Radiological Study of the Effect of Omental Pedicel Flap on Fracture Healing in Unfixed Ribs in Dogs

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Summary

This study was conducted to evaluate the effects of omental flap on healing of unfixed fractured ribs in dogs. Sixteen adult local breed dogs were used, which they were divided into two equal groups (Control and Treated group). The experimental animals were pre-medicated with atropine sulfate 0.04 mg/kg BW intramuscularly, and after 10 minute anesthetized with a mixture of Ketamine hydrochloride (15 mg/kg BW) and Xylazine hydrochloride (5 mg/kg BW) intramuscularly. In control group, the rib was fractured by wire saw and left unfixed then the muscles and skin was closed routinely. While in treated group, the rib was fractured by wire saw and a flap of omentum was put around the fractured rib, then muscles and skin were closed. Animals were observed clinically for one week and radiologically every week for three months. The radiological findings revealed that the healing process was faster in the treated group compared with the control group. The fracture line began to disappear in the eight and at the fourth weeks in the control and treated group respectively. The callus formation was large in size in control group compared with small dense callus in treated group. The remodeling process began in the fourth week in the treated group while at the eighth week in control group. These results indicated that the omental flap play an important role for enhancing healing and help to stabilize unfixed fractured ribs.

Key words: omental ,radiological, flap, rib, dog.

دراسة شعاعيه لتأثير طية الثرب في التأم الكسور في الأضلاع غير المثبتة في الكلاب

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الخلاصة

تم إجراء هذه الدراسة لتقيم تأثير طيه الثرب في عملية الالتئام في الأضلاع المكسورة والغير مثبتة في الكلاب. استخدم 16 حيوان من الكلاب البالغة المحلية والتي قسمت إلى مجموعتين متساويتين (سيطرة و معاملة). تم تخدير حيوانات التجربة بأعطاء مادة الاتروبين سلفيت بجرعة 0.04 ملغم/كغم من وزن الجسم، وبعد 10 دقائق تم حقن مزيج من الكيتامين (15 ملغم/كغم من وزن الجسم) والزايلازين (5 ملغم/كفم من وزن الجسم) بالعضلة كمخدر عام. في مجموعة السيطرة تم عمل كسر في الضلع بواسطة السلك الناشر ثم ترك طرفي الضلع المكسور

من دون تثبيت بعد ذلك تم غلق العضلات والجلد بالطريقة الروتينية. بينما في مجموعة المعاملة تم عمل كسر في الضلع بواسطة السلك الناشر بعدها وضعت طيه الثرب حول منطقة الكسر وغلقت العضلات والجلد. تم متابعة الحيوانات سريريا لمدة اسبوع وكذلك شعاعيا \ أسبوعيا ولمدة 3 أشهر متواصلة.

أظهرت النتائج الشعاعية أن عملية الالتئام كانت أسرع في مجموعة المعاملة مقارنة مع مجموعة السيطرة. بدء خط الكسر بالاختفاء في الأسبوع الرابع في مجموعة المعاملة بينما استمرت مشاهدته حتى الأسبوع الثامن في مجموعة السيطرة. كذلك فان تكون الدشبذ كان اكبر في مجموعة السيطرة مقارنة مع دشبذ كثيف وصغير في مجموعة المعاملة. بدأت عملية الترميم في مجموعة المعاملة في الأسبوع الرابع بينما بدأت في الأسبوع الثامن لمجموعة السيطرة. أظهرت النتائج أن طيه الثرب لعبت دورا مهما في الإسراع من عملية الالتئام وكذلك ساعدت بتثبيت الأضلاع المكسورة الغير مثبتة.

Introduction

Bone is slow to heal but when the ends are approximated opposite each other, and when movement between the bone ends is eliminated, healing will normally occur. Complete fractures usually need to be immobilized for good repair (1). The primary goal of any fracture treatment is to restore the function of the injured bone as soon as possible and completely. A variety of fracture treatment options exists, including internal fixation with open reduction, external skeletal fixation with open or closed reduction (2).

Rib fractures are common after thoracic trauma. Complications of rib fractures include underlying pulmonary contusion and thoracic wall pain, hemothorax, pneumothorax, diaphragmatic hernia, and even sudden death which can result after laceration of intra-thoracic vessels, lung parenchyma, and cardiac tissue by displaced fractured ribs (3,4,5 and 6).Thoracic trauma and fractured ribs can have harmful effects and are a substantial contributor to morbidity and mortality in affected animals (3,5,6,7 and 8). There are many materials used in the immobilization of bones depending on the animals species, site of fracture, size of the animal, condition of the fracture and even the age of the animals, such as intramedullary pin, Steinmann pin, kirschner wire, rush pin and kuntscher nail (2 and 9). The size of the external callus produced has been related to both the magnitude and frequency of the inter-fragmentary movements. While some inter-fragmentary movement has been shown to be important to stimulate callus formation and healing, a large callus does not necessarily provide the best stability (10).

Disturbances in the healing of fractures occur more often when the circulation is severely damaged by trauma, therefore the necrobiotical changes in the bone tissue and the corresponding structures are caused by lack of circulation. For this purpose numerous methods are used in practical clinical work like application of bone morphogenetic protein and homologous bone transplant which is most certainly one of most efficient methods for healing of complicated fractures, and the application of free transplant of the greater omentum for improving the bone defect healing process also used (11). Although the omentum has received considerable attention and is extensively used in general, reconstructive, thoracic, and neurologic surgery, its function has long been the subject of much speculation. The overwhelming majority of surgeons view the omentum as a protective structure (12). The greater omentum may be used as an autograft, both pedicel and free. It may be transferred from the abdomen to a site as high as the scapula and brain or as low as the perineum and lower extremities (13).

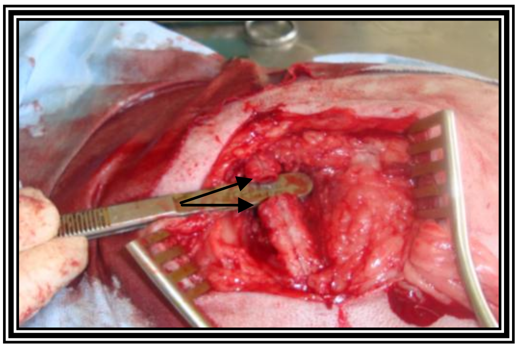
It has long been recognized that the greater omentum has great ability in revascularization and brings blood supply to the tissues and promote angiogenic activity in adjacent structures to which it is applied (4,14 and 15). Indeed the angiogenic material obtained from the omentum is abundant in supply, also the omentum delivers vascular endothelial growth factor, and because of this unique ability of the omentum, it has been used in many frequent surgeries (14 and 15). The omentum can rapidly produce a layer of fibrin by which to adhere to the contaminated area at the point of contact. In the course of a few days, the fibrin begins to organize with the development of new blood vessels and fibroblasts. In the long term, if the host survives, the area will be walled off with collagen, and thereby forming dense adhesions (4,16 and 17).

The object of this study was to evaluate the effect of omental pedicel flap on unfixed rib fracture radiographically.

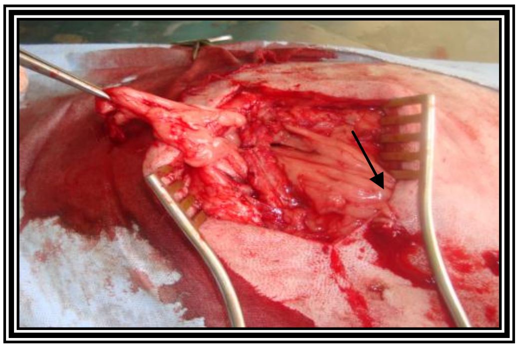
Materials and Methods

This study was performed on 16 local breed dogs, of both sexes, weighing between 15-20 kg and 1-3 years in age. Animals were examined before the experiment for any condition or infection and the animals maintained under standardized condition. Animals were divided into two equal groups (Control and Treated groups).

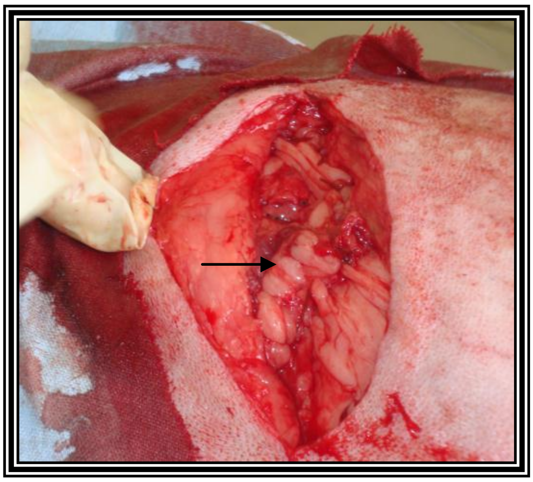
The experimental animals were pre-medicated with atropine sulphate 0.04 mg/kg b.w. intramuscularly, 10 minute later a mixture of Ketamine hydrochloride 15 mg/kg b.w. and Xylazine hydrochloride 5 mg/kg b.w. intramuscularly was given as a general anesthesia. Positive pressure ventilator was used in this study before making the fracture in the ribs in order to avoid pulmonary collapse if the chest cavity was penetrated during the operation. Operative animals were laid on the lateral recumbence depending on the side we need to make the fracture on it. The fracture was made on the fifth rib in all experimental animals and from both sides under aseptic technique. Incision of the skin and muscles was performed directly over the chosen rib, it was explored and the fracture line was made transversely in the middle of the rib by using the wire saw (Fig.1). In the control group the ribs were left without fixation then the muscles and the skin were closed in routine methods, while in the treated group similar manner as in control group, but the fracture site was covered by an omental pedicel flap which was harvested after laparotomy and pulling it through a subcutaneous canal toward the fractured rib (Fig.2 and 3). Then the omentum was fixed over the ribs by two or three simple interrupted stitches using cat gut suture material, then the muscles and skin were closed routinely. Penicillin-streptomycin at a dose of 10.000 IU, 20 mg/kg b.w. intramuscular respectively was given for three days post operatively. Then the animals monitored after operation clinically every day and radiologically weekly for 12 week to evaluate the healing process in the two groups.



(Fig.1): Macroscopic picture show the fractured rib in dog.



(Fig.2): Macroscopic picture show the omental flap passing through a subcutaneous canal in treated group in dog.



(Fig.3): Macroscopic picture show the omental pedicel flap covering the rib in treated group in dog.

Results and Discussion

The clinical examination of the two groups were manifested by swelling at the site of operation, and some animals suffered from a mild cough. The swelling on fractured area may be due to inflammatory reaction or may be due to thickness of omental flap that cover the fractured area in treated group, this finding agree with (18 and 19). Some cases in the control group suffered from pneumothorax which may be due to free movement of the fractured fragments which lead to penetration of the thoracic wall and passing of air into thoracic cavity, which treated by evacuation of air and suture of opening. This finding was reported by other researcher (3). Callus detected clinically by palpation at the fracture site after the third week of operation which was large in size in control group. This enlargement may be due to movement of fracture ends (10), while in treated group the omentum may fixed the fracture ends and enhance the healing (19 and 20). The radiological results of the two groups revealed that the treated group was better than the control group which is summarized in Table (1).

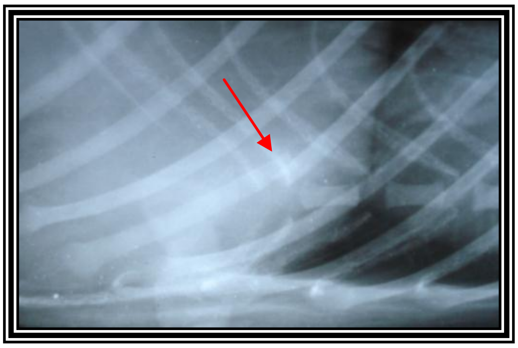
Table (1): Show the radiographic findings of control and treated group:

Week	Control group	Treated group
1	Radiographic finding showed clear fracture line, no periosteal reaction at the fracture site, in some cases there was overlapping of the bone fragments (Fig.4).	Radiographic finding showed clear fracture line, no periosteal reaction at the fracture site (Fig.5).
2	There is periosteal reaction at the fracture site, clear fracture line (Fig.6).	There is dense periosteal reaction around the fracture site, slight visible fracture line (Fig.7).
3	Large external callus formation around the fracture site, still clear fracture line (Fig.8).	Dense external callus formation bridge the fracture site, invisible fracture line (Fig.9).
4	Large external callus formation cover the fracture site, still slight visible fracture line (Fig.10).	Decrease in the size of the callus around the fracture site, signs of simple remodeling process at the fracture site (Fig.11).
6	Still large size of external callus around the fracture site, slight visible fracture line (Fig.12).	Small size of external callus around the fracture site with incorporation of the callus with the cortical bone (fig.13).
8	Decrease in size of external callus around the fracture site, the fracture site began to alignment with original bone (Fig.14).	Continuance of remodeling process, fracture line has completely disappeared (Fig.15).
10	The remodeling process of the cranial aspect of fracture site was more prominent than the caudal aspect and still external callus present (Fig.16).	The bone may take the normal shape, but is still visible external callus (Fig.17).
12	The remodeling process is continued but still external callus around the fracture site (Fig.18).	There is progress of remodeling process and the bone may take the normal shape (Fig.19).

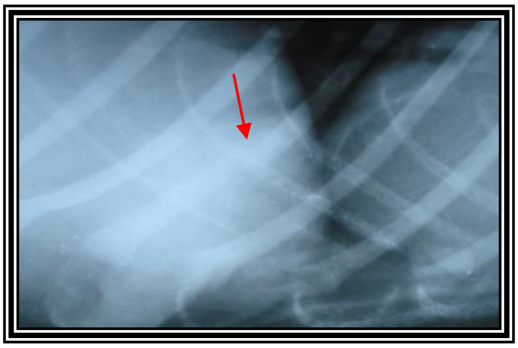
The periosteal reaction around the fractured rib began at the end of second week in control group, but in the treated group, dense reaction at the same time above, this may be due to the presence of omental flap, which help in the revascularization of the fracture site, this agrees with (21,22 and 23), they reported that the omentum could be a good vascular bed that promote angiogenic activity and healing to which area contact to.

In the third and fourth week, there was large callus in control group when compared with small dense callus formation around the fractured rib in treated group, this could be due to the unstability of the bone fragments in control group, this coincided with Epari (10) who explained that the production of the external callus has been related to both the magnitude and frequency of the inter-fragmentary movements, and the callus still produced due to the presence of gap between the fragments, and this will prolong the time of the healing. Other researchers (19,20 and 24), mentioned that the adhesion between muscles and omentum around the fracture site and the converting of the omentum into fibrous connective tissue give more fixation to the fracture site. It obvious that the enhancing of osteogenesis was more prominent in treated group than in control group, this may be due to the omentum around the fracture site which carried a rich blood supply with high absorptive capacity and pronounced angiogenic activity. This facts were described by another researcher (15).

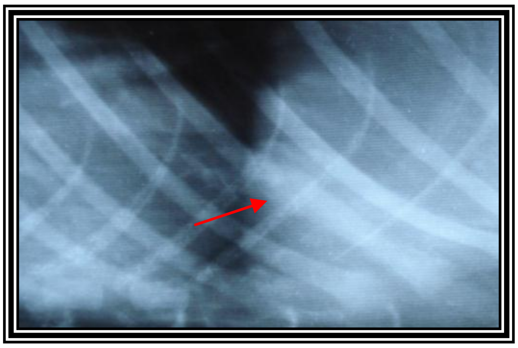
In present work, the fracture line was invisible at the end of the fourth week in treated group, while take more time to disappear, in control group. The obliteration of fracture line may be due to the periosteal proliferation that played an important role in formation of compact bone and this process was proved more in treated group, this fact agrees with (25) who demonstrated that omental adipo-cytes, are the primary source of vascular endothelial growth factor (VEGF protein), which can stimulate bone repair not only by promoting angiogenesis but also by accelerating and enhancing bone turnover. Also, they demonstrated that VEGF directly promotes the differentiation of primary osteoblasts and play an important role in callus formation. The callus around fracture site was decreased at the end of four weeks in treated group that means that the remodeling begin, while in control group this process began later. In addition, the bone has taken almost the normal shape and callus incorporation with original bone at the end of twelve weeks in treated group, but still did not achieve this degree in the control group at the same time. The characteristics of the speed of osteogenesis and healing process in treated group may be explained this phenomena (26). In conclusion of this study it indicated that the using of omental pedicel flap may play an important role in enhancing bone healing through accelerating of the osteogenesis and help in bone fixation.



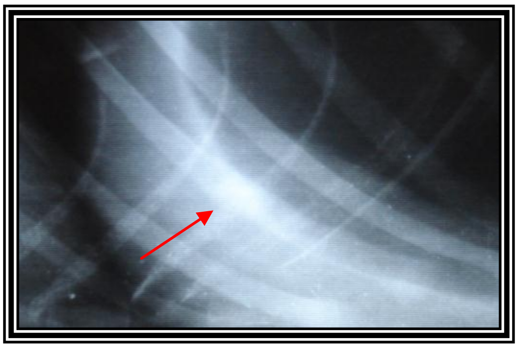
(Fig.4): Radiography show clear fracture line, no periosteal reaction at the fracture site, there was overlapping of the bone fragments in control group.



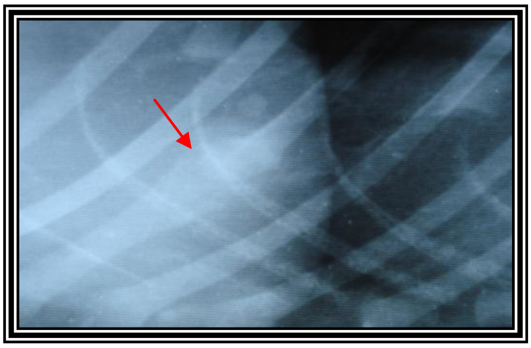
(Fig.5): Show clear fracture line, no periosteal reaction at the fracture site in treated group.



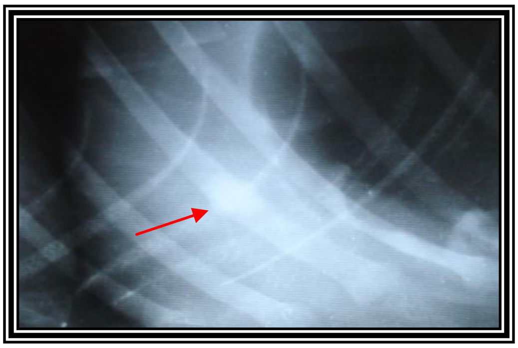
(Fig.6): Show periosteal reaction at the fracture site, clear fracture line in control group.



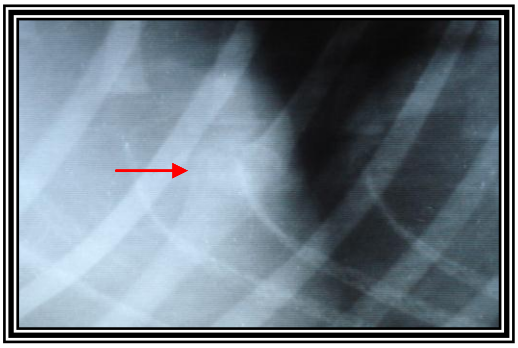
(Fig.7): Show dense periosteal reaction around the fracture site, slight visible fracture line in treated group.



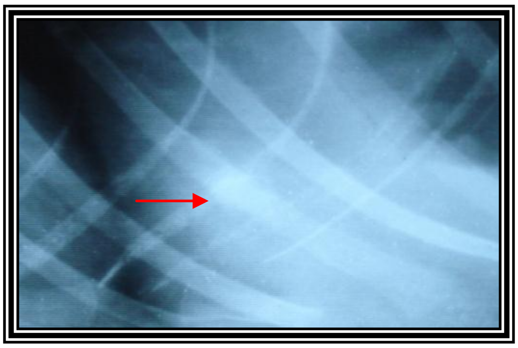
(Fig.8): Show large external callus formation around the fracture site, still clear fracture line in control group.



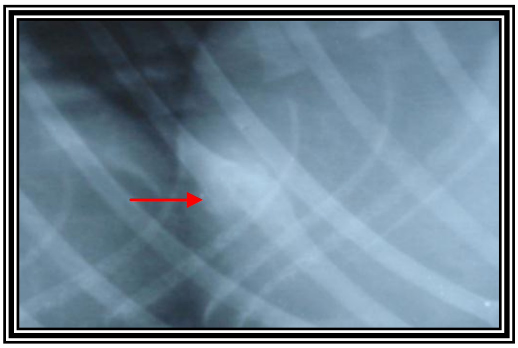
(Fig.9): Show dense external callus formation bridge the fracture site, invisible fracture line in treated group.



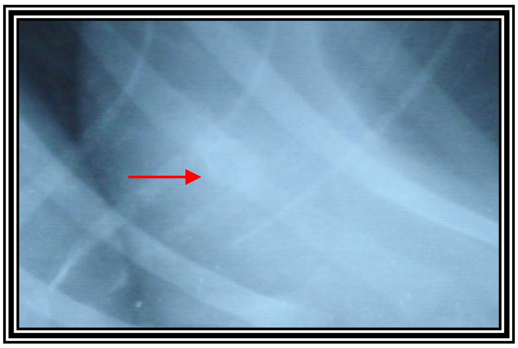
(Fig.10): Show large external callus formation cover the fracture site, still slight visible fracture line in control



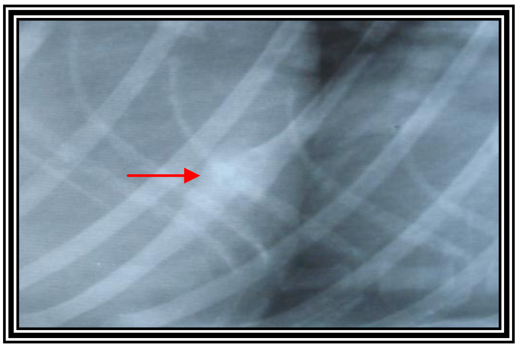
(Fig.11): Show small callus around the fracture site, and simple remodeling process at the fracture site in treated group.



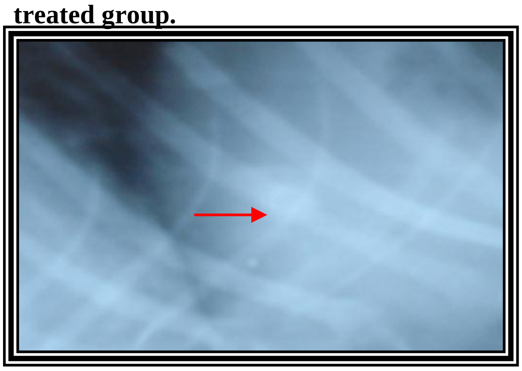
(Fig.12): Still large size of external callus around the fracture site, slight visible fracture line in control group.



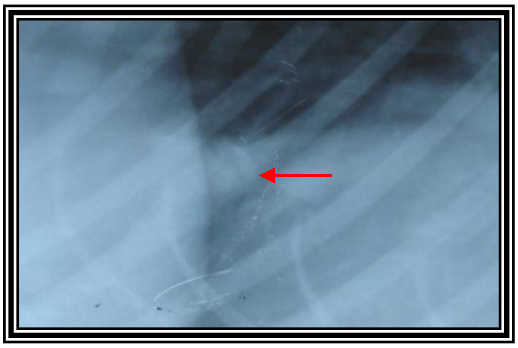
(Fig.13): Show small size of external callus around the fracture site with incorporation of the callus with the cortical bone in treated group.



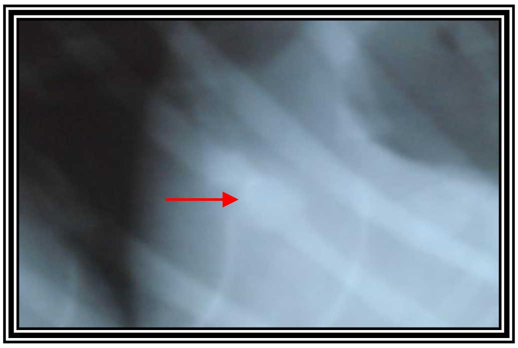
(Fig.14): Show small size of external callus around the fracture site, the fracture site began to align with original bone in control



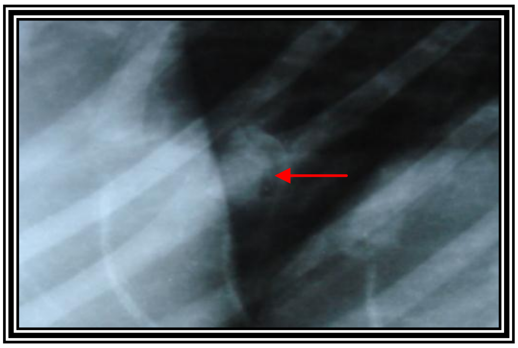
(Fig.15): Continuance of remodeling process, fracture line completely disappeared in treated group.



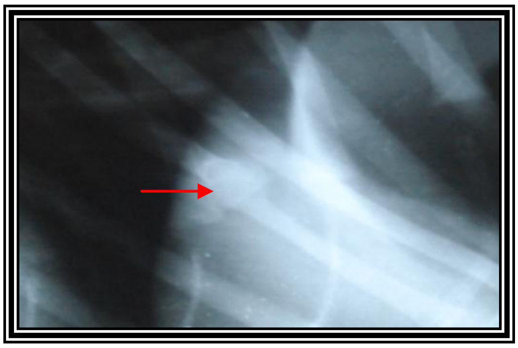
(Fig.16): Show the remodeling process of cranial aspect of fracture site was more prominent than the caudal aspect and still present of external callus in control group.



(Fig.17): Show that the bone may take the normal shape, but still visible and slight external callus in treated group.



(Fig.18): The remodeling process is continued but still external callus around the fracture site in control group.



(Fig.19): There is progress of remodeling process and the bone may take the normal shape in treated group.

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