IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 15, Issue 11 Ver. VII (November. 2016), PP 66-69
www.iosrjournals.org

Evaluation The Role of Decortication of Cortical Bone in Bone Formation In Periosteal Distraction Osteogenesis: An Experimental Study in The Rabbits

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Abstract: *The purpose of this study is to evaluate the role of decortication of cortical bone on bone formation in periosteal distraction osteogenesis . Titanium mesh was placed between the periosteum and lateral surface of the mandible in 10 adult rabbits. The buccal cortical bone was porously perforated by drilling in 5 rabbits (test group) and the others without decortication (control group). Rabbits were sacrificed after 8 weeks. Specimens were fixed, decalcified, and stained with hematoxylin and eosin. Histologic examination was performed on all specimens. Histologic evaluation in control group showed a newly formed bone under the titanium mesh, large marrow spaces were observed in the regenerated region. The bone is separated from the original bone by connective tissue and collagen fibers. In control group Lamellar new bone was detected, it is relatively thick and surrounded by osteoblasts. The newly formed bone was attached to the original bone. We conclude that decortication of cortical bone enhances the bone formation in periosteal distraction osteogenesis.*
Keywords: *Decortication, Osteogenesis, Periosteal Distraction*

I. Introduction

Recently, osteogenesis by "periosteal distraction (PDO)" without corticotomy has been suggested as a technique for bone augmentation. This method is based on the concept that tensile strain on the periosteum, which causes tenting of the subperiosteal capsule, is sufficient to produce bone formation without corticotomy or local harvesting of the bone.[1-5] PDO can produce new bone formation which derives from both, the periosteum and the underlying bone [6] . Despite good results that have been achieved by this technique there are a lot of variations existed regarding the rate of augmentation, site and surgical technique and the length of consolidation period. [1,3,7-10] However, Sencimen et al, [11] reported an abundance of adipose tissue and an insufficient mature bone in the PDO gap area, they concluded that this newly formed bone is not suitable for occlusal forces, and it would be impossible to insert an endosteal implant into the area. The lack of bone marrow cells might play a role in the occurrence of fatty tissue[12].The purpose of this study is to evaluate the role of decortication of cortical bone on bone formation in periosteal distraction osteogensis.

II. Materials and Methods

1.1 Experimental animals:

Ten adult white male rabbits with a mean weight of 2.6 ± 0.39 kg were used as the animal model. Experimental protocols were approved by University of Al Andalus university Committee of Animal Research. The animals were divided equally into experimental and control group according to decortication of the buccal cortical bone.

1.2 Surgical procedures:

All surgical procedures were performed under general anesthesia with a combination of 35 mg/kg intramuscular ketamine and 5 mg/kg subcutaneous xylazine. Local anesthesia, consisting of 2% lidocaine with 1:100,000 epinephrine was infiltrated into the lateral surface of the mandibular body. The surgical site was shaved, prepared with 10% povidone-iodine solution, and draped to maintain aseptic conditions. A 1.5-cm-long incision in the skin was made along the inferior border of the mandible, and dissection was performed through the subcutaneous and muscle layers. The periosteum was carefully elevated to expose the lateral aspect of the mandibular body. In the test group, the buccal cortex was porously perforated by drilling with fissure bur, whereas the cortical bone was left intact in the non-decortication group (Fig 1). The periosteum was distracted with a titanium mesh 0.1 mm in thickness, and was cut to a size of approximately 12 ×15 mm and adjusted to distract the periosteum 4 mm apart the surface of bone. The wound was closed in layers, using 4-0 Vicryl

sutures. Postoperative analgesics included ketorolac (0.5 mg/kg by mouth) and buprenorphine (0.3 mg intramuscular).

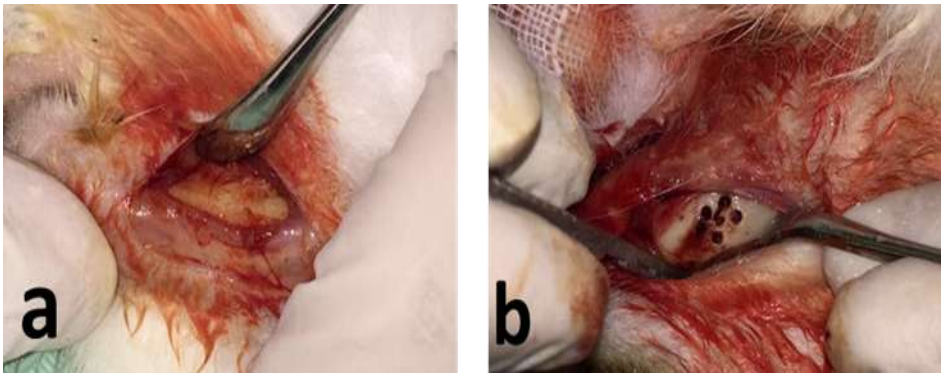

Figure 1. Intraoperative photograph, a: submandibular dissection without decortication, b: with decortication

2.3 Specimen preparation:

After healing period of 8 weeks, animals were sacrificed by an intravenous over dose of pentobarbital sodium. The mandibular distraction areas, including peripheral soft tissues, and titanium mesh were carefully removed. All resection materials were kept in a 10% neutral buffered formalin solution for at least 3 days. Next, each titanium mesh was removed. The specimens were then decalcified in the formic acid solution. When sufficiently soft, tissue samples were processed and embedded in paraffin for histological examination. Standard 4–5-mm sections were prepared and transferred onto slides for each block of tissue. All slides were stained with haematoxylin and eosin, and evaluated using a light microscope.

III. Results

All animals resumed normal dietary habits during the first 24 hours after the operation, and none of the animals had a weight loss during the experimental study. Newly formed bone was seen between the cortical bone and periosteum in both groups by H&E staining.

1.3 Control group:

Histologic evaluation showed newly formed bone on the lateral side of the mandible under the titanium mesh, the bone was covered by a lining of osteoblasts. large marrow spaces were observed in the regenerated region. The bone is separated from the original bone by connective tissue, collagen fibers . Fig 2

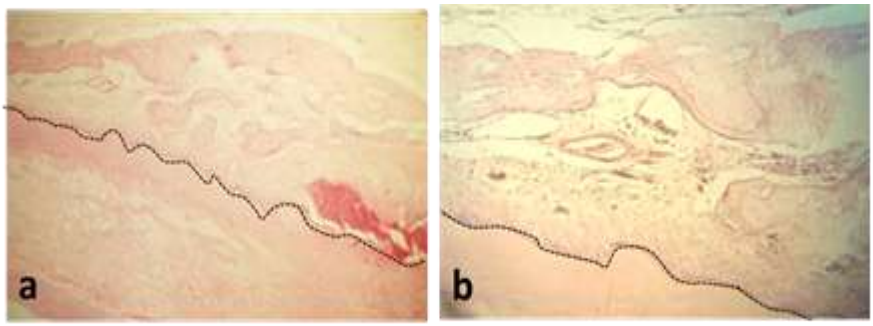

Figure 2. Histologic analyses of 8 week biopsy sample of control group: new bone formation attached to the internal surface of periosteum. a: (H&E staining, X 40), b: (H&E staining, X 100),

1.4 Test group:

Lamellar new bone was detected, it is relatively thick and surrounded by osteoblasts The newly formed bone was attached to the original bone and characterized by an increase in the number of osteocytes per unit area. Fig 3

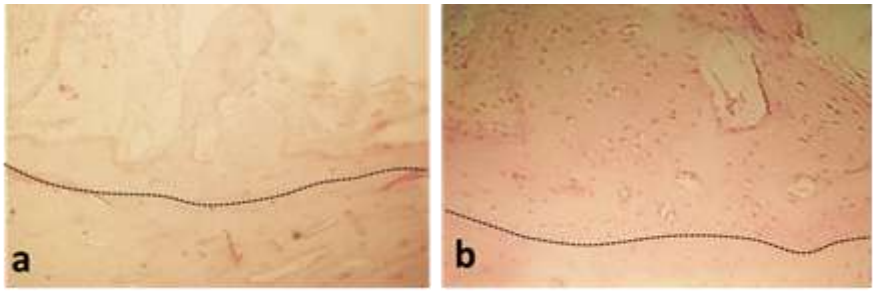

Figure 3. Histologic analyses of 8 week biopsy sample of test group: new bone formation attached to the original one. a: (H&E staining, X 40), b: (H&E staining, X 100),

IV. Discussion

The purpose of this study is to evaluate the role of decortication of cortical bone on bone formation in periosteal distraction osteogenesis. The elevation technique of periosteum combines aspects of distraction osteogensis (DO) and Guided Bone Regeneration (GBR).[13-16] This technique is not invasive procedure, doesn't require osteotomy or corticotomy and there is no risk of donor site morbidity. [1,3] different methods to distract the periosteum either immediately [17-19] or gradually [3,20] have been described previously and reported different results regarding to the quality and quantity of the new generated bone. Sencimen et al and Altug˘ et al, [11,12] reported an abundance of adipose tissue and an insufficient mature bone in the PDO gap area, they concluded that this newly formed bone is not suitable for occlusal forces, and it would be impossible to insert an endosteal implant into the area. It seems to be important to have sufficient communication between the periosteum and the underlying bone with appropriate mechanical strength against the overlying soft tissue to encourage new bone formation.[8] In our study we used perforated titanium mesh to provide a communication between the basal bone and the internal layer of periosteum and newly formed bone was seen between the cortical bone and periosteum in both groups. In the other hand, it has been reported that elevation of periosteum with collagen membrane covering the perforated titanium plate produces more new bone compared to the elevation with the perforated titanium plate alone, [21] this in accordance with Zakaria et al studies, [10 ,22] who confirmed that newly formed bone originated mainly from the basal bone and the progenitor cells of blood. During periosteal distraction, a competition arises between soft tissue cells derived from periosteum and osteoblast cells originating from cancellous bone in the gradually created space. The former cells have the ability to invade the maintained space and multiply faster than the latter. Altug˘ et al [12] claimed that lack of bone marrow cells may play a role in the occurrence of fatty tissue. The perforation of cortical bone in our study led to a positive results. This is in agreement with Oda et al,[2] who stated that the decortication in PDO might be effective in promoting bone formation. Also this results are in accordance with the results of Yamauchi et al, [8] they confirmed that the decortication procedure enhanced early bone formation from the original bone surface the same positive effect of decortication demonstrated by [23, 24] , they suggested that this technique initiation of bleeding and the possible inflow of mesenchymal stem cells, hypothesizing that these events are the origin of new bone formation In contrast to these findings, several investigators denied an essential role of the cortical perforations. Different studies could show new osteogenesis under devices that completely shielded the periosteum from the inside of the devices without creating a connection to the underlying bony marrow [25.29].

V. Conclusion

Decortication of cortical bone enhance the bone formation in Periosteal distraction osteogenesis.

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