Iraqi Journal of Veterinary Sciences

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Comparison effects of nano-magnesium oxide and advanced platelet rich fibrin on the healing of tenotomized Achilles tendon in dogs

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Article information

Article history:
Received 13 April 2025
Accepted 11 August 2025
Published 16 September 2025

Keywords:
Tendon
Healing
Nanoparticles
Biological materials
Lameness

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Abstract

The study aims to compare effects of local application of liquid magnesium oxide nanoparticles (MgO-NPs) and advanced platelet rich fibrin (A-PRF) on healing of the severed superficial digital flexor tendon in dogs (SDFT). The study was conducted on Twenty-seven mature dogs. Their weights ranged between 25-30 kg. while their ages ranged from 18-24 months. The dogs were randomly divided in three groups equally. The first (control group) in which the complete cutting SDFT was sutured without the addition of any adjuvant. In the second group there was a suture of cutting SDFT with the addition of 3ml of Nano-magnesium oxide. In the third group there was a suture of cutting SDFT with the addition of 3ml of advanced platelet rich fibrin. In one group, animals were divided into three subgroups equally that were examined after 15, 30, 45 days of surgery. Evaluated the severity of lameness, adhesion, histopathological and immunohistochemical examination of the healed tendons were performed after 15,30,45 days of surgery in each group. in comparison to the control, the adhesion degree more than A-PRF and MgO-NPs. The results of histopathological examination of SDFT healing in first group reveled sever infiltration of mononuclear inflammatory cell, proliferation of tenocyte deposition of collagen bundle without orientation and angled toward axis of tendon and newly capillary while in second and third groups the result show slightly to moderate respectively. The result of immunohistochemical examination in the first group showed moderate positive collagen reaction, in second group with intense positive collagen reaction, while in third group very slight positive collagen reaction in all periods except in 45 days the third group show intense positive collagen reaction. Therefore, it could be concluded that the MgO-NPs and A-PRF are effective materials for enhancing SDFT healing in dogs but the MgO-NPs group better than the A-PRF group.

DOI: 10.33899/ijvs.2025.158993.4224,

Introduction

The tendon which was chosen to conduct this study is (SDFT), is considered as a one of the components of Achilles tendon (AT) or calcaneal tendon, because the Achilles tendon consists of three main tendons, which located within a uniform sheath. These three main tendons are gastrocnemius tendon; superficial digital flexor tendon; and the common tendon, which in turn consists of three muscles tendons: the biceps femoralis muscle, the gracillis muscle, and the semitendenous muscle (1). Acute trauma considered as a one of the most common causes of Achilles tendon rupture, this rupture of AT may be complete or partial. The partial Achilles tendon rupture can occur during races or excessive training of large breed dogs (2). The main goal for repairing of traumatized tendon is to obtain a permanent healing with great tensile strength as well as a gliding movement, and because the healing process of traumatized

tendon takes a long time, may be many months due to little vascularity of it, Therefore, several studies aimed to accelerate tendon healing by using prosthetic materials such as polypropylene mesh or by using bioactive materials, such as stem cell transplantation, tenocyte growth factors, low level laser therapy (3), platelet-rich plasma, platelet rich fibrin (4), and nanoparticles (5). Nanomaterials are particles that have a dimension less than 100 nanometers; therefore, the nanoparticles considered as a bridge between the molecules of conventional sizes and the structures at atomic level (5). Many biomedical engineering experiments have been conducted on the properties of nanomaterials, to discover a new treatments strategy in various medical applications, including oncology, neurology, soft and hard tissues regeneration, and urogenital organs (6). The nanomaterials having many effects on the cellular or molecular processes which helping change the microenvironment of the wound from non-healing or delayed healing to complete healing and this is through its antimicrobial, anti-inflammatory action besides promoting angiogenesis (7). The magnesium oxide nanoparticles (MgO-NPs) possess a biocompatibility with high stability, as well as the redox properties that made it's a bioactive substance which can be used to combat microbes, especially for those that are resistant to antibiotics. The NMO also having a harmless biodegradability with no biological toxicity (8). According to the cell-based tissue engineering, a new concept emerged in 2014, is advanced platelet-rich fibrin (A-PRF). This was done by reducing the number of revolutions per minute (rpm) while increasing the time of standard platelet-rich fibrin. In this manner, the A-PRF having more platelets in its distal part compared to the standard platelet-rich fibrin (9). French researcher Choukroun was the first one describe platelet-rich fibrin (PRF) in 2001, as a self-implantable biomaterial of concentrated platelets, growth factors, and cytokines, which existing on absorbable membrane of fibrin matrix (10,11). PRF is a second generation of concentrated platelets, which can be obtained by drawing fresh blood from a main vein and placing it directly in the centrifuge without adding anticoagulant or any other chemical materials. Therefore, the preparation of PRF is considered as a one of the most simple, safe, economic and uncomplicated methods for obtaining the autologous bioactive substances, which necessary for wound healing or bone regeneration (12). PRF is promotes and accelerates healing through the presence of a fibrin matrix, which act as a glue in the damaged connective tissues such as tendons, ligaments, cartilage and muscles. The fibrin matrix filling the cavities or gaps between the damaged tissues, besides acting as a scaffold to facilitate transferring inflammatory cells, growth factors and stem cells to the inflamed or affected area, and these properties promote healing (13). The use of A-PRF significantly reduced postoperative pain and enhanced early soft tissue healing (14). The study aims to compare effects of local application of liquid magnesium oxide nanoparticles (MgO-NPs) and advanced platelet rich fibrin (A-PRF) on healing of the severed superficial digital flexor tendon in dogs (SDFT).

Materials and methods

Ethical approval

Ethical approval was granted through the local committee of animal care and use at the College of Veterinary Medicine within the University of Mosul number UM.VET.2024.073 dated 01/04/2024.

Animals

Twenty-seven mature dogs. Were used, their weights ranged between 25-30 kg. while their ages ranged from 18-24 months. The dogs were randomly divided in three groups equally. The first (control group) in which the complete cutting SDFT was sutured without the addition of any adjuvant. In the second group there was a suture of cutting SDFT with the addition of 3ml of Nano-magnesium oxide. In the third group there was a suture of cutting SDFT with the addition of 3ml of advanced platelet rich fibrin. In one group, animals were divided into three subgroups equally that were examined after 15, 30, 45 days of surgery. All animals before conducting the practical experiments of this study received subcutaneously injecting of Ivermectin 1% at a dose 0.4 mg/kg BW., and the dose repeated after 14 days; for controlling of internal and external parasites, The surgery was done under general anesthesia using.

Surgical technique

After ensuring that the animal was in the surgical stage of general anesthesia, the animal was placed in the lateral recumbent position, the site of operation was prepared in aseptic technique, the skin incised about 3-4 cm caudolaterally parallel to the Achilles tendon, to show whole Achilles tendon described by Minei *et al.* (15). A transverse cutting of SDFT (Figure 1), after separating it from the rest tendons which Achilles tendon composed, then suturing two ends of severed tendon by modified Kessler suture technique using Nylon No. 0.1 (Figure 2), while suturing the subcutaneous tissue by Polyglactin 910 No. 0.1, lastly suturing the skin by simple interrupted technique using silk No. 1 reported by Frame *et al.* (16). The experimental animals were allocated randomly in to 3 equal main groups each group containing 9 animals. In control group severed SDFT was sutured by modified Kessler suture technique and without adding any bioactive materials; the second group after suturing of SDFT added 50µg/ml of MgO-NPs suspension of 3 cc distilled water at the site of severed tendon with suturing the subcutaneous tissue to ensure kept the suspension of MgO-NPs around the tenorrhaphy site. The nanoparticles of magnesium oxide that used in this study produced standardized by US research nanomaterials, Inc. having specific surface area (SSA) 60 m^2/g, and 99% of

average particle size (APS) has 20nm. While in the third group surrounded the tenorrhaphy site by advanced platelets rich fibrin which prepared just before the beginning of the surgical operation. The A-PRF is prepared by drawing 10 cc of venous blood from the jugular vein of the same operated animal. Collected this blood in a plain test tube (without anticoagulant), then directly to the centrifuge at speed of 1500 rpm, for 14 minutes; after that, we will get a test tube having three layers, the upper one platelets poor plasma in a very little amount, the bottom layer it's a red blood cells which discarded and the middle layer platelets rich fibrin that used in this study as described by Suvarna *et al.* (17).

Figure 1: A transverse cutting of superficial digital flexor tendon SDFT.

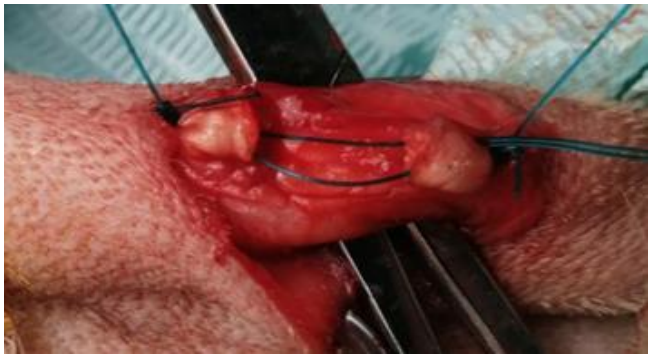

Figure 2: Suturing two ends of severed tendon by modified Kessler suture technique.

Postoperative care

Daily wound dressing and intramuscular injection of broad-spectrum antibiotic respectively for 5 consecutive days (18). Tendon biopsies were taken at three periods 15, 30, 45 days post-surgical operation from all trial animals, for histopathological study. The specimens of SDFT were for histopathological sections in thickness not more 3-4µ. The histopathological slices stained by traditional stain Hematoxylin and Eosin (H&E). Lastly the tissue slices examined under light microscope for detection of the histopathological changes in different groups that aids to identify which the best group for tendon healing (19,20), the collagen packing and orientation was scoring as in table 1. To describe the categories and grade of repairing and healing tendon, five criteria were evaluation (21-23), as in table 2.

Table 1: Score and categories of collagen packing and orientation of tendon healing

Score	Collagen fiber packing and development	Collagen fiber orientation
4	Packed, Homogenous and tightly collagen bundle	collagen strands running parallel to the axis of the tendon
3	Packed, regular and densely collagen bundle	Slight angled of collagen strands toward axis of tendon
2	Packed, regular and moderately collagen bundle	moderate angle of collagen strands toward axis of tendon
1	Packed, Irregular and loosely collagen bundle	evidently angled of collagen strands toward axis of tendon
0	amorphous and extracellular substances formation	No orientation of collagen strands

Table 2: Categories and score system of repair and tendon healing

Categories	Score assessment of repair tendon			
	0	1	2	3
Fiber Structure	Long and contentious	mild fragmented	moderate fragmented	sever fragmented
Shape of nuclei	Non rounded spindle	Slight not spindle	Moderate not spindle	Severe not spindle
Cellularity	Less than 10%	10 to 20%	20 to 30%	More than 30%
Angiogenesis	Less than 10%	10 to 20%	20 to 30%	More than 30%
Cell density	Normal	Slight	Moderate	Severe

Semi-quantitative analysis (score / grade system)

Collagen types I (Rabbit antibovine collagen type I; Millipore; California, USA) and III (Rabbit anti-rat collagen type III; AbD Serotec; Kidlington, UK) were subjected to IHC examination. Prior to counterstaining with Harris's haematoxylin, a positive reaction was identified using chromogen 3,3-diaminobenzidine tetrahydrochloride (Sigma). As previously reported (24), a 5-point semi-

quantitative grading system was employed to assess the strength and extent of the positive reaction against collagen types I and III, as in table 3.

Table 3: Score and grade five scale of immunohistochemical collage -I reactivity staining (extension and intensity)

Description	Score	Grade
High staining > 80%	4	Intense
Moderate staining > 80%	3	Moderate
Mild staining 50-80 %	2	Slight
Mild staining< 50%	1	Very slight
Without staining	0	No reaction

Statistical analysis

The data were analyzed by the Kolmogorov–Smirnov test for normality of distribution. The quantitative data (grade / score) of IHC study of collagen types I were analyses with the Mann–Whitney test. Values of the data are expressed as median ± sd. Differences were considered significance at the level $P \leq 0.05$ which was determined by Dunn test (25).

Results

The results showed that the experimental animals returned to normal physiological functions after awakening from general anesthesia, except two from the first group, which showed marked lethargy during the first two days, with decreased activity and loss of appetite after surgery. They then returned to regular two days after surgery, with their condition improving and their activity returning. No signs of inflammation were observed in the surgical site, which appeared normal for all experimental animals. Grade 2 lameness was observed when walking or running, and the experimental animals in all three groups could not bear weight on the affected limb. The degree of lameness varied among the experimental animals. It was most severe in the control animals and lasted 12-14 days after surgery, while it was less severe and lasted 7-8 days in the second group and 9-10 days in the third group. The lameness began to decrease significantly in the experimental animals, progressing to grade 1 lameness, and became evident only during running after 30 days of the experiment in the first group, while it was evident for 15 days after surgery in second group while it was between 20-25 days in the third group. At the same time, there was a variation in the ability of the animals to bear weight on the affected limb in the first group after 40 days from the date of surgery, while it varied between 25-30 days in both second and third groups respectively. Visual pathological alterations, such as adhesions between the tendon and the surrounding tissues and adhesions with the skin, were noted during a visual examination of the location of the severed tendon. The first group adhesions were observed to be more severe than those of the second and third groups in all periods (Figures 3-5) respectively.

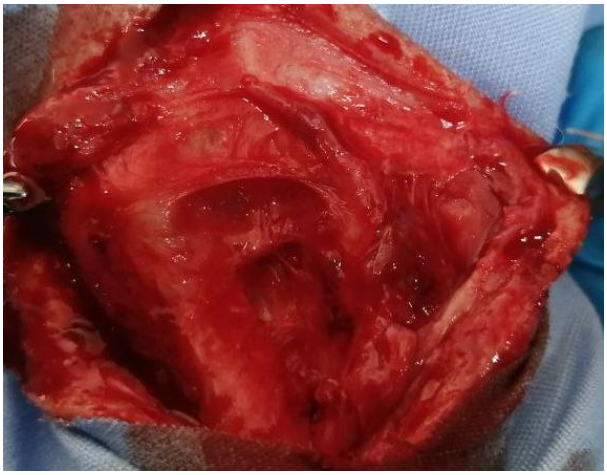

Figure 3: Show the severity of adhesion between tendon, surrounding tissues and also with the skin, with large quantity of connective tissue.

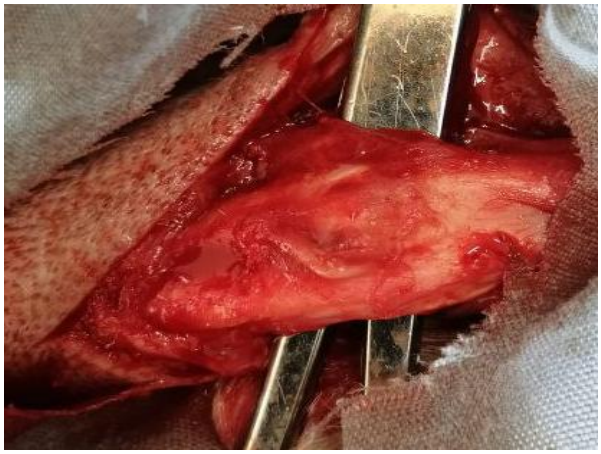

Figure 4: Show very slight adhesion in the site of severed tendon substantial connective tissue is found around the tendon sheath.

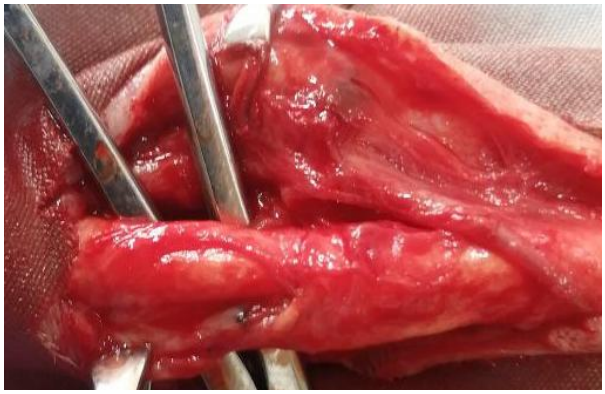

Figure 5: Show not severe adhesion in the site of severed tendon with mild reactive connective tissue.

Histopathological examination

The histological criteria of normal of Achilles tendon is was score (0), following the Achilles tendon's surgical cutting, a notable rise inflammatory cells and tenocyte density, adequate blood supply and shape of nuclei were found in all groups but deferent in severity, so the categories of histological examination of Achilles tendon healing at 15 day post-operative in control group scoring 3 (maximum abnormality) which reveled sever infiltration of mononuclear inflammatory cell, proliferation of tenocyte, deposition of collagen bundle without orientation and angled toward axis of tendon and newly capillary, in second group the lesions were scoring 2(moderate abnormality), while in third group the histological categories scoring 2 (moderate abnormality), reveled moderate infiltration mononuclear inflammatory cells, packed, regular and densely collagen bundle development angled to tendon axis with newly capillary (Figure 6).

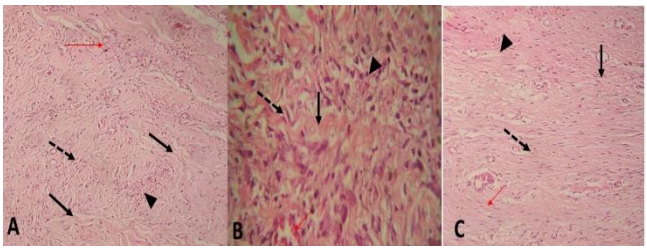

Figure 6: Photomicrograph of Achilles tendon healing at 15day post-operative (A) first group reveled sever infiltration of mononuclear inflammatory cell black arrow head, proliferation of tenocyte black dot arrow collagen bundle without orientation and angled toward axis of tendon black arrow newly capillary red arrow100X , (B) second group reveled slight infiltration of mononuclear inflammatory cell black arrow head , moderate proliferation of tenocyte black dot arrow with moderately organized collagen bundle, with congested newly capillary red arrow 400 X , (C) third group reveled moderate infiltration mononuclear inflammatory cells black arrow head, Packed, regular and densely collagen bundle development angled to tendon axis black arrow with newly capillary red arrow, H&E, 100x.

The results of histological examination of Achilles tendon healing at 30 day post-operative in first group scoring 3 which reveled more than 30% of cellularity characterized by sever infiltration and aggregation of mononuclear inflammatory cell, and sever proliferation of tenocyte, with packed, irregular and loosely disorganized collagen bundles development with angled toward axis of tendon and increase in angiogenesis, while in second group reveled slight infiltration of inflammatory cells 10-20% without aggregation, mild proliferation of tenocyte, scoring 1, with regular and moderately organized collagen bundle development parallel to the axis of the tendon and newly capillary, in contrast the third group reveled 20-30% cellularity, moderate infiltration and aggregation of mononuclear inflammatory cell, sever proliferation of tenocyte, with packed, homogenous and tightly bundle of collagen development parallel to the axis of the tendon and newly capillary scoring 2(moderate abnormality) (Figure 7), with sever congestion in control group and mild to moderate in both second and third groups , respectively (Figure 8).

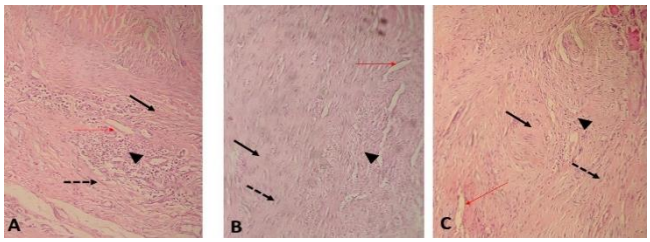

Figure 7: Photomicrograph of Achilles tendon healing at 30 day post-operative (A) first group reveled sever infiltration and aggregation of mononuclear inflammatory cell black arrow head, sever proliferation of tenocyte black dot arrow, Packed, Irregular and loosely disorganized collagen bundles development with angled toward axis of tendon black arrow and newly capillary red arrow, (B) second group reveled slight infiltration of inflammatory cells without aggregation black arrow head, mild proliferation of tenocyte black dot arrow, Packed, regular and moderately organized collagen bundle development parallel to the axis of the tendon black arrow and newly capillary red arrow, (C) third group reveled moderate infiltration and aggregation of mononuclear inflammatory cell black arrow head, , sever proliferation of tenocyte black dot arrow, Packed, Homogenous and tightly bundle of collagen development parallel to the axis of the tendon black arrow and newly capillary red arrow, H&E, 400x.

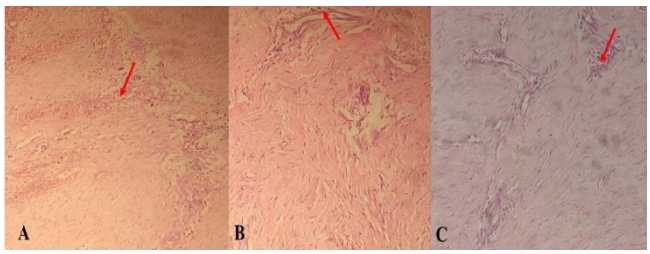

Figure 8: Photomicrograph of Achilles tendon healing at 30-day post-operative red arrow revealed congestion variable in severity (A) first group sever congestion(B) second mild congestion, (C) third group moderate congestion, H&E, 100x.

The results of histological examination of Achilles tendon healing at 45-day post-operative in first and third groups reveled sever and moderate perivascular infiltration

of inflammatory cells and density scoring 3 and 2 respectively sever proliferation of tenocyte in first group with organized collagen, on other hand the second group reveled slight perivascular infiltration of inflammatory cells and density scoring 1, slight proliferation of tenocyte with organized collagen (Figure 9).

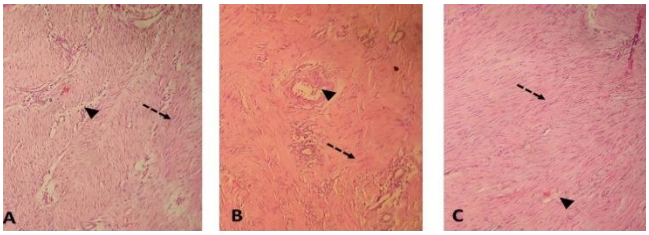

Figure 9: Photomicrograph of Achilles tendon healing at 45-day post-operative (A and C) first and third groups reveled strong perivascular infiltration of inflammatory cells black arrow head, sever proliferation of tenocyte black dot arrow with organized collagen, (B) second group reveled slight perivascular infiltration of inflammatory cells black arrow head, slight proliferation of tenocyte black dot arrow with organized collagen, H&E, 400x.

Semi-quantitative IHC analysis

At 15 days postoperative the first group showed moderate positive collagen reaction > 80% and occupy score 3 and grade moderate in second group with high intense positive collagen reaction > 80% occupy intense grade and score 4, while the IHC analysis for collagen in third group was very slight grade with score 1 and the percentage of positive collagen reaction<50% (Figure 10).

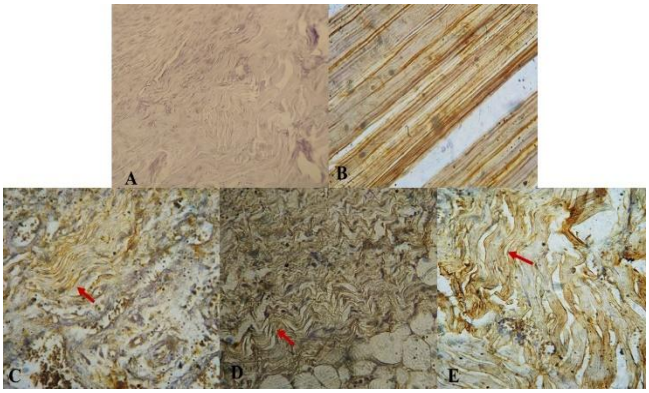

Figure 10: Immunohistochemically reactivity collagen-I staining in Achilles tendon in dogs at 15 days postoperative, (A and B) negative and positive reaction, (C) first group with moderate positive collagen reaction > 80% with grade moderat, (D) third group very slight positive collagen reaction <50%, (E) second group with high intense positive collagen reaction > 80% with grade intense, 400x.

At 30 days postoperative the first group showed high positive collagen reaction occupy intense grade and score 4, the second group with intense grade and high positive collagen reaction > 80%, and third group very moderate grade and moderate intense immune staining of collagen reaction > 80% (Figure 11). At 45 days postoperative the first group showed very slight grade and mild positive collagen reaction <50%, while in the second group the IHC description was mild immune stain 50-80% and occupy slight grade and score 2 for positive collagen reaction, while third group the immunohistochemistry examination was investigate moderate intense immune staining >80% and occupy moderate grade with score 3 (Figure 12).

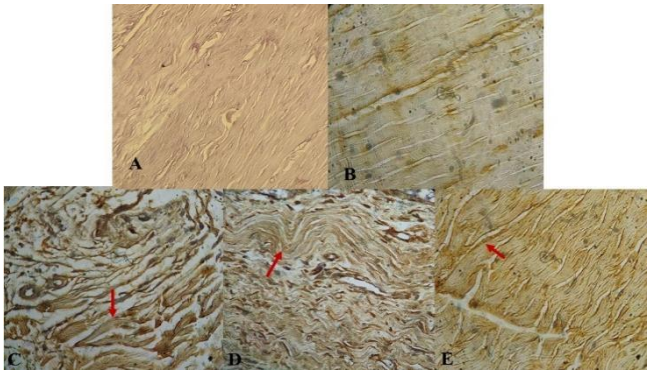

Figure 11: Immunohistochemically reactivity collagen-I staining in Achilles tendon in dogs at 30 days postoperative, (A and B) negative and positive reaction, (C) first group with high positive collagen reaction with intense grade, (D) third group very moderate grade and moderate intense immune staining of collagen reaction, (E) second group with grade intense and high positive collagen reaction, 400x.

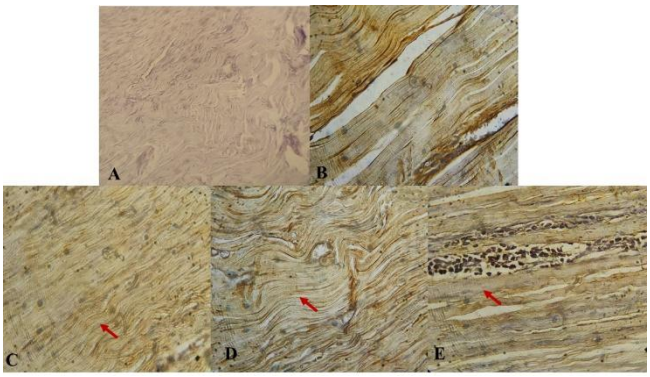

Figure 12: Immunohistochemically reactivity collagen-I staining in Achilles tendon in dogs at 45 days postoperative, (A and B) negative and positive reaction, (C) very slight grade and mild positive collagen reaction <50%, (D) third group moderate intense immune staining >80% with moderate grade, (E) second group with mild immune stain 50-80% and slight grade, 400x.

The Semi-quantitative assessment of IHC revealed an highly significant (P≤0.05) expression of collagen type I in the extension of the positively stained area in second group at 15 day post-operative (23) in contrast to first group (13) this two groups were highly significant rather than third group (8) and, while in both period (30 and 45) day post-operative the IHC analysis revealed increase significant of collagen-1 expression in both groups second and third groups (38 and 35) respectively, and in this two groups the extension of the positively stained area was increase significantly in comparison to first group (15 and 28) , However, when comparing the periods postoperative, it is noted that the longer the period is more significant. It is noted that the periods at 30 and 45 days are more significant than 15 days, this data given as in table 4.

Table 4: Semi-quantitative of Immunohistochemical collage -I reactivity staining

Groups	15 days	30 days	45 days
First	13 E	15 E	28 C
Second	23 D	38 A	38 A
Third	8 F	35 B	35 B
Kruskl value		34.53**	

Different horizontal letters mean Signiant differences at P<0.05.

Discussion

Clinical exams revealed that all animals had second-degree lameness, with first group animals experiencing this condition for a longer period of time than animals in other groups. This is explained by the fact that using MgO-NPs and A-PRF helped to improve and speed up tendon recovery, which in turn improved the tendon's functional performance which agree with Moshiri and Oryan (26). The reason MgO-NPs and A-PRF group's healing process is advancing is because these materials help form the connective tissue, which is composed of collagen and is essential in joining the two severed tendon segments. This helps hasten the tendon's return to mechanical function and movement this agree with Olsson (27). In general, tendon repair is a very slow process characterized by the creation of scar tissue and adhesions agree with James *et al.* (28). Because of the tension, muscle retraction, or inadequate suture retention, it may prove difficult to successfully heal a torn tendon. All of these elements are causing the gap to build, which lowers the tensile strength and ultimately causes the tendon to rupture this agree with Alam *et al.* (29). The faster healing and sufficient tendon tissue regeneration achieved also prevent adhesion formation by animals treated with MgO-NPs (30) and A-PRP (31) compared to those in first groups was one of the most significant and therapeutically relevant findings. According to this research, MgO-NPs and A-PRF may be useful in hastening the repair of tendons. This is because it can transport a variety of growth factors and proteins locally this agrees with McDougall *et al.* (31) and Zhou *et al.* (30).

The result of histopathological investigation indicated that the using MgO NPs had beneficial value and more improve healing than A-PRPand was superior in progressing healing process in deferent periods as a compare to control. The result of current study during different days showed infiltration of mononuclear inflammatory cell, proliferation of tenocyte, deposition of collagen as packed, regular and densely fibers with newly capillary. All these features can be considered as the keystone for proper healing process, the second most common intracellular cation, MgO-NPs, is essential for preserving homeostasis and controlling cellular processes such ion channels, enzyme activity, DNA stability, and cell division and proliferation. It is also thought to have antioxidant properties this agree with Gatou *et al.* (32).

By supporting a healthy and homeostatic environment and scavenging free radicals, all of these features contribute to an enhanced and folded stage of wound and tendon healing this agree with Podder *et al.* (33). In contrast to normal healing events, MgO-NPs' pro-angiogenic activity aids in wound healing by increasing the expression of vascular endothelial growth factor (VEGF) in the wound site, which is thought to be the primary cytokine that will increase and promote the angiogenesis process and increase in the formation of newly formed blood vessels. These vessels are thought to be the means of transporting more nutrients, cells, and supporting collagen synthesis, which aids in the healing process and ultimately leads to the completion of the healing agree with Lili *et al.* (34). furthermore, MgO-NPs, releasing Mg2+ ions to further promote angiogenesis agree with Liu *et al.* (35). these process in the tendon have specialized features related to the end-stage extracellular matrix that should be deposited which is related to the collagen fibers agree with Salman *et al.* (36), these fiber of collagen should be arranged in a such arrangements to not affect the function of the tendons during contraction process, this improper arranging and deposition will lead to losing the strength of the tendon and it is main function during muscle contraction agree with Salman *et al.* (36).

In addition to that the infiltration of mononuclear inflammatory cell in the site of healing should be at its highest level during the first period of healing then it should be subsided after their function was done which is included removing the dead necrotic tissues and prevent bacterial infection to the site of wound also agree with Pumarala *et al.* (37). The proliferation and hyperplasia of tenocyte is essential for healing with collagen fibers to be deposition in the site of injury, in which the fibrocytes in situ start to be activated as a result of cytokines produced in the affected tissues, then as a respond to that the suffer from transgenic transformation to be tenocyte which is start to travel in site of wound and produce the collagen fibers which is composed from 9 chains of arachidonic acid, later another tenocyte start

to knitting these 9 chains into the desire type of collagen which is collagen type I in this type of tendon agree with Salman *et al.* (38).

The results of using MgO-NPs and A-PRF had an effect on the accelerating tendon healing and collagen deposition, and the result of the IHC was significant for both regenerative materials, with the advantage being for MgO-NPs, IHC regarding the collagen type I have a great significant influence in the study result, in which it is confirmed that the type of collagen that deposited in this type of wound was collagen type I, in which it is showed moderate positive reaction in first 15 days post operation, and it increased in deposition with time and their intensity was increase at 30 days, and reach its maximum reaction during the last days of experiment at 45 days post operation agree with Augsburger and Henzi (38).

Conclusion

Tendon injury repair is a drawn-out procedure that usually leaves the repaired tissue with poor structural, mechanical, and functional qualities. Currently available clinical solutions for tendon injuries are frequently inadequate, particularly for older populations. Consequently, a number of different approaches are being investigated. Tendon healing is accelerated by the biological characteristics of MgO-NPs, including their superior biocompatibility, stability, and biomedical flexibility, Additionally, the idea of biological therapy as A-PRF material is appealing since it utilizes the body's natural ability to repair and heal its injured tissues. Clinical trials are required to evaluate MgO-NPs' effectiveness in tendon regeneration.

Acknowledgments

Authors extend their sincere appreciation to Department of Surgery and Theriogenology at College of Veterinary Medicine, University of Mosul, whose support played important role in completion of this research

Conflicts of Interest

Authors declare no conflicts of interest that could affected integrity of study. Notably, magnesium oxide nanoparticles exhibited superior ability to neutralize reactive species, achieving around 60% scavenging activity against superoxide anions. Additionally, they demonstrate complete (100%) scavenge of DPPH free radicals, likely due to their exceptionally high specific surface area (measured at 342.2 m^2/g).

Editorial board note

Muneer S. Al-Badrany and Dhafer M. Aziz the editors of the Iraqi Journal of Veterinary Sciences, did not participate in any stage of the decision-making process for this article.

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مقارنة تأثير صغائر أوكسيد المغنيسيوم والفبرين الغني بالصفائح الدموية المتقدم على التئام وتر اكيليس المقطوع في الكلاب

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الخلاصة

تهدف الدراسة الى مقارنة تأثيرالتطبيق الموضعي لصغائر أوكسيد المغنيسيوم النانوية السائلة والفبرين الغني بالصفائح الدموية المتقدم على التئام وتر المثنية الرقمية السطحي المقطوعة في الكلاب. أجريت الدراسة على سبعة وعشرون كلبا ناضجا وقد تراوحت أوزانهم بين ٢٥-٣٠ كيلوغراما فيما تراوحت أعمارهم بين ١٨-٢٤ شهرا. تم تقسيم الكلاب بشكل عشوائي الى ثلاث مجموعات بالتساوي المجموعة الأولى (مجموعة سيطرة) في هذه المجموعة نقوم بخياطة وتر المثنية الرقمية السطحي المقطوع بالكامل بدون إضافة أي مادة مساعدة، في المجموعة الثانية (مجموعة صغائر أوكسيد المغنيسيوم) في هذه المجموعة تم خياطة وتر المثنية الرقمية السطحي المقطوع مع إضافة ٣ مل من صغائر أوكسيد المغنيسيوم، في المجموعة الثالثة (مجموعة الفبرين الغني بالصفائح الدموية المتقدم) في هذه المجموعة تم خياطة وتر المثنية الرقمية السطحي المقطوع مع إضافة ٣ مل الفبرين الغني بالصفائح الدموية المتقدم. في المجموعة الواحدة يتم تقسيم الحيوانات الى ثلاث مجاميع فرعية بالتساوي ويتم فحصها بعد ١٥ و ٣٠ و٤٥ يوم من العملية الجراحية. تم تقييم شدة العرج والالتصاقات وإجراء الفحص النسيجة والكيميائي المناعي للأوتار الملتئمة بعد ١٥و ٣٠و ٤٥ يوما من الجراحة في كل مجموعة. وبالمقارنة بين مجموعة السيطرة ومجموعة صغائر أوكسيد المغنيسيوم ومجموعة الفبرين الغني بالصفائح الدموية المتقدم كانت درجة الالتصاق اعلى في مجموعة الأولى عما هو عليه في المجاميع الثانية والثالثة. وكشفت نتائج الفحص النسجي المرضي لالتئام وتر المثنية الرقمية السطحي في المجموعة الأولى عن ارتشاح شديد للخلايا الالتهابية أحادية النواة وتكاثر الخلايا الوترية وترسب حزم الكولاجين بدون اتجاه وبزاوية نحو محور الوتر والشعيرات الدموية الجديدة بينما في المجموعة الثانية والثالثة أظهرت النتائج بشكل طفيف الى معتدل على التوالي. أظهرت نتائج الفحص الكيميائي النسجي في المجموعة الأولى تفاعل كولاجين إيجابي معتدل، أما في المجموعة الثانية

تفاعل كولاجين إيجابي مكثف، بينما في المجموعة الثالثة تفاعل كولاجين إيجابي طفيف جدا في جميع الفترات باستثناء فترة ٤٥ يوما حيث أظهرت المجموعة الثالثة تفاعل كولاجين إيجابي مكثف. لذلك يمكن أن نستنتج أن مجموعة صغائر أوكسيد المغنيسيوم والفبرين الغني بالصفائح الدموية المتقدم مواد فعالة لتعزيز التئام وتر المثنية الرقمية السطحي المقطوعة في الكلاب ولكن مجموعة صغائر أوكسيد المغنيسيوم كانت أفضل من مجموعة الفبرين الغني بالصفائح الدموية المتقدم.