The effect of static magnetic field on the healing of open wounds in rabbits*(Lepus cuniculus domestica)*

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Summary

The present study was designed to investigate the effect of 10, 30 and 50 gauss of magnetic fields on wound healing. Thirty adult rabbits of both sexes were used .The animals were divided into 3 groups of 10 rabbits each.3cm wound were made in all rabbits at gluteal region under effect of Xylazine hydrochloride and ketamine hydrochloride, the groups one, two and three exposed to magnetic field in dose 10,30 and 50 gauss at the site of wound for 15 minutes daily for seven days .

The study showed that the static magnetic field has resulted in dryness of the edges of the wound associated with wound redness at the time of exposure then disappeared shortly after the discontinuation of the treatment. wounds remained open during the 7 days of observation period . Histopathological examination at various stages of wound healing, various parameters were investigated revealed ulcer formation, epidermal thickening, dermal fibrosis, fibroblast infiltration, inflammatory cells infiltration and scab formation.

The result revealed that the formation of erosion were noticed in all treatments after the first and second week with the least effect that appeared with the dose of 50G of magnetic field. Epidermal thickening has been seen in all treatments after the first and second week of treatments and continued after the third week . When the dose of 10G of magnetic field was used while the epidermal thickening continued after the fourth week when the dose of magnetic field increased to 50G.

Dermal fibrosis was seen in all doses, at all the times of the experiment, however, it was highest with the doses of 30G and 50G. on fibroblast infiltration, all treatments showed no effect.

Inflammatory cells infiltration was seen with doses of 10G and 50G and after the first and second week of treatment and continued after the third week after the treatment with the dose of 10G ,the inflammatory cells infiltration was noticed and only a small change was seen in the dose of 50G at the first week.

The treatment with 10G and 50G of magnetic field has resulted in the formation of scab after the first and second week of the treatment Scab formation did not appear in the group treated with a dose of 30G of magnetic field .

Keywords: Magnetic field , injury, wound healing.

Introduction

Wound healing and tissue repair are complex processes that involve a series of biochemical and cellular reaction [1].

Immediately following an injury the healing process begins by getting rid of damaged tissue, then rebuilding healthy connective tissue in a step – by – step manner. The phase of normal wound healing include hemostasis, inflammation, proliferation and remodeling. Each phases of wound healing is distinct, although the wound healing process is continuous with each phase overlapping the next. The redness, swelling, heat and pain of

inflammation are natural signs of the healing process [2] .

Wound healing must occur in a physiologic environment conducive to tissue repair and regeneration [3].

Szor and Topp, found that in particular magnetic therapy may have benefits to offer in healing chronic wounds in women with an abdominal wound that had been present for one year and had not achieved in one month [4].

More recent studies [5 and 6] showed that the magnetic field treatment significantly favors the healing of skin ulcer of venous origin in human.

In experiments on rabbits and guinea pigs a suturless zipper with permanent magnets stuck on externally was first developed.The incision line,treated with magnetic field, healed showing only a fine, lined, totally level scar line without excessive scar tissue. Histologically most remarkable and clinically verified was the orderly growth of the collagen fiber bundles parallel to the magnetic field. In contrast, wounds not treated with magnetic fields showed a disorderly a ligament of fibers. It is remarkable that the fibroblast reaches the fibrocyle stage earlier when the magnetic field treatment is used [7].

Kokoschinegg , reported further on scar treatment by using magnetic field, the definite improvement of scar quality could be achieved and the affected area could be alleviated [8].

Ottani et al, proved that by using permanent magnet in animal experiments, the healing process of nerve ending reconnected without sutures.Kraus(1974) reports on the healing of acid burn necrotic skin wound of animal, the treatment with magnetic field as compared to controls without it showed a better organization of collagen fiber after ten days[7].

The same author describes the influence of low frequency fields on the healing of skin wounds on the back of the rats [9].

The remarkably improved wound healing and scar formation healing without significant scar formation were achieved by placing permanent magnets in the wound area, as mentioned by [8 and 10] referred to previously, resulted in this case through the influence of static magnetic field.

Daniel et al, studied to evaluate the effect of static magnetic field on post operative wounds in 21 patients who undergo cosmetic plastic surgical procedures, the magnetic devices in a form of patches (with magnetic field strength 2450 and 3950G) were placed over the operative region, in eight cases prophylactically, and in thirteen cases after pain, edema and discoloration had appeared. Were fixed with non-compressive dressings and oriented unidirectional to the skin in a way to assure the best fit to the area being treated. The magnetic patches were left in place for total of 48hrs and the treated area has been inspected at 24, 36, 48 and 72hrs after the operation. The results suggest that in approxinally 60% of patient's pain, edema and discoloration were diminished and in 75% patient's pain and edema disappeared. The magnitude of the reduction in post operative pain was therefore significant allowing for a decrease in the need for analgesic reserve. The manifested clinical benefits include a reduction of edema, anti-inflammatory effect, and analgesic effect [11].

Daniel et al ,showed that the treatment with permanent magnetic field had significant reduction in pain on post operative days 1 through 7, in edema on the forth day, and in the discoloration reduction on the first day through 3 when compared with the control group [12].

The use of static magnetic field in the present study was aimed to Investigate the effect of static magnetic field on Clinical and histopathological changes of the wound.

Materials and Methods

Thirty adult rabbits of both sexes aged between 5-6 months and body weight 1-1.5Kg were used in this study. Rabbits were housed at the college of veterinary medicine and given food and water.

All rabbits were anesthetized with intramuscular administration (I.M.) of 10 mg/kg body weight Xylazine hydrochloride and 50 mg/kg body weight ketamine hydrochloride.

The area of gluteal region was shaved and cleaned. Then a longitudinal incision in skin was made by sharp discective involving epidermis, dermis and hypodermis. The length of each incision was 3cm. Animals were left for about 24hrs under the same normal environmental conditions . These animals of both sexes were divided randomly into three groups of ten rabbits for each .

After 24hrs of wounding the animals in treated groups were exposed to the magnetic field at the site of the wound for 15 minutes daily for

seven days and the distance between the wound and the center of the coil was 5 cm.

The histopathological sections prepared from the wounds were examined by compound microscope to evaluate the degree of scab formation, ulcer formation, epidermal thickness, dermal fibrosis, inflammatory cell infiltration and fibroblast infiltration.

Results

Morphological study, the result revealed the following:-

(i) Dryness of the wound margin in all treated with 10, 30 and 50 gauss.

(ii)Variation in the temperature of wound area and around the wound depending on the type of treatment.

(iii)Variance in the degree of redness in the wound area which increased with the increase of the dose.

Histopathological study

(i).50G dose

A- In the first week there was a large depressed area associated with the erosion and scab formation. Marked dermal fibrosis, also an area of vascularisation (dermal vascularisation).Newly formed epidermis can be seen (minimal) in the depressed area of epidermis. (Fig.1a)

B- In the second week a large area of erosion associated with scab formation. Moderate dermal fibrosis, moderate epidermal thickening.(Fig.1b)

C . In the third week a moderate dermal fibrosis, moderate epidermal thickening, and healed wound with no evidence of ulcer. (Fig.1c)

d-In the fourth week a minimal dermal fibrosis, minimal epidermal thickening, and no evidence of erosion. (fig.1d)

(ii). 30 G dose

A- In the first week a massive erosion and inflammation, moderate epidermal thickening, and moderate dermal fibrosis. (Fig.2a)

B . In the second week a moderate dermal fibrosis, moderate epidermal thickening, and erosion with heavy infiltration of inflammatory cells .erosion reduced in size in comparison with first week of 30G. Moderate erosion and inflammation. (Fig.2b)

C- In the third week a moderate dermal fibrosis, epidermis within normal limit, no evidence of erosion, and evidence of inflammatory cells. (Fig.2c)

D- In the fourth week a moderate dermal fibrosis, epidermis within normal limit, and no evidence of erosion. (Fig.2d)

(iii). 10 G dose

A- In the first week a marked area of ulceration and inflammation, with scab formation, moderate epidermal thickness, and moderate dermal fibrosis due to fibroblast proliferation. (Fig.3a)

B- In the second week a marked area of ulceration and scab formation associated with infiltration of inflammatory cells. Marked dermal fibrosis due to fibroblast proliferation, and marked area of epidermal thickness. (Fig.3b)

C- In the third week a moderate dermal fibrosis with fibroblast proliferation, minimal epidermal thickness, inflammatory cells infiltration, and no evidence of erosion. (Fig.3c) d- In the fourth week a moderate dermal fibrosis, no evidence of erosion, and epidermis within normal limit. (Fig.3d)

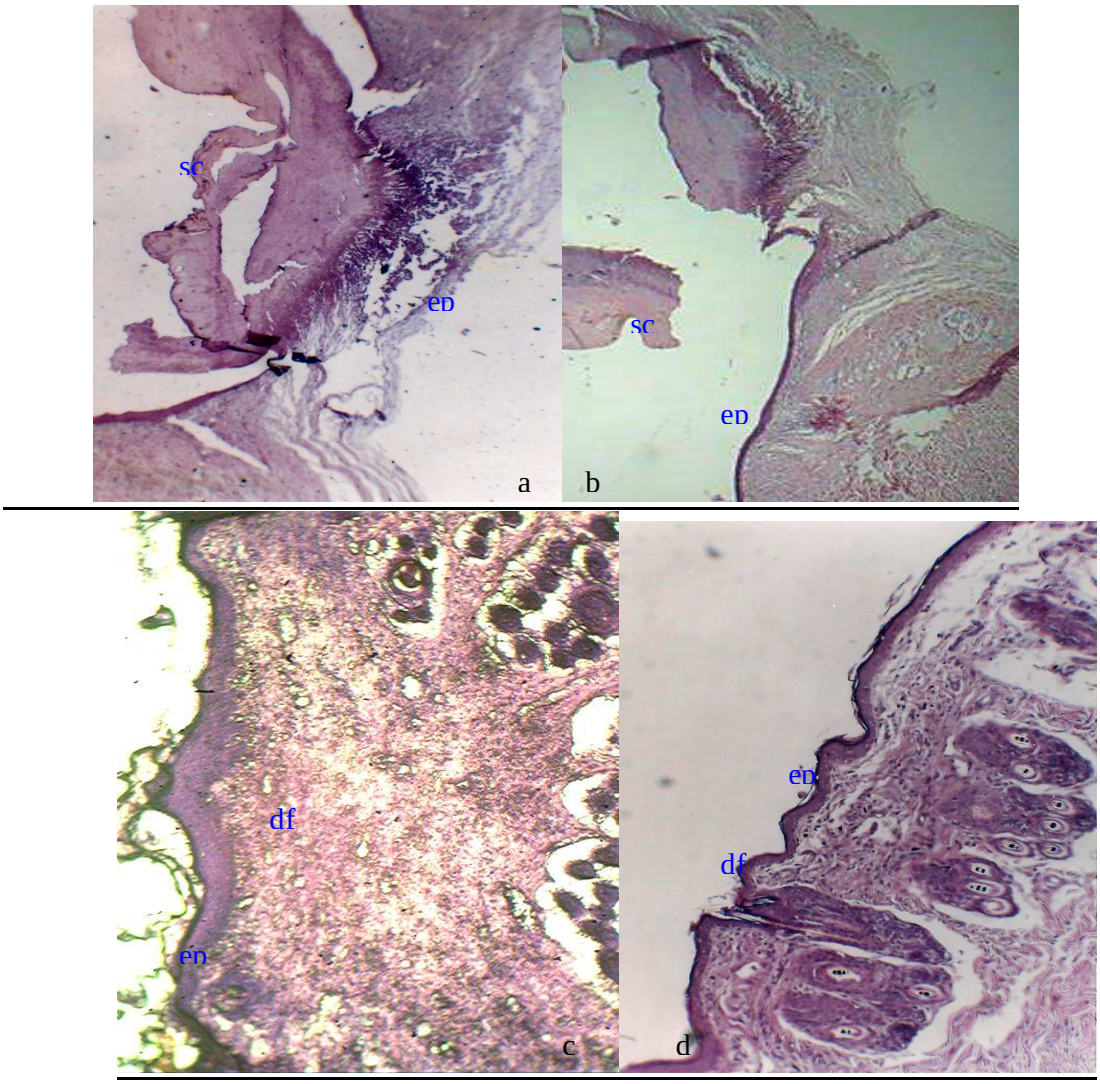

Fig.1. Effect of magnetic field 50G: a- scab and erosion formation after 1st week(H&Ex20).. b- scab and erosion formation(sc), epidermis thickening and dermal fibrosis, after 2nd week(ep) (H&Ex20)..c- epidermal thickening and dermal fibrosis after 3rd week (df) (H&Ex20). .d- epidermal thickening and dermal fibrosis after 4th week of treatment.(H&Ex40).

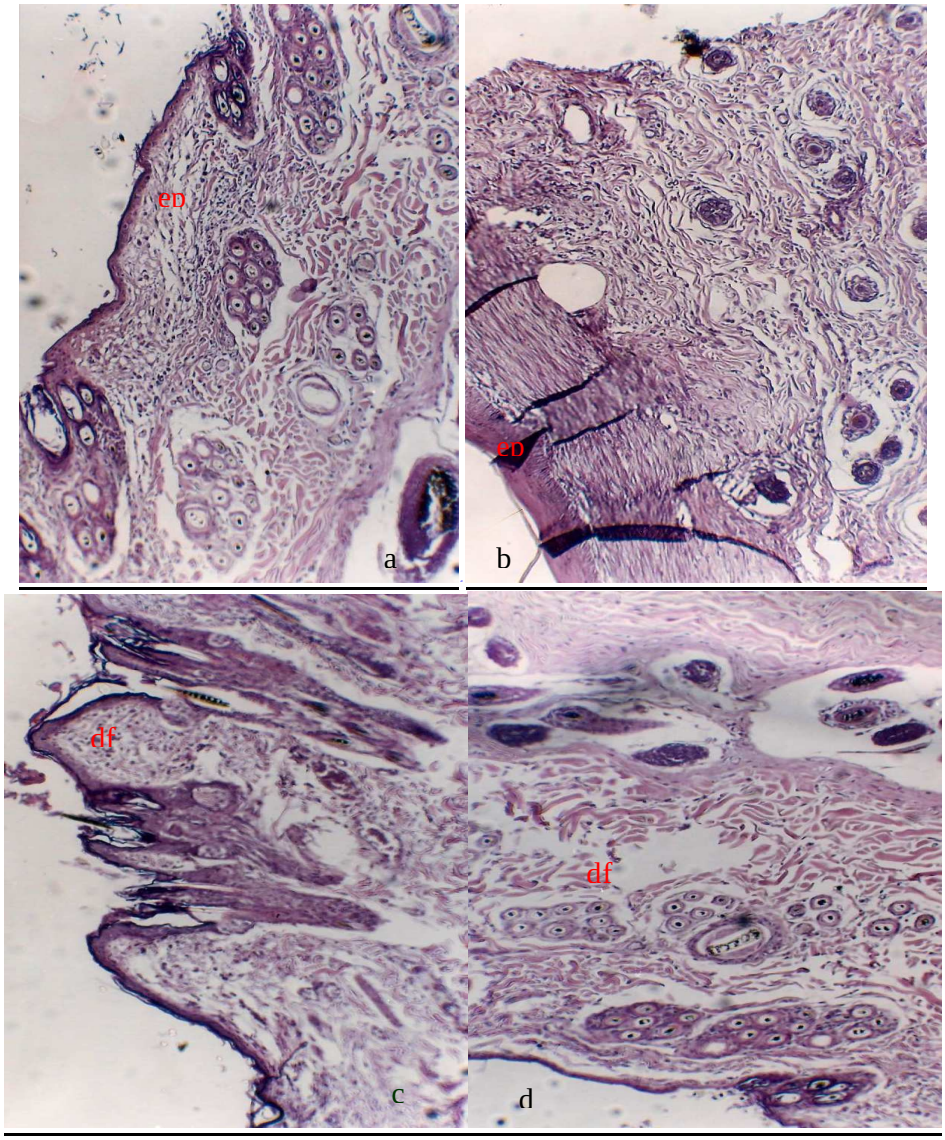

Fig. 2.Effect of MF 30G: a- epidermal thickening (ep)and dermal fibrosis (df) after 1st week. b- epidermal thickening and dermal fibrosis after 2nd week .c- dermal fibrosis after 3rd week. d- dermal fibrosis after 4th week of treatment.(H&E.x40)

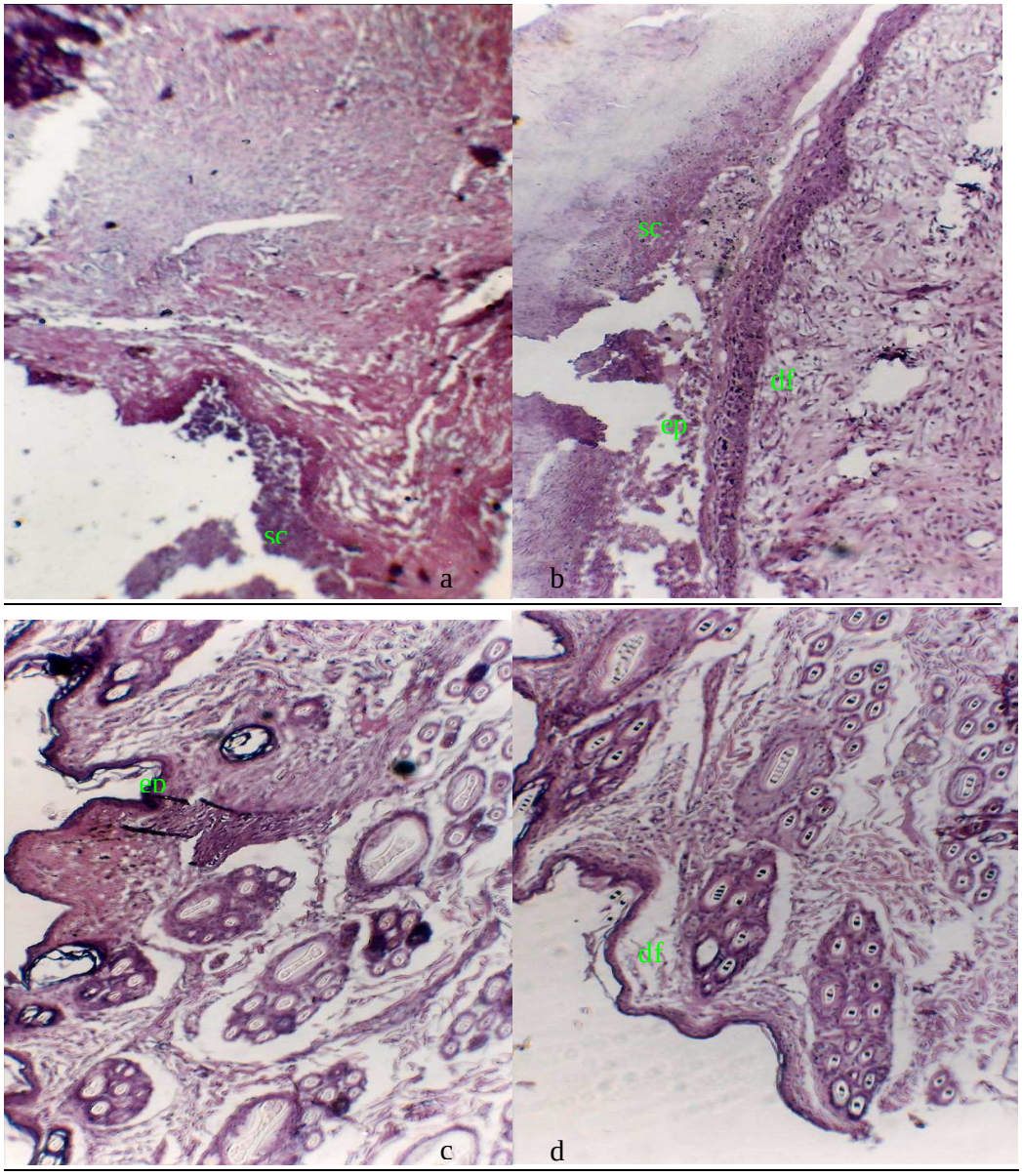

Fig.3.Effect of MF 10G: a-scab formation after 1st week.(H&E.x20).
b-scab formation, epidermis thickening and dermal fibrosis,after 2nd week.(H&E.x20) .
c-epidermal thickening and dermal fibrosis after 3rd week.d-dermal fibrosis after 4th week of treatment.(H&E.x40)

Discussion

There is a considerable amount of evidences that magnetic field has a role in wound healing [5,13 and 14].

Accelerating wound healing is an important goal in general surgical practice, more importantly wound healing with minimal scar formation is highly advocated in plastic surgery. Accelerating wound healing by the use of magnetic field could find a place in the field

of surgery since scar formation is allegedly reported low [10].

In the present study the device which was used for the generation of magnetic field is assembled and tested locally to transmit a static range of magnetic fields between 0 to 50 gauss and more upon exposing the wounded skin to the magnetic field, the area became red with slight increase in local temperature which could be resulted from increased regional blood flow induced by magnetic field [15 and 16].

Blood flow carries more oxygen and nutrients to the wound thus promoting wound healing. In addition to that it was noticed when the animals were exposed to magnetic field, they became calm and less irritable, this may indicate that the magnetic field has pain modifying effect [17and 18].

Six indices involved in wound healing were selected for the study, the most important of which is erosion formation, followed by epidermal thickening, dermal fibrosis,fibroblast infiltration, inflammatory cells infiltration and finally scab formation .

These parameters are based on histopathological observation, and to make the maximum use of these observation they were quantitatively transferred into numbers (scores) of three level 1, 2 and 3 according to the presence of changes. Variation in the degrees was noticed of redness of the wound area in all magnetic field treatment groups which is believed due to the increase of blood flow in wounds area which is important for wound healing [19 and 20].

In all treatment groups there was erosion formation after 1st and 2nd week of treatment, then was absent after 3rd and 4th week and these results agreed with the [5,6 and 21]. These authors have found a success rate of 66.6 % in the experimental group compared with 31 % in the placebo group. The result of the present study has shown some degree of epidermal thickening. To the best of our knowledge this histopathological changes has not been studied thoroughly and therefore faces for comparison can not be made, however, it can be speculated that epithelial thickening can result from an increase in inflammatory cells infiltration or epidermal oedema associated with enhanced blood flow. Regarding dermal fibrosis, again no much work has been directed to study this feature, however, the observed dermal fibrosis in the present study came as a result of the organisation of inflammatory cells. In all cases there was no fibroblast proliferation after 1st, 2nd 3rd and 4th week of treatment. This negative effect on fibroblast proliferation was also reported by [22 and 23].

However, improved fibroblast function by the magnetic field can not be ruled out since oxygen is required for the synthesis of collagen by fibroblast [24], the magnetic field caused an increase in the blood flow in the wound area to supply oxygen to the wound [15], and make oxygen available to improve collagen formation for wound healing .

Greenough and Roland et al , showed that the electromagnetic field caused stimulation for neovascularisation and vessels growth that caused [25 and 26].

an increase in blood flow in the wound area and more oxygen which in turn stimulate fibroblast function.

In the present study all treatment showed inflammatory cell infiltration after 1st week of treatment and 2nd week for 30G, 10G, and penicillin and after 3rd week for 10G while there was no inflammatory cells infiltration in the control, and after 4th week in all other treatment .

Kumar and Kumar et al ,said that the inflammation is a common and an important precursor to wound healing. The treatment stimulates inflammatory cells infiltration in the area of the wound [27 and 28].

The same case appeared in an electrical current which has been proposed to promote neutrophils, monocytes, and macrophages migration to the wound area. Daniel et al , Kloth and McCulloch, showed that the electrical current stimulation accelerated the healing and intensified inflammatory reaction[12 and 29] .

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تأثير المجال المغناطيسي الثابت على التئآم الجروح المفتوحه في الارانب

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الخلاصه

صممت هذه الدراسة لغرض معرفة تأثير المجال المغناطيسي للجرعات 10و30 و50 كاوس على شفاء الجروح المفتوحة في الأرانب . أستعمل 30 أرنبا من كلا الجنسين و قسمت الى 3 مجاميع لكل مجموعة 10 ارنب. وقد خدرت الحيوانات تحت تأثير الكيتامين والزايلازين ثم عمل جرح بطول 3 سم في منطقة الفخذ. عرضت المجموعات الاولى والثانية والثالثة للمجال المغناطيسي وبجرعات10و30و50 كاوس في منطقة الجرح لمدة 15 دقيقة يوميا ولمدة 7 ايام,

أظهرت نتائج الدراسة إن المجال المغناطيسي أدى الى جفاف حافات الجرح مع إحمرار منطقة الجرح في وقت التعريض ويختفي بعد فترة قصيرة من توقف التعريض .

كشفت النتائج على إن تكوّن القرحة قد ظهر في جميع المعاملات بعد الأسبوع الأول والثاني وكانت أقلها في المجموعة 50 كاوس من المجال المغناطيسي .

كما لوحظ تثخن البشرة في جميع المعاملات بعد الأسبوعين الأول والثاني من المعاملة وأستمر حتى الأسبوع الثالث عند إستعمال الجرعه 10 كاوس بينما إستمر التثخن حتى الأسبوع الرابع عند زيادة جرعة المجال المغناطيسي الى 50 كاوس .

لقد أظهرت النتائج حالة تليف الجرح في جميع المعاملات وفي جميع أوقات التجربة وكانت اعلى معدل في معاملة الجرعتين 30 و50 كاوس أما في إرتشاح الأورمات الليفية فلم تظهر في المعاملات أي تأثير .

ظهرت حالة إرتشاح الخلايا الألتهابية في المعاملات 10 كاوس و30 كاوس بعد الأسبوعين الأول والثالث من المعاملة واستمرت بعد الأسبوع الثالث من معاملة 10 كاوس ، بينما هناك إرتشاح قليل في معاملة 50 كاوس بعد الأسبوع الأول.

لقد ظهر تكون القشرة في المعاملات 10 كاوس و50 كاوس من المجال المغناطيسي بعد الأسبوع الأول والثاني و لم تظهر في مجموعة 30 كاوس.