D.

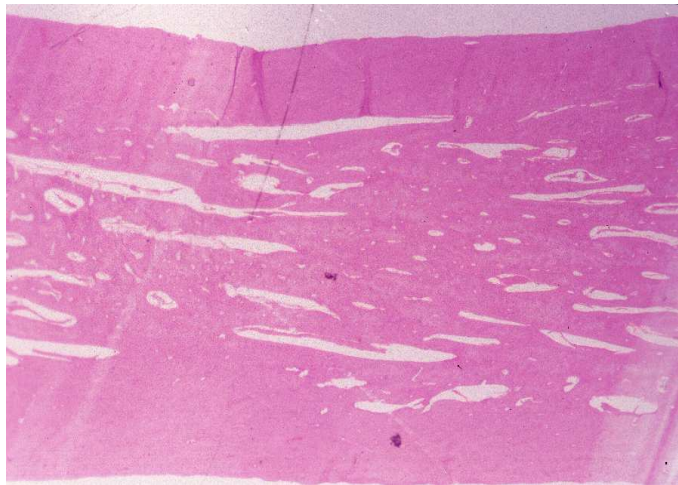


Fig. 4. A mandible in which 35 mm- and 40 mm-defects were created preserving periosteum. A: photograph of specimen. B: histological appearance showing bone bridging. C: occlusal radiograph taken 2 weeks postoperatively. D: occlusal radiograph taken 12 weeks postoperatively.

A.



B.



C.

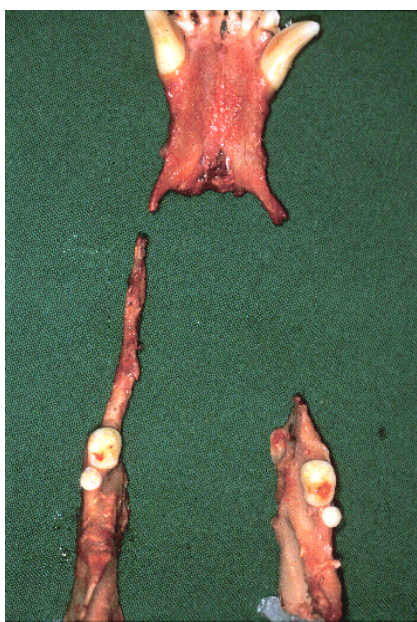


D.



Fig. 5. A mandible in which 50 mm- and 55 mm-defects were created preserving periosteum. A: photograph of specimen. B: occlusal radiograph taken 2 weeks postoperatively. C: occlusal radiograph taken 12 weeks postoperatively.

A.



B.



C.

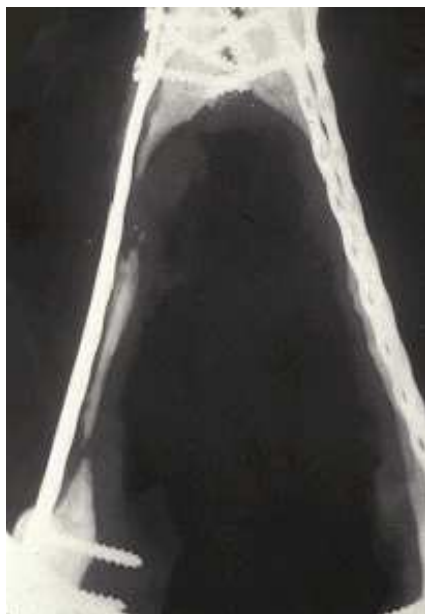


Fig. 6. View of bone bridging in dog 1. A. Radiograph: Rt, autologous fibrin glue side; Lt, control side. B. Histological appearance of the autologous fibrin glue side. C. Histological appearance of the control side.

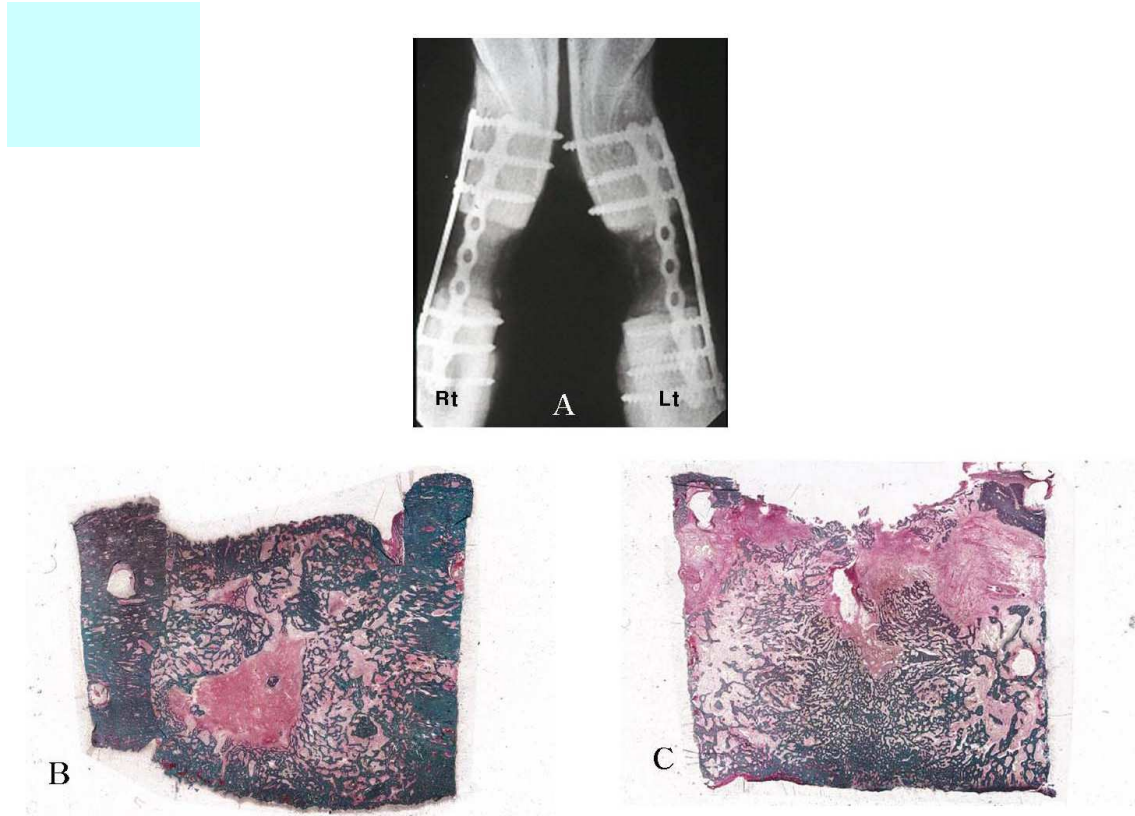


Fig. 7. View of bone bridging in dog 2. A. Radiograph: Rt, autologous fibrin glue side; Lt, control side. B. Histological appearance of the autologous fibrin glue side. C. Histological appearance of the control side.

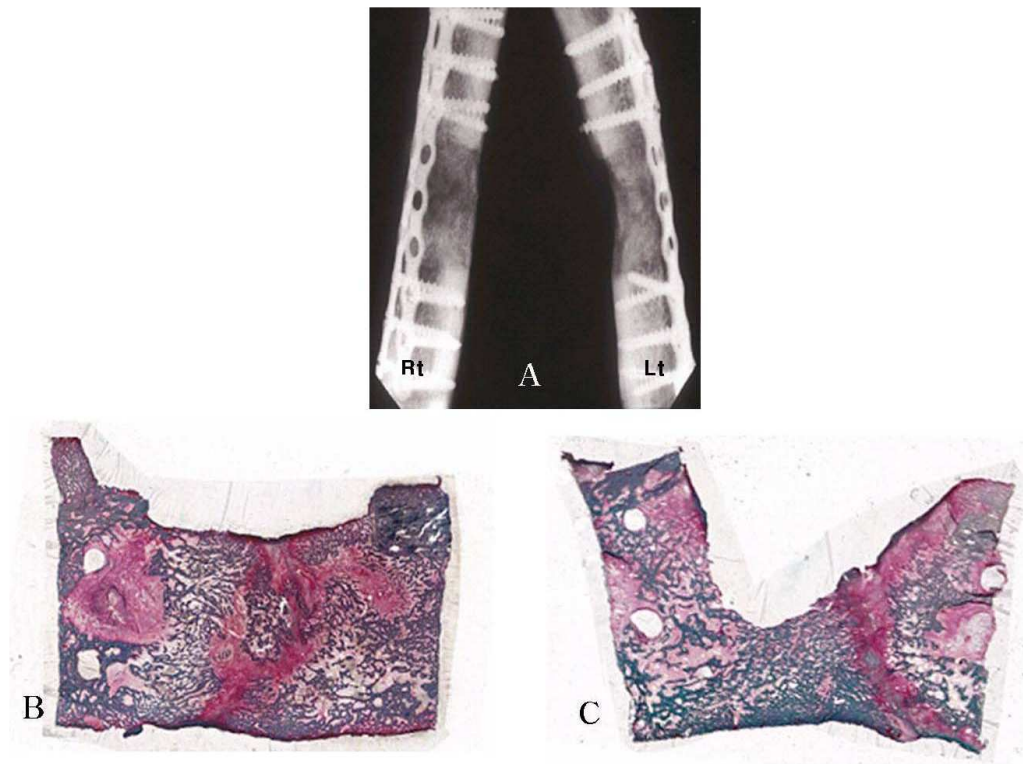
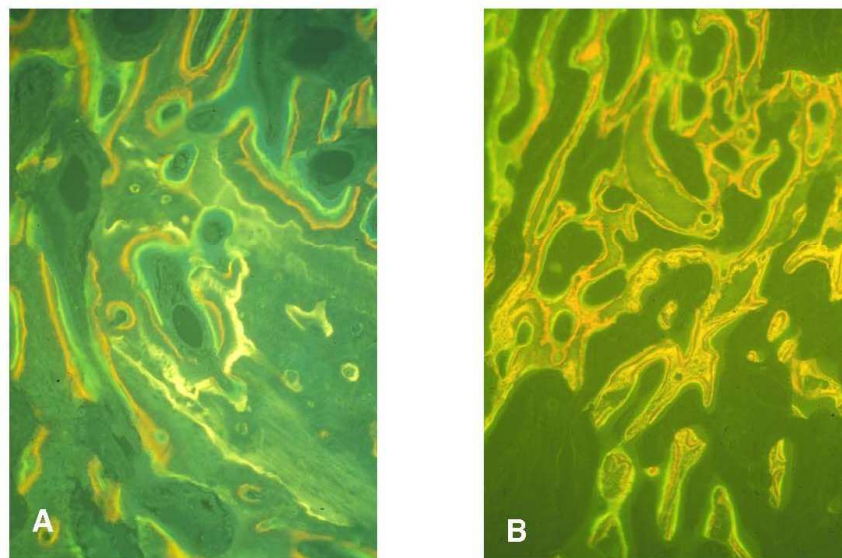


Fig. 8. Sagittal sections of the grafts showing the deposition of fluorochrome stains (tetracycline: yellow, alizarin red: red, calcein green: green). A: autologous fibrin glue side (x40), B: control side (x40).



국 문 요 약

골이식시 혈소판농축 피브린 접착제의 골재생 효과

연구 목적

성견 하악골 임계결손부에서 혈소판농축 피브린 접착제의 골재생 효과를 검증하기 위하여 연구를 시행하였다. 이에 앞서 성견 하악골의 임계결손부 크기 결정이 필수적이므로 임계결손부 크기를 결정하기 위한 실험을 우선적으로 시행하였다.

재료 및 방법

성견 하악골에서 임계결손부 크기 결정 : 18 마리의 성견에서 하악골 좌우 양측에 골절제술을 시행하여 연속성이 없는 완전한 결손부를 형성하였다. 18 마리 중 6 마리에서는 골절제시에 골막을 함께 절제하였고 결손부의 크기는 5-20 mm 로 하였다. 나머지 12 마리에서는 골절제시에 골막을 보존하였으며 결손부의 크기는 15-60 mm 로 하였다. 12 주 경과시에 성견들을 희생시켜 결손부위에 대한 방사선사진 및 조직학적 검사를 시행하였다.

성견 하악골 임계결손부에서 혈소판농축 피브린 접착제의 골재생 효과 검증 : 7 마리의 암컷 성견에서 하악골 좌우 양측에 임계결손부 크기에 해당하는 15 mm 크기의 골막을 포함하는 골절제술을 시행하였다. 실험군으로 한쪽 결손부는 혈소판농축 피브린 접착제를 첨가한 자가분쇄골을 이식하여 재건하였다. 대조군으로 동일 개체의 다른 한쪽 결손부는 자가분쇄골만 이식하여 재건하였다.

결과

성견 하악골에서 임계결손부 크기 결정 : 골막을 함께 절제한 골절제시에 15 mm 이상 결손의 경우 치유가 되지 않았으며, 골막이 보존된 골절제시에는 50 mm 이상 결손의 경우 치유가 되지 않았다. 따라서 성견 하악골에서 임계결손부 크기는 골막이 제거된 경우 15 mm, 골막이 보존된 경우 50 mm 임을 알 수 있었다.

성견 하악골 임계결손부에서 혈소판농축 피브린 접착제의 골재생 효과 검증 : 6 주 경과시에 시행한 조직검사서 혈소판농축 피브린 접착제를 첨가한 자가골 이식군에서 보다 양호한 신생골이 형성되었다.

결론

본 연구를 통하여 골이식 부위에서 혈소판농축 피브린 접착제가 골재생을 효과적으로 증진시킬 수 있음을 확인하였으며, 이러한 효과는 접착제 내의 혈소판에서 유리된 성장인자와 섬유소원에서 유래된 피브린망 때문으로 사료된다.

핵심되는 말 : 피브린 접착제; 혈소판농축혈장; 골재생; 골이식; 임계결손; 성견 하악골