Role of Autogenous pedicle Flap and Free Graft of Omentum on Healing of Oblique Rib Fracture in Dog

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Abstract

This study was assigned to investigate the role of autogenous pedicle flap and free graft of omentum in healing of induced oblique rib fracture in dogs. Twelve adult dogs were used weighing (15-20) Kg and were maintained under same condition then were divided into two groups .all animals subjected to oblique rib fracture in both side of thoracic chest at 4th last rib by wire saw in interval of long period. The skin over the rib opened, then blunt dissection to underlining tissue till reach the rib, once this had been achieved an oblique fracture was performed by using wire saw. Then fracture is fixed with stainless steel orthopedic wire throw drill a hole on both fracture end. In the first group omentum pedicle was extended subcutaneously after laparotomy operation in the left flank region then wrapped around the fracture and fixed with adjacent muscle over the fracture site by multiple stitches of 2.0 catgut suture. While in the second group free omentum graft was harvested then enrolled around the fracture site and fixed as the same pattern of the first group. During clinical follow-up of treatment dogs record signs of fever, cellulites, swelling at fracture site, stitch abscess in tow case, fracture overlap accrue in 2 fracture site. Biopsies were taken from the fracture site to follow-up fracture healing microscopically at 1,2,3,4th week, histopathological results of each group showed present of omentum tissue rich with blood vessels with formation of fibrous connective tissue in first group at 1st week that help to form thick regular direction of trabecular bone at 2nd week while in second group show convert fibrous connective tissue in some area to hyaline cartilage then form at 2nd week narrow irregular direction of trabecular bone. in first group at 3rd week record start well compact bone surround haversian canal and progress to more thick at 4th week, at the same period in second group show increase in thickness of trabecular bone with simple compact bone formation while at 4th week show small area of haversian canal surround by lamenated compact bone. Conclusion of this study reveals that autogenous omentum pedicels promote oblique rib fractures healing more than free graft.

دور السويقة الذاتية والطعم الحر للثرب في التئام الكسور المائلة للأضلاع في الكلاب

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الخلاصة

صممت هذه الدراسة لتقييم دور سويقة الثرب والطعم الحر الذاتي للثرب في عملية التئام كسر الضلع المحدث في الكلاب. اختير للدراسة 12 كلبا بالغا من السلالات المحلية بأعمار (1–4) سنة وبأوزان تراوحت (15–20) كغم, قسمت إلى مجوعتين بالتساوي. عرضت كافة الحيوانات إلى كسر احد الأضلاع من كلا الجانبين وخلال فترات متباعدة في الضلع الرابع ما قبل الأخير بواسطة السلك المنشاري. شق الجلد المغطي للضلع ثم عمل فصل أعمى للأنسجة تحته لحين الوصول إلى الضلع وبمساعدة المنشار السلكي تم كسر الضلع بصورة مائلة، بعدها ثبت الكسر باستعمال سلك عديم الصدأ الخاص بجراحة العظام من خلال عمل ثقب واحد في نهايتي العظم المكسور. في المجموعة الأولى سحبت سويقة الثرب تحت الجلد بعد أجراء عملية فتح البطن من الخاصرة اليسرى لفت حول منطقة الكسر وثبتت بعدة غرز بعضلات المنطقة من خيط الكت كات بينما في المجموعة الثانية حصدت طعم الثرب الحر بعد عملية فتح البطن ولفت حول منطقة الكسر بنفس الطريقة للمجموعة الأولى. خلال فترة المتابعة السريرية للحيوانات المستخدمة في هذه الدراسة سجلت علامات ارتفاع درجات حرارة الجسم، تورم وتجمع السوائل عند منطقة الكسر، خراج في العقد الجراحية وانزلاق عند منطقة الكسر للفحص النسجي عند الأسبوع 1، 2، 3، 4

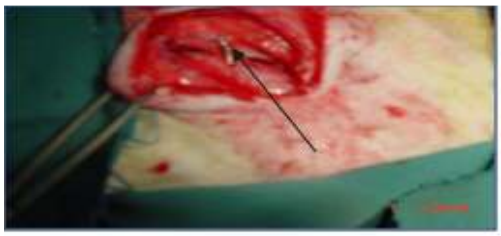
لمتابعة الشفاء وقد أظهرت النتائج لكلا المجموعتين وجود نسيج الثرب الغني بالأوعية الدموية المحتقنة وتكون النسيج الليفـــي عند الأسبوع الأول للمجموعة الأولى والتي ساعدت على تكون العظم الحويجزي بشكل سميك ومنتظم عند الأسبوع الثاني بينما لوحظ في المجموعة الثانية تكون مساحات من النسيج الليفي الضام وتحوله في بعض المساحات إلى نسيج غضروفي ثم تحوله عند الأسبوع الثاني إلى العظم الحويجزي والذي امتاز بنحافته وعدم انتظامه. عند الأسبوع الثالث للمجموعة الأولى سجل بدء تكون العظم الصلد المتطور حول قنوات هافرس والذي تطور ليصبح أكثر سمكا عند الأسبوع الرابع، وبنفس الفترة للمجموعة الثانية لوحظ زيادة سمك العظم الحويجزي وتكون بسيط للعظم الصلد بينما عند الأسبوع الرابع لوحظ مساحات قليلة من العظم الصلد حول قنوات هافرس. الخلاصة أشارت نتائج هذه الدراسة قيام سويقة الثرب بتشجيع عملية التئام الكسور المائلـــة فـــي الأضلاع مقارنة بالطعم الحر الذاتي.

Introduction

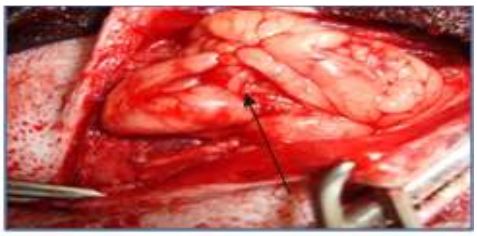
Rib fracture is almost always happen due to trauma, or as a complication of osteoporosis (1,2). The main clinical signs of rib fracture that include subcutaneous emphysema, pneumonia acute hemopneumothorax, paradoxical chest wall movement, respiratory failure and sometimes death (3). Rib resection is done when there is tumor of the rib, such as osteosarcoma or chondrosarcoma and in case of sever traumatic injury to the thorax (4). Numerous methods are used for repairing of rib fracture i.e. internal fixation with reconstruction plate, self tapping cortical screw, cercilage wire, locking compression plates, stainless steel wire, simple wire sutures locking compression plates, kirschner wires as intramedullary pin (5,6). Techniques of stabilization can be difficult, time consuming and the additional dissection required to accomplish these repair may lead to increase local tissue injury (7). Free omental graft can enhance bone healing through augmentation of vasculogenesis, as an essential element for proper bone healing (8). It can be used as plastic and disinfecting material in a pedicle form in combination with laser radiation in the management of chronic osteomylitis of ribs and sternum (9,10). Early reports describe it use as free graft, without microvascular anastomosis (11). There are a few researches about the effect of omentum in tissue healing, thus decided to study the effect of omentum in healing of rib fracture in dogs referring to histopathological aspect.

Materials and Methods

Twelve adult local breed dogs, aged 1-4 years and weighing 15-20 kg were enrolled for this study, the animals divided randomly and equally into two groups prior to initiate the surgical interference, animals were anesthetized by mixture of ketamine hydrochloride 15 mg /kg B.W and Xylazine hydrochloride 5 mg /kg B.W, preceding via a premedication (atropen sulphate) in a dose of 0.03 mg\kg B.W. All drugs injected intramuscularly. The operative site (thoracic wall) was prepared for aseptic surgery, and the animal put in lateral recumbent position. All animal were subjected to oblique fracture of the last four rib on both sides, by making an incision in the skin covering the rib, then blunt dissection to subsequently tissue was performed until reached the rib, with the help of wire saw, a complete fracture in the rib was done at suitable distance from the costo-vertebral articulation. Fixation of fracture ends was achieved by introducing stainless steel orthopedic wire through a hole which don by drill on each site and twisted into each other over the fracture site (Fig.1). In The first group, omental pedicel flap which was harvested through left flank laparotomy region and extended through subcutaneous canal then warped on the fracture site then fixed with muscle by absorbable suture material (2.0 cat gut) (Fig.2). While in the second group, autogenous omentum graft was harvested and covered the fracture site. All animals received antibiotic represented by penicillin 20.000 IU/kg and streptomycin 10mg\kg B.w, injected IM for five days. Biopsies from the fracture site were collected at 1, 2, 3, 4^{th} week post-surgery to follow-up fracture healing .The resected ribs were decalcified by 10% nitric acid solution, then fixed in 10% formalin solution and stained with Hematoxylin–Eosin and examined under light microscope.



(Figure 1)



(Figure 2)

Fig. (1) Shows stainless steel orthopaedic wire (arrow) is used to fix the fracture ends of the rib
Fig. (2) Show pedicle flap of greater omentum which warped around the fracture site (arrow) and fixed by several stitches with muscle over the fracture sit

Results

The operative time of fracture repair somewhat longer in first group compared with second group. The anesthetic time were sufficient for (10) animal out of (12), two animals require additional dose of general anesthetic drugs. Animals tolerated the surgical operation, in eight animal rib fracture was accompanied with mild cough especially association with opening of pleural cavity during rib fixation as well as mild bleeding accurse around the fracture site in all animals due to blind resection of paracostal muscle around the site of rib and need some ligations with 2.0 cat gut suture. Following complication of surgery and during clinical follow-up of treatment dogs, some non-specific secondary health problems were encountered, represented by fever, cellulites, swelling at fracture site, stitch abscess in two cases, fracture overlap accrue in 2 fracture site, most animals not eating in the first two days post operation then return after that. During biopsy collection, there were severe adhesion in between fracture site with muscles and omentum in first group than in second group.

Histopathological examination of biopsies are listed in the following table

Time	First group (omental pedicle flap)	Second group (free omental graft)
1st week	The histopathological section refere to presence of adipose tissue of omentum rich with congested blood vessels (Fig. 3), formation of fibrous connective tissue that replaced the omentum tissue (Fig. 4).	The histopathological section showed proliferation of fibrous connective tissue in the gap of fracture and converted of it in some area into hayalin cartilage (Fig.5) and presence of cartilage tissue that start convert into trabecular bone (Fig. 6)
2nd week	Presence of cartilaginous tissue that convert large area into trabecular bone (Fig. 7), also this section refer to thicker regular direction of bone trabecule and presence of cartilage tissue with decrease space between trabecule (Fig. 8)	Continues converted of cartilaginous tissue into trabecular bone (Fig. 9), as well as the woven bone that formed which characterized by irregular direction with narrow trabecule with presence of space between it also cartilage tissue and fibrous connective tissue presence (Fig. 10)
3rd week	The histopathological section also refer to increase in the thickness and regularity of trabecular bone with start of well compact bone formation and osteoblast lined compact bone (Fig. 11), also well compact bone surround the haversian with the presence of cartilage (Fig.12)	Increase in the thickness of trabecular bone as well as fibrous connective tissue (Fig. 13), also showed trabecular bone start converted into simple compact laminated bone (Fig. 14)
4rd week	There is more thicker compact laminated bone around haversian canal (Fig.15), also formation of large area of mature compact bone (Fig. 16)	Increase in the thickness of trabecular bone and small amount of it converted to laminated compact bone (Fig. 17), also compact laminated bone formed around the haversian canal (Fig.18)

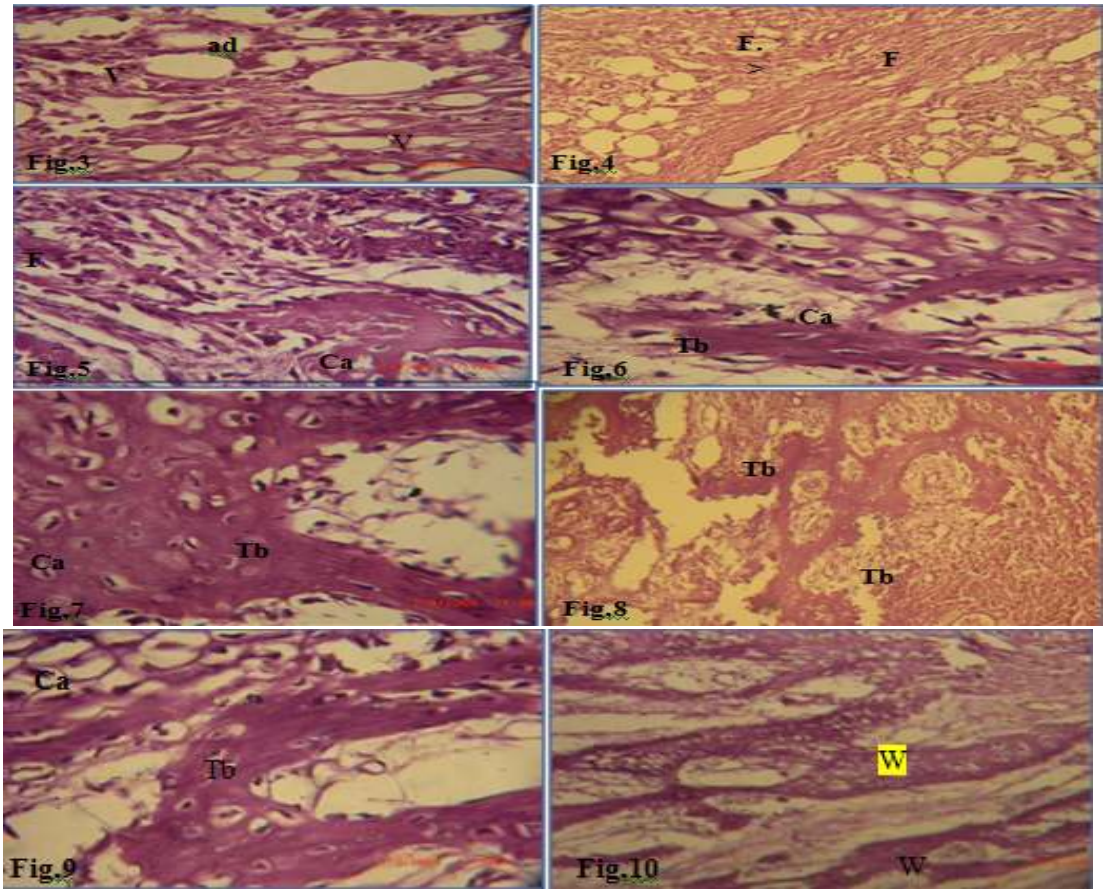


Fig. (3) The histopathological section showed present of adipose tissue (ad) of omentum rich with congested blood vessels (V) at 1week post operation in first group (pedicle) (H & E. 40).

Fig. (4) Formation of fibrous connective tissue (F) that replaced the omentum tissue at 1week post operation in first group (pedicle) (H & E. 10).

Fig. (5) Proliferation of fibrous connective tissue (F) and some of it converted into hyaline cartilage at 1week post operation in second group (graft) (H & E. 40).

Fig. (6) Present of cartilage tissue (Ca) that start convert less amount of it into trabecular bone (Tb) at 1week post operation in second group (graft) (H & E. 40).

Fig. (7) Present of cartilage tissue (Ca) that convert large amount of it into trabecular bone (Tb) at 2week post operation in first group (pedicle) (H & E.40).

Fig. (8) Thicker same regular direction bone trabecule (Tb) with present of cartilage tissue in some area and less space between bone trabecule at 2 week post operation in first group (pedicle) (H &E. 10).

Fig. (9) Continues cartilage tissue (Ca) converted into trabecular bone (Tb) at 2 week post operation in second group (graft) (H & E.40).

Fig. (10) Present of cartilage tissue (Ca) in large area of section and some of it converted into woven bone (W) which character by irregular direction with narrow trabecule also fibrous connective tissue (F) still present at 2 week post operation in second group (graft) (H & E. 10).

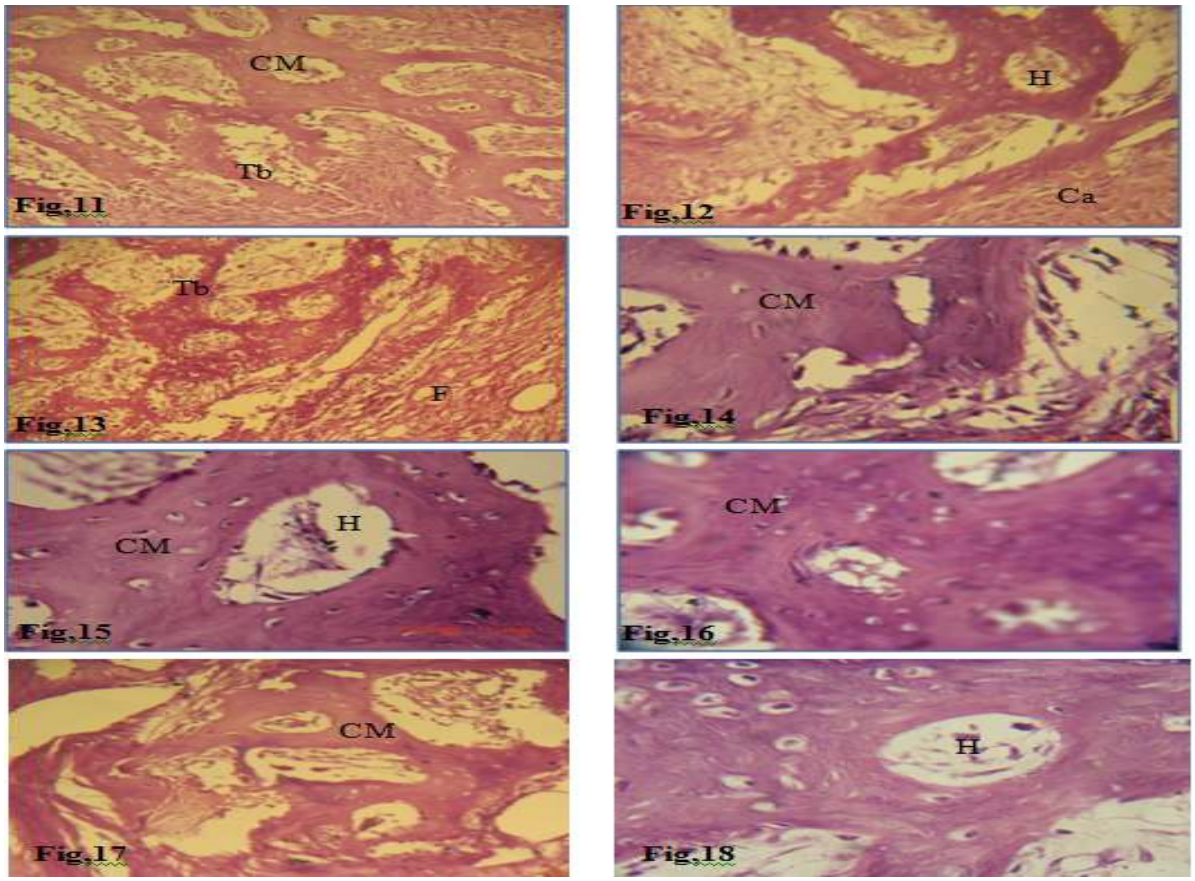


Fig. (11) Increase in the thickness and regularity of trabecular bone (Tb) with start of well compact bone (CM) formation and present of osteoplast lined compact bone at 3week post operation in first group (pedicle) (H &E.10).

Fig. (12) Showed compact bone surround the haversian canal (H) as well as the cartilage (Ca) also present at 3 week post operation in first group (pedicle) (H & E. 10).

Fig. (13) Increase in the thickness of trabecular bone (Tb) as well as fibrous connective tissue (F) also present at 3 week post operation in second group (graft) (H & E. 10).

Fig. (14) Trabecular bone start converted into simple compact laminated bone (CM) also present of cartilage tissue (Ca) at 3 week post operation in second group (graft) (H & E. 40).

Fig. (15) There is well thicker compact laminated bone (CM) around haverson canal (H) at 4 week post operation in first group (pedicle) (H & E. 40).

Fig. (16) Formation of large area of mature compact bone (CM) at 4 week post operation in first group (pedicle).

Fig. (17) Increase in the thickness of trabecular bone and small amount of it converted to laminated compact bone (CM) at 4 week post operation in second group (graft) (H & E. 10).

Fig. (18) Compact laminated bone formed around the haversian canal (H) at 4 week post operation in second group (graft) (H & E. 40).

Disscusion

This study designed to use of omentum pedicel or omental graft to estimate the differences in possibility of there in improving oblique rib fracture in dog. The operative time in first group longer than second group because of careful manipulation of omentum pedicel to avoid tearing or bleeding due to hard manipulation and at the same time choice pedicel of specific long to reach the stabilizing rib, while in graft group only required choice any graft of it then made transverse ligation around it by cat gut suture after that

harvested of it and wrapped around the stabilized rib. All results give indicator about rarely post operative complications of internal rib fracture fixation that enhance rapidly restore normal chest wall dynamic and decrease pain resulting in decrease mortality and this agree with (7, 12, 13) whom said that decrease post operative complications by immediately fixation of rib fracture lead to restore normal mechanical ventilation, prevent penetration of lung lobe, rupture of blood vessels or affect of heart and mediastienal region. In this experimental study chose oblique fracture designed because (1) said that rib bone relatively have thin cortex and it tendency to fracture obliquely, and (13) refers that oblique fracture of ribs have large area which suitable for proliferation of blood vessels from surrounding tissue and migration into the fracture line. Use of stainless steel orthopedic wire in this type of fracture fixation give a good indicator as a good fixation method while there is only two fracture rib overlap was records, in the same time it not need reoperation to remove it or special post operative maintenance, but only note that it used associated at operative time with mild bleeding at fracture site and plural puncture was accurse as a result of manipulation for fracture fixation this agree with (7) whom said that the techniques of internal stabilization can be difficult, time consuming and the additional dissection required to accomplished these repair and cause increase local tissue injury. In this type of induce fracture periosteam of ribs don't remove before fracture because it is one source of precursor cells which develop into chondroblast and osteoblast that are essential to the healing of bone (14). In each group omentum stabilized around fracture site by multiple stitches according to the recommendation of (15) home refers that surgical technique is important in acceleration of bone healing, on the other hand, putting a piece of omentum into the bone defect has a different result with attaching the piece of omentum over the bone defect by suturing it to the periosteam. Clinical signs of animals that record in the two groups include local swelling at the fracture site still three day post operation associated with hotness and pain also animals appetite which decrease because of healthy condition due to surgical operation, in fact local swelling occur normally after fracture due to tearing of blood vessels of bone and muscle around it that cause diffuse of plasma, white blood cells that increase acidity at fracture site and inflammatory reaction which accurse to removal of necrotic tissue, swelling and cellulites present for more time in graft group than in pedicle group may be due to (16) said that omentum tissue consider rich lymphatic system helps to absorb edema that decreasing swelling in traumatized area, (17) said seroma formation may occur in graft bed secondary to venues or lymphatic vasculature collapse, necrosis of omental fat or non septic inflammation. When taken biopsy there is adhesion between fracture site and muscle around it this adhesion in first group more than in second group, this may be due to omentum contain adhesion factor and fibroblast in there tissue structure that release collagen and fibrin network but it more in first group may be as a result of still of blood supply that help to continues release fibroblast growth factor to stimulate mesenchymal cells to differentiated to fibroblast that lead to adhesion and this adhesion give support to fixed rib fracture site when wrapped around it that enhance healing in pedicel group more than graft group. In this study during laparotomy to make omentum tissue to wrapped around rib fracture site show different in amount of fatty tissue of it in each animal for that (14) refer that there is some differ in role of omentum in accelerate bone healing and it depend on amount of macroscopic fat deposit, according to that it may effect in bone healing specially in graft group due to loss of blood supply to still health of fatty tissue and prolong of angiogenic activity. In this study not record any signs of osteomylitis for that (19) said omentalization of the fracture is a novel approach in an attempt to introduce of blood supply and echaurage the of callus at fracture site and to aid resolution of infection, but (18) was record two cases of osteomylitis in graft group when wrapped around femoral fracture in adult dog due to incomplete sterilization of surgical

instrument and omental graft not resolve of infection. Histopathological study of each group show at first week in pedicel omental group large amount of adipose tissue that contain congestive blood vessels this agree with (20) Interestingly, even after flap transfer, it release polypeptide growth factor and activated microphage which result in capillary ingrowths into surrounding tissue (21) and agree with (20) said when used omental pedicel it contain stromal cells that produce high level of vascular endothelial growth factor and exhibit stem cell properties enabling them to be used for repaired and possibly regeneration of damaged tissue. All this factors which promote to form cartilage tissue in wide area of section at 2nd week of post operation convert large amount of it into trabecular bone that promote to form thick and regular direction of bone trabecule, while at the 1st week post operation in the second group showed proliferation of fibrous connective tissue and present of cartilage tissue with start to convert in same area into trabecular bone while at 2nd week post operation refer continue in conversion of cartilage tissue into trabecular bone to form woven bone which character by irregular direction and narrow trabecule. All differ in early increase in thickness and regularity of bone trabecule at 2nd week and continue to early formed compact bone in first group more speed than second group may be associated with (10) refers that omentum pedicel contain stem cells that can differentiated into a variety of cell types also it a good source of angiogenic factors like fibroblast growth factor that provide oxygen at fracture site and stimulate mesenchymal cell to differentiated into osteoblast to form trabecular bone in early time with more mature when compared first group with 2nd group at same time. Effect of omentum graft or role in rib fracture healing related with. (15) focused on comparing the potential of acceleration of bone healing by omentum with macroscopic fat deposition have fatty tissue that it faster replaced or transport to fibrous connective tissue due to it graft and not pedicle that still restore blood supply for that record present of adhesion at fracture site in 2nd group less than 1st group .At 3rd week in first group show progress increase in thickness and regular of trabecular bone with start of well compact bone formation around the haversian canal, while at the same period in the second group record transport narrow and irregular trabecular bone to increase in thickness also start in same histopathological area converted into simple but not well compact laminated bone these refer to develop and progress in bone healing in pedicel group faster than graft group. At 4th week show complete in thickness of compact laminated bone (mature compact bone) in first group when compared at this time with second group there is small area of histopathological section contain compact laminated bone around haversian canal. In conclusion omentum pedicel play a good role in promote oblique rib fracture healing than graft group by it still blood supply that supplement fracture site by angiogenic growth factor, oxygen, fibroblast growth factor all that enhance form newly blood vessel at fracture site that accelerate healing and able to form good adhesion to fixed fracture site.

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