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Evaluation of the efficacy of freeze-dried bovine pericardium and acellular bovine skin in the treatment of diaphragmatic hernia in dogs

O.H. Al-Hyani[1], S.M. Ibrahim[1] and A.M. Al-Saiegh[2]

[1]Department of Surgery and Theriogenology, College of Veterinary Medicine, University of Mosul, Mosul, [2]Department of Community Health, College Health, and Medical Technology Shekhan, Duhok Polytechnic University, Duhok, Iraq

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Correspondence:
O.H. Al-Hyani
osamahazim854@yahoo.com

Abstract

The article was designed to evaluate the efficiency of lyophilized bovine pericardium and acellular bovine skin for repairing diaphragmatic hernia in dogs. Twelve local breed adult dogs were used. In all animals, the diaphragmatic hernia was induced by removing 5cm diameter circular piece the diaphragm. The animals were divided into two equal groups (n=6). In the first group, the diaphragmatic hernia was repaired using lyophilized bovine pericardium, and in the second group, acellular bovine skin was applied. The results were evaluated studying the gross and histopathological changes on the 15th and 30th postoperative days. The gross results showed a different degree of adhesion at the site of hernial repair. The adhesion rate was developed more severely in the second group animals compared to the first group. The histopathological manifestation of the first group showed excessive and more mature granulation tissue formation with few inflammatory cell infiltrations with good angiogenesis comparable to the second group, which revealed moderate granulation tissue formation and blood vessel formation with sever infiltration of inflammatory cells. In conclusion, we can use lyophilized bovine pericardium and acellular bovine skin to repair diaphragmatic hernias in dogs, although lyophilized bovine pericardium is regarded as the best option despite its high cost.

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Introduction

The diaphragm is the musculoaponeurotic dome-shaped physical wall that separates the abdominal and thoracic cavities and arches over the abdomen, allowing the liver and the spleen to be located underneath it and to be protected by the lower ribs and the chest wall. It consists of a noncontractile central tendon part and two other muscular portions, the crural and costal, and a minor sternal muscular portion (1). Diaphragmatic hernia (DH) is the most common disorder occurring in dogs and cats due to trauma or congenital causes. Rupture of the thin musculotendinous structure of the diaphragm may cause herniation of abdominal structures into the chest, causing a life-threatening respiratory condition and potential entrapment of abdominal organs (2). Despite advances in therapeutic techniques, the repair of hernia defects continues to be deficient and costly, resulting in chronic healthcare problems. However, hernia repair options are achieved either by surgical or conservative management (3). Generally, the DH is treated surgically (4,5). The biological or synthetic grafts are suggested in large hernial ring cases with a chronic disease (6). Polypropylene mesh, is hard and handled yet related sever complications such as adhesion, mesh extrusion, obstruction, and fistula formation with chronic pain (7,8). Therefore, some complications may lead to a recurrent hernia (9,10). To overcome these undesired weaknesses of synthetic mesh, another natural alternative biodegradable material should be tried, especially when these choices are reliably inert and resistant to microbial

colonization and chronic infection. In addition, other perfect properties of any hernial grafts should also have no initiation for adherence with internal structures, biocompatibility, no carcinogenicity, good ability to withstand pressure over a long period, suitable costs, and pain free following implantation. They should provide the cells to grow, multiply, and dissolve. However, no synthetic implants meet these demands, so the hope finding more suitable mesh materials remains (11). A high complication rate during the healing process may appear when using autogenous tissue. Therefore, different xeno and allografted tissues are indicated. The xenogeneic and allogenic materials are varied in their characteristics, such as strength, cellular response, vulnerability to infection, ability to transmit diseases, and biodegradability. Besides, the mechanical properties of such grafts can be changed following in vivo implantation (11). The de-cellularization and crosslinking process deeply influence the long-term host response against implantation. Nearly, all kinds of biologically originated meshes elicit a mononuclear cell inflammatory infiltration with different degrees of remodeling response in the long-term (12). During the preparation process, especially the crosslinking step, the collagen of the implantation grafts is treated chemically to counterattack the degradation process by collagenases, which enhance implant strength and, at the same time, limit tissue regeneration and hence influence host responses against the implanted grafts (13). The lyophilization technique, also known as freeze-drying, is one of the most recent useful cryopreservation techniques used to preserve various biological tissues (14). Lyophilization is a procedure in which the samples water content is frozen, and then removed via sublimation and desorption. It is essential for the protection of materials (15). However, the concentration and recovery of reaction goods as lyophilization is an efficient method of drying materials without damaging them (16,17). Despite the many desired characteristics of the biological material meshes, several complications have been documented with their use, including adhesion, rejection, fistula development, stretching, function loss during early degradation, infection, and finally, secondary granulomatous inflammatory reaction (18).

Therefore, this article aims to show the effectiveness of using biodegradable xenograft materials derived from bovine skin and pericardium for diaphragmatic hernioplasty in dogs based on macroscopical and histopathological parameters.

Materials and methods

Ethical approve

The research was approved by the ethics of the Institutional Animal Care and Use Committee for College of Veterinary Medicine, University of Mosul.UM.VET.2022.044.

Animals

Twelve (n=12), 1-3 years adult local breed dogs, from both sexes, weighing 20-25 kg. were acclimatized for seven days before the beginning of this experiment. All surgical and handling procedures were achieved in agreement with the ethical standards and animal utilization protocols. A circular diaphragmatic defect about 5 cm. diameter was created in all dogs. Then, animals were divided randomly into two equal experimental groups (n=6). In the first experiment group, a segment of the bovine lyophilized pericardium was implanted onto a diaphragmatic defect and fixed with a 2/0 polypropylene suture, using a simple interrupted suture technique. Acellular bovine skin was fixed using the same suture material and technique to close the induced diaphragmatic defect in the second group.

Preparation of a cellular bovine skin

Bovine skin was taken from the local abattoir and immediately kept within ice-cold sterile phosphate-buffered saline (PBS, pH 7.4) enriched with broad-spectrum antibiotic (Amikacin-1 mg/ml), and a proteolytic inhibitor (0.02% EDTA) (Figure 1).

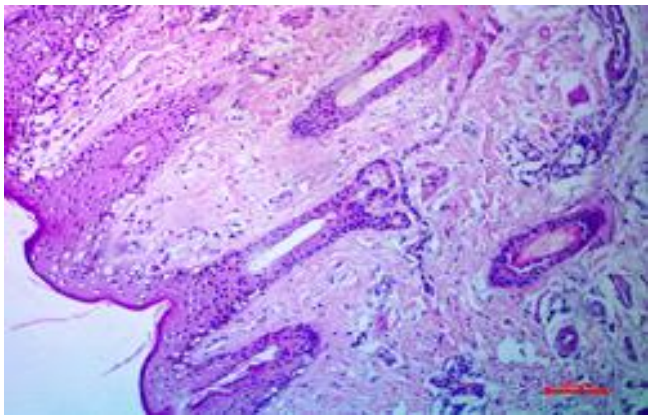

Figure 1: Microscopic picture of the normal bovine skin (H&E, 40X).

In the preparation room, the skin was shaved, and all the adherent debris and blood were washed out thoroughly using sterile PBS. De-epithelization of the skin was done using 0.25% trypsin and 2 M sodium chloride solution for 8 hours. Then, the dermis was decellularized using 2% sodium deoxycholate for 48 hours. The samples were subjected to continuous agitation in a horizontal orbital shaker at 180 rotations per minute to ensure optimal skin contact with chemicals and a better de- epithelization and de-cellularization process. To ensure the cellularity of the prepared skin samples, a microscopic examination following staining with Hematoxylin and Eosin (H&E) was performed (Figure 2). Then, the prepared acellular bovine skin was washed with sterile PBS solution six times (2 hours each) to remove the residual chemicals and finally stored at -20^{o}C in

PBS solution containing 0.1% amikacin solution (19,20). Finally, the prepared cellular bovine skin was stored at 4°C in PBS containing 1% Gentamycin (21).

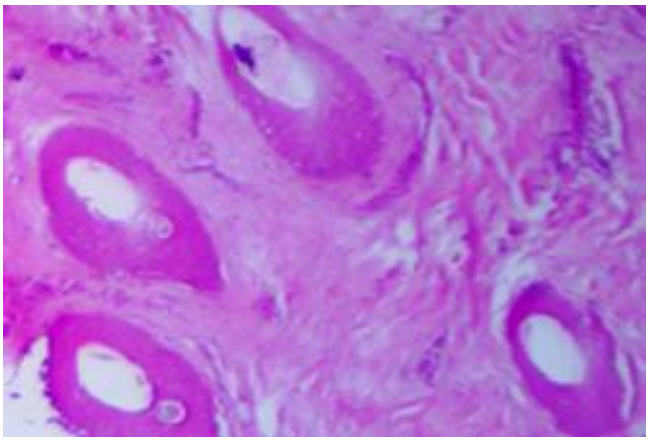

Figure 2: Microscopic picture for acellular bovine skin (H&E, 100X).

Lyophilized bovine pericardium (LyoPlant)

The lyophilized bovine pericardium was purchased from the local market. It is a biological, absorbable sheet consisting of a bilayer membrane made of pure collagen implant of lyophilized bovine pericardium manufactured by Aesculap, Inc., Center Valley, PA, B. Braun, Germany (Figure 3).

Figure 3: Photographic picture of lyophilized bovine pericardium.

Anesthetic protocol

The dogs were off feed for about twelve hours before the surgical intervention. The surgical operations were applied under general anesthesia using atropine sulfate of a dose of 0.044mg/kg as a premedication, then followed by a premixed intramuscular mixture of 10 mg/kg of Ketamine Hydrochloride and 5 mg/kg of xylazine (22). All the experimental animals were connected to the positive pressure ventilation machine to prevent lung collapse (23).

Surgical procedure and creation of the diaphragmatic hernia.

Routine surgical skin preparation on the site of the thoracic cavity was performed. The access to the diaphragmatic muscle, intercostal thoracotomy was achieved. About 10 cm skin incision in the ninth left intercostal space was made. The surgical incision was continuous through the subcutaneous tissue and thoracic muscles until it reached the pleura. Then, the pleura was opened very carefully with blunt scissors to avoid any accidental damage to the lung tissues (Figure 4) (24).

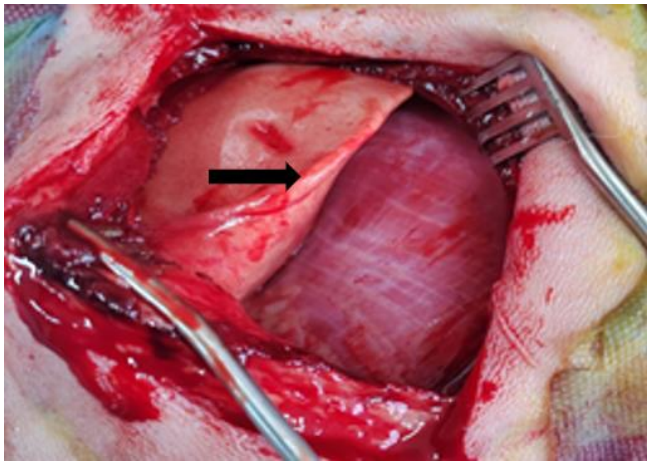

Figure 4: Photographic image for the normal approached diaphragm.

After identifying the muscular part of the diaphragm, a circular piece of about 5cm diameter of the left diaphragm muscle was demarcated and removed with a scalpel, resulting in a defect of the exact dimensions (Figure 5).

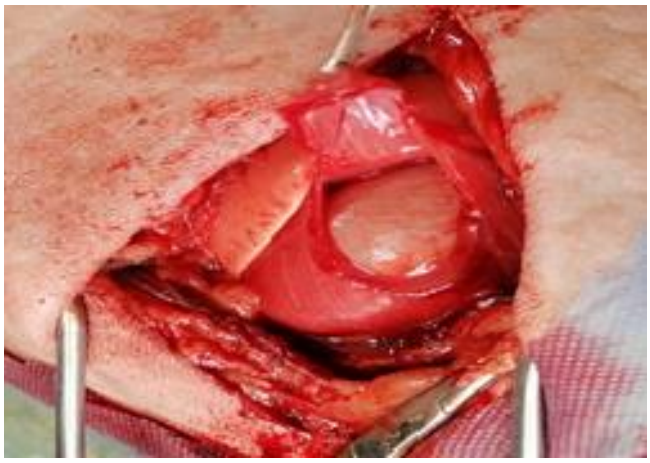

Figure 5: Photographic image of the induced diaphragmatic defect

Then, a double layer of lyophilized bovine pericardium segment was fixed and sutured into the edges of that diaphragmatic injury by 2/0 polypropylene suture using simple interrupted in the first group (Figure 6). At the same time, cellular bovine skin sheets were used for the second group (Figure 7). Finally, thoracorrhaphy was performed with simple continuous stitches made of 2/0 Vicryl.

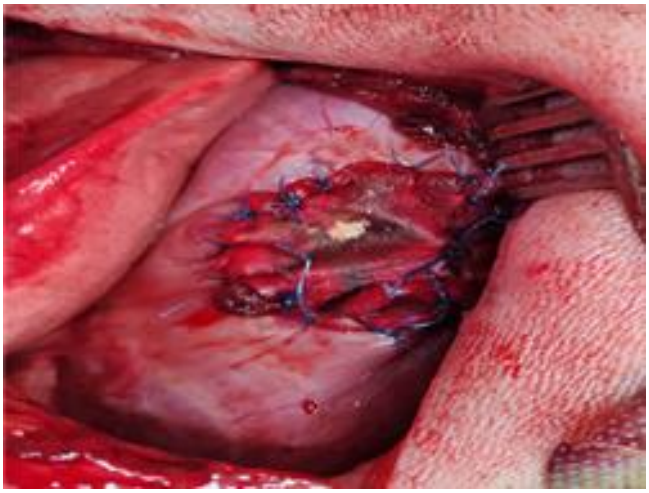

Figure 6: Photographic image for grafting the hernia with lyophilized bovine pericardium.

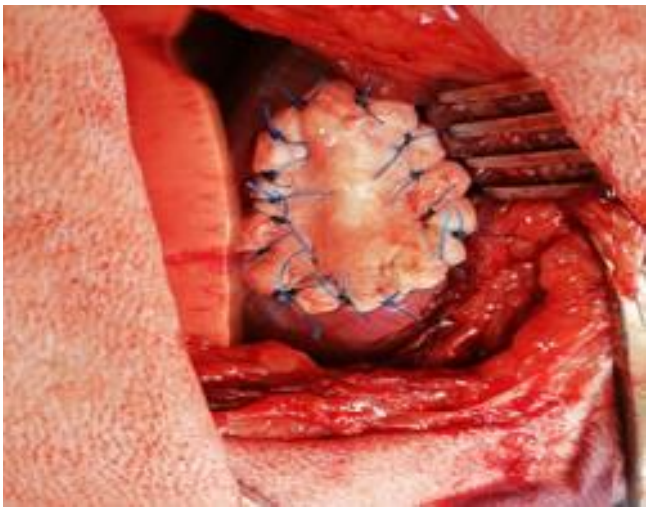

Figure 7: Photographic image for grafting the hernia with a cellular bovine skin.

Postoperative care

A daily inspection of the intercostal thoracotomy skin wounds was done for any gross signs of wound complications or dehiscence. Penicillin/streptomycin (Nederhorst den Berg, Holland) (1 ml/10 kg body weight per day for five days) and Metalgen (SPI, Saudi) (1 ml/day for five days) were administered to the dogs.

Assessment of healing

The progress of the healing process was evaluated through observation of the clinical signs post-operation during all study periods. The gross and histopathological changes were also studied on the 15th and 30th days after the operation. The experimental animals did not kill where the biopsies of the graft area were obtained for histopathological evaluation by intercostal thoracotomy procedures, and the samples were fixed in 10% formalin and stained with hematoxylin and eosin (H&E) stain.

Results

Gross results

All experimental animals survived after surgery and showed no complications post-operation. In both groups, varying degrees of adhesion were developed at the site of diaphragmatic hernial repair on the 15th day postoperatively. The degree of adhesion of the second group appeared more than that of the first group. While, on the 30th postoperative day, the adhesion was also evident at the site of diaphragmatic hernial repair, adhesion formation was much more abundant in the second group than in the first group.

Histopathological findings

In the first group (lyophilized bovine pericardium), the histopathological sections for the site of diaphragmatic hernia at the 15th day postoperative revealed the presence formation of excessive new granulation tissue, excellent profuse development of new blood vessels and mild infiltrations of mononuclear inflammatory cells (Figures 8-10). After the 30th day, the histopathological features were characterized by granulation tissue maturation with no or tiny infiltration of mononuclear inflammatory cells and reduced angiogenesis (Figures 11-13).

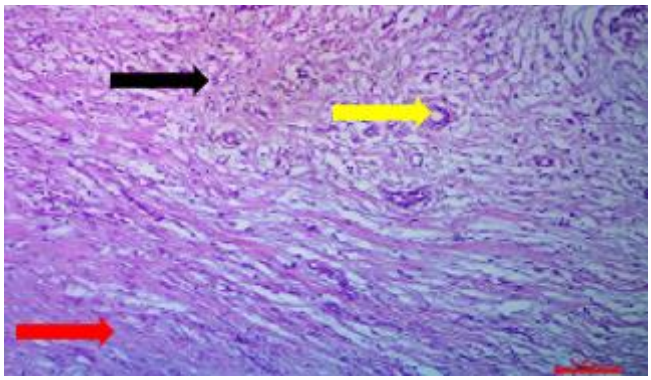

Figure 8: Micrograph at 15th day post operation in the first group showing newly granulation tissue formation (red arrow), severe angiogenesis (yellow arrow), and little infiltration of inflammatory cells (black arrow). (H&E 100X).

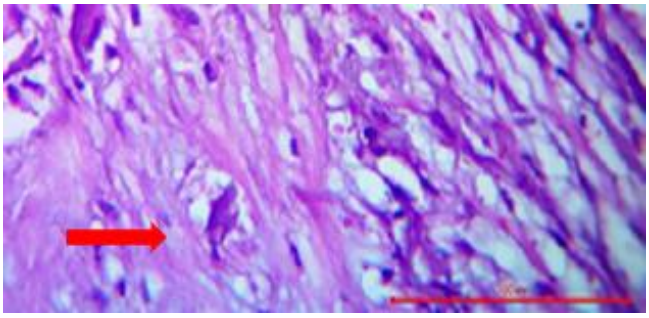

Figure 9: Micrograph at 15th day post operation in the first group showing newly granulation tissue formation (red arrow) (H&E, 400X).

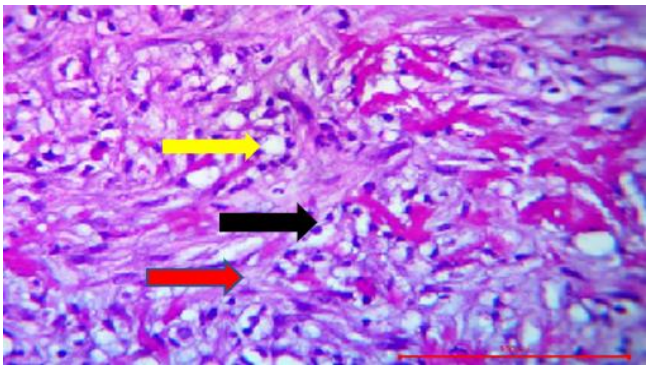

Figure 10: Micrograph at 15th day post operation in the first group showing newly granulation tissue formation (red arrow), severe angiogeneis (yellow arrow), and little infiltration of inflammatory cells (black arrow).(H&E 400X).

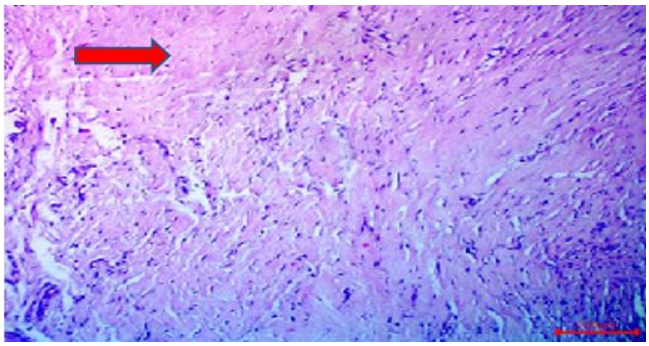

Figure 11: Micrograph at 30th day post operation in the first group showing mature granulation tissue (red arrow). (H&E 100X).

On the other hand, the histopathological features for the second group (A cellular bovine skin) after the 15th day post-implantation, showed moderate new granulation tissue formation and blood vessel development with severe infiltration of mono and multinuclear inflammatory cells (Figures 14-16). Besides, on day 30 following surgery, the histopathological changes were characterized by less angiogenesis and the presence of inflammatory cells. The acellular part starts to rebuild its cellular components, and maturation of granulation tissue was observed (Figures 17-19).

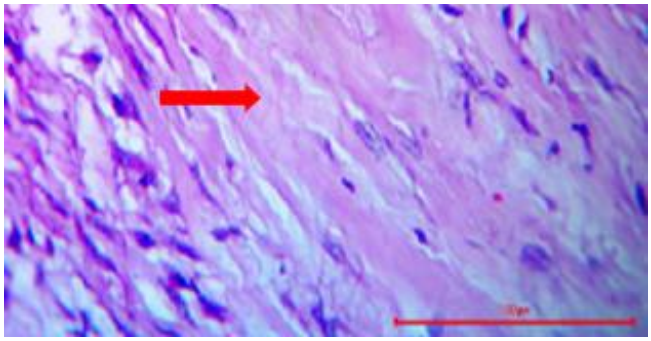

Figure 12: Micrograph at 30th day post operation in the first group showing mature granulation tissue (red arrow). (H&E 400X).

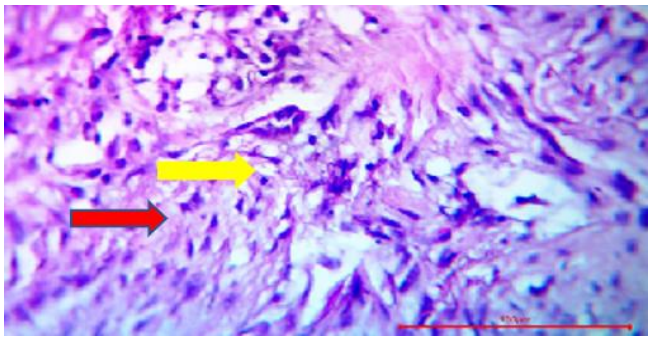

Figure 13: Micrograph at 30th day post operation in the first group showing mature granulation tissue (red arrow) and few infiltrations of inflammatory cells (yellow arrow). (H&E 400X).

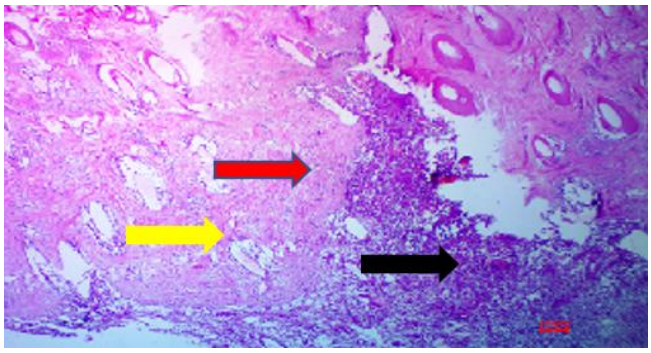

Figure 14: Micrograph at 15th day post operation in the second group showing newly granulation tissue formation (red arrow), moderate angiogenesis (yellow arrow), and more infiltration of inflammatory cells (black arrow). (H&E 40X).

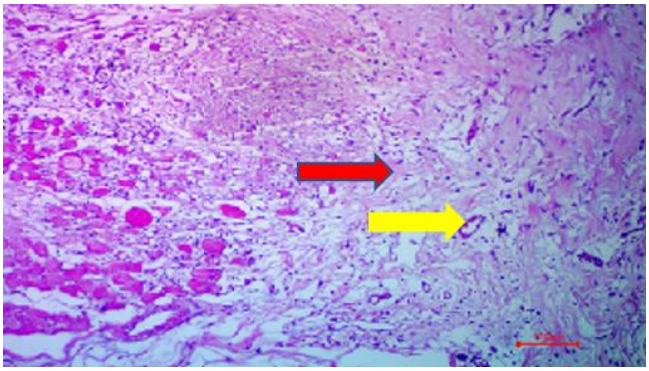

Figure 15: Micrograph at 15th day post operation in the second group showing newly granulation tissue formation (red arrow), moderate angiogenesis (yellow arrow). (H&E 100X).

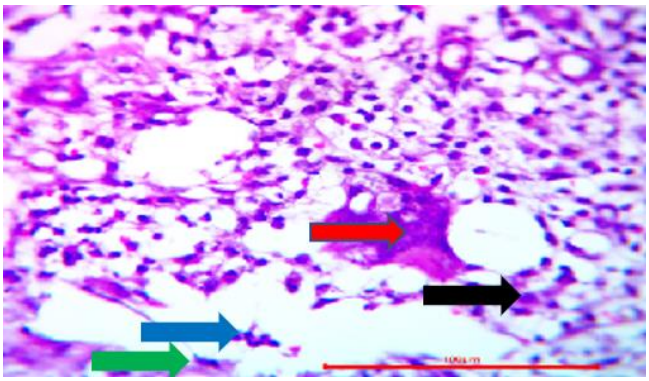

Figure 16 Micrograph at 15th day post-operation in the second group showing infiltration mono and multinucleated inflammatory cells as neutrophil (blue arrow), giant cell (red arrow),macrophage (black arrow), and lymphocyte (green arrow) (H&E, 400X).

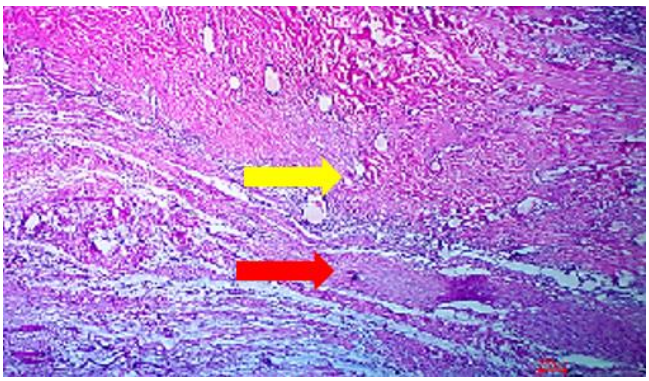

Figure 17: Micrograph at 30th day post-operation in the second group showing mature granulation tissue (red arrow) and angiogenesis (yellow arrow)(H&E 100X).

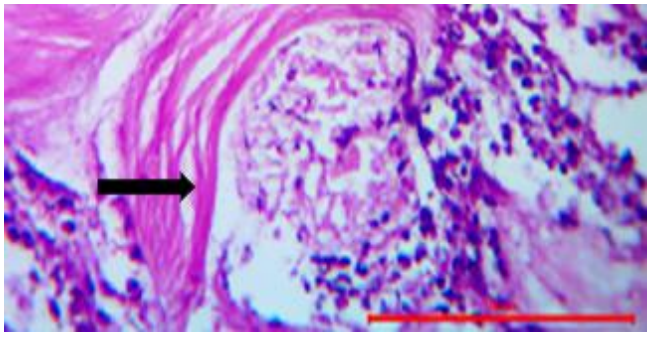

Figure 18: Micrograph at 30th day post operation in the second group showing the orientation of collagen fibers (black arrow) (H&E 400X).

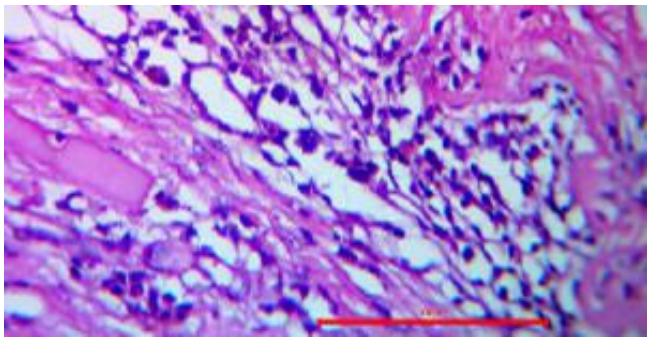

Figure 19: Micrograph at 30th day post operation in the second group showing infiltration of inflammatory cells (H&E 400X).

Discussion

Utilizing various prostheses for hernial repair is highly recommended in cases of the presence of insufficient tissue margins for perfect closing of the defect with sutures or in chronic hernias when first reduction may cause primary postoperative dehiscence as a result of high sutures tension or intraoperative rupture (6). In this research, we used processed skin and pericardium xenografts derived from cows as a biological scaffold due to their huge bioavailability and the long history of their successful applications (25-28). The extracellular matrix (ECM) of acellular bovine skin and lyophilized bovine pericardium both supplied the host cell with the suitable basement to invade and grow as well as supported structural and functional performance that enabled the complete closure of induced hernial defects, which had been noticed since the early period following transplantation. Furthermore, these viable scaffolds have many vital proteins that preserve the health of tissue differentiation, and support the host response to tissue damage, which becomes an ideal option for replacing missing or damaged tissues (29).

In the current study, the macroscopic data following the use of lyophilized bovine pericardium and a cellular bovine

skin showed the existence of adhesion between the site of diaphragmatic hernial repair and the internal surrounding tissues of the thoracic wall following surgery. However, that adhesion was much higher with cellular bovine skin than with lyophilized bovine pericardium. This noticed adhesion may be due to foreign suture materials and initiation of inflammatory reaction following xenograft implantation (30,31). The more adhesion associated with cellular bovine skin was because it elicited a more inflammatory reaction, which was more obvious histopathologically comparable to lyophilized bovine pericardium. The less adhesion accompanied by lyophilized bovine pericardium is a good prognosis as the perfect implant should irritate less tissue reaction with good incorporation into the receipt tissue because adhesion with prosthetic subject remains an unsolved clinical problem (30). Furthermore, the adhesion associated with hernia repair continues to be one of the most common complications in about 90% of all patients undergoing hernial repair surgery (32). Other researchers even tried using some substances like Aloe vera gel to decrease the adhesion rate between hernial ring, graft, and viscera following implantation during their work for repairing induced abdominal hernia (33). Our mentioned results followed another research finding that noticed the presence of adhesion within the hernial site following its repair (30,34).

The microscopic findings following implantation of lyophilized bovine pericardium indicated the presence of slight inflammatory cell infiltration as comparable with their heavy existence associated with acellular bovine skin. The existence of inflammatory cells associated with lyophilized bovine pericardium (35), who documented the lack of inflammatory cells nor calcification associated with using of CardioCel graft, which is a material manufactured from bovine pericardium after processing through a series of tissue engineering protocol. This difference in the severity of inflammatory reaction between these two xenografts could be because the use of bovine pericardium as lyophilization decreases tissue immunogenicity and enhances its acceptance (36). Furthermore, less immunogenicity lessens cell infiltration and enhances the shelf life of the graft (37). Besides, it is highly accepted that lyophilization does not significantly influence the microstructure or the tissues expression of bioactive factors (38). Also, the less foreign body reaction associated with using lyophilized bovine pericardium in our research is in great accordance with other researchers' data who also utilized bovine pericardium to close experimentally induced abdominal defects in rats and concluded that bovine pericardium initiated a minimal foreign-body reaction and less or no macrophage response thus offering excellent mechanical support as early as two weeks after implantation (39). Other clinical studies on using a cellular bovine pericardium within contaminated tissues proved its superiority for repairing major abdominal defects because of its high tensile strength and low infection rate (40,41). All these factors enabled the lyophilized bovine pericardium to initiate a less inflammatory reaction when compared with cellular bovine skin. On the other hand, the histopathological manifestation of a cellular bovine skin showed severe infiltration of inflammatory cells, especially mononuclear, which indicates that it elicited more immunogenicity and less acceptance. Other researchers who documented the severe cell infiltration also noticed the intense spreads of these inflammatory cells associated with cellular bovine skin (42-44). Furthermore, the infiltration of inflammatory cells with cellular bovine skin indicated the presence of foreign body reactions and chronic inflammation (45).

Another histopathological inspection of a cellular bovine skin and lyophilized bovine pericrdium revealed the presence of angiogenesis, which was more developed and huge with lyophilized bovine pericardium compared to a cellular bovine skin; this revascularization developed more and more with the progress of the healing process which is considered as the key for perfect hernial repair as angiogenesis and the formation of new capillaries is the elementary phenomena within any tissue regeneration as these new formed blood vessels would transport esssential nutrients and oxygen supply to the actively energetic regenerative tissue which is crucial for biologic ingrowth in hernia prosthetics as they need an adequate tremendous vascular support. The network of newly formed blood vessels seems to confirm the enhancement of the lyophilized bovine pericardium's biological features that made it resemble a regenerative scaffold (46). Our data agrees with other investigartors data noticed the presence of angiogenesis following transplantation in his comparative hernioplasty in sheep using pericardium and tunica vaginalis allografts (47). Good angiogenesis following implantation helped the sound performance of lyophilized bovine pericardium comparable with a cellular bovine skin, as a slow rate of angiogenesis during the healing process is considered one of the chief drawbacks of using scaffolds.

Finally, The existence of abundant and developed granulation tissue associated with a lyophilized bovine pericardium group in comparison to a cellular bovine skin was evident post-implantation, indicating that the lyophilized pericardium incorporated into the tissue much better than cell bovine skin and indicative for the sound development of repairing process within the grafted site (18,21). Furthermore, granulation tissue was also observed with another worker (48) who noticed the presence of granulation tissue associated with irregular angiogenesis invading the implant during his study for hernial treatment.

Conclusions

The macroscopic and the microscopic results of this study exhibited that repairing the diaphragmatic hernia in dogs can be done by using either lyophilized bovine

pericardium or acellular bovine skin as biological implants with superiority of the lyophilized bovine pericardium.

Acknowledgments

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Conflict of interests

The authors declare that there is no conflict of interest regarding the publication of this article.

Reference

1. Anraku M, Shargall Y. Surgical conditions of the diaphragm: Anatomy and physiology. Thorac Surg Clin. 2009;19(4):419-429. DOI: 10.1016/j.thorsurg.2009.08.002
2. Gibson TW, Brisson BA, Sears W. Perioperative survival rates after surgery for diaphragmatic hernia in dogs and cats: 92 cases (1990–2002). J Am Vet Med Assoc. 2005;227(1):105-109. DOI: 10.2460/javma.2005.227.105
3. Harting MT, Jancelewicz T. Surgical management of congenital diaphragmatic hernia. Clin Perinatol. 2022;49(4):893-906. DOI: 10.1016/j.clp.2022.08.004
4. Saltzman DA, Ennis JS, Mehall JR, Jackson RJ, Smith SD, Wagner CW. Recurrent congenital diaphragmatic hernia: A novel repair. J Pediatr Surg. 2001;36(12):1768-1769. DOI: 10.1053/jpsu.2001.28818
5. Morgan KR, Singh A, Giuffrida MA, Balsa IM, Hayes G, Chu ML, Thomson CB, Arai S, Smeak DD, Monnet E, Selmic LE. Outcome after surgical and conservative treatments of canine peritoneopericardial diaphragmatic hernia: A multi-institutional study of 128 dogs. Vet Surg. 2020;49(1):138-145. DOI: 10.1111/vsu.13360
6. Feranti JP, de Oliveira MT, Hartmann HF, Corrêa LF, Pinto Filho ST, Linhares MT, Chaves RO, Silva MA, Brun MV. Laparoscopic diaphragmatic hernioplasty in a dog. Braz J Vet Res Anim Sci. 2016;53(1):103-106. DOI: 10.11606/issn.1678-4456.v53i1p103-106
7. Welty G, Klinge U, Klosterhalfen B, Kasperk R, Schumpelick V. Functional impairment and complaints following incisional hernia repair with different polypropylene meshes. Hernia. 2001;5:142-147. DOI: 10.1007/s100290100017
8. Robinson TN, Clarke JH, Schoen J, Walsh MD. Major mesh-related complications following hernia repair: Events reported to the food and drug administration. Surg Endosc. 2005;19:1556-1560. DOI: 10.1007/s00464-005-0120-y
9. Klinge U, Junge K, Spellerberg B, Piroth C, Klosterhalfen B, Schumpelick V. Do multifilament alloplastic meshes increase the infection rate? Analysis of the polymeric surface, the bacteria adherence, and the in vivo consequences in a rat model. J Biomed Mater Res. 2002;63(6):765-771. DOI: 10.1002/jbm.10449
10. Harrell AG, Novitsky YW, Kercher KW, Foster M, Burns JM, Kuwada TS, Heniford BT. In vitro infectability of prosthetic mesh by methicillin-resistant *Staphylococcus aureus*. Hernia. 2006;10:120-124. DOI: 10.1007/s10029-005-0056-0
11. Bellows CF, Alder A, Helton WS. Abdominal wall reconstruction using biological tissue grafts: Present status and future opportunities. Expert Rev Med Devices. 2006;3(5):657-675. DOI: 10.1586/17434440.3.5.657
12. Zheng MH, Chen J, Kirilak Y, Willers C, Xu J, Wood D. Porcine small intestine submucosa (SIS) is not an acellular collagenous matrix and contains porcine DNA: Possible implications in human implantation. J Biomed Mater Res B Appl Biomater. 2005;73(1):61-67. DOI: 10.1002/jbm.b.30170
13. Melman L, Jenkins ED, Hamilton NA, Bender LC, Brodt MD, Deeken CR, Greco SC, Frisella MM, Matthews BD. Early biocompatibility of crosslinked and non-crosslinked biologic meshes in a porcine model of ventral hernia repair. Hernia. 2011;15:157-164. DOI: 10.1007/s10029-010-0770-0
14. Leirner AA, Tattini Jr V, Pitombo RN. Prospects in lyophilization of bovine pericardium. Artif Organs. 2009;33(3):221-229. DOI: 10.1111/j.1525-1594.2009.00712.x
15. Kasper JC, Winter G, Friess W. Recent advances and further challenges in lyophilization. Eur J Pharm Biopharm. 2013;85(2):162-169. DOI: 10.1016/j.ejpb.2013.05.019.
16. Nireesha GR, Divya L, Sowmya C, Venkateshan NN, Lavakumar V. Lyophilization/freeze drying-a review. Int J Novel Trends Pharm Sci. 2013;3(4):87-98. https://scienztech.org/index.php/ijntps/article/view/96.
17. Gaidhani KA, Harwalkar M, Bhambere D, Nirgude PS. Lyophilization/freeze drying–a review. World J Pharm Res. 2015;4(8):516-543. https://www.researchgate.net/publication/292047227_LYOPHILIZATION_FREEZE_DRYING-AREVIEW.
18. Linde KJ, Kelleher TR, Perry JA. Biological implant-associated granulomatous inflammation resulting in secondary hypercalcemia and azotemia in a dog. Clin Case Rep. 2018;6(9):1801. DOI: 10.1002/ccr3.1661
19. Kumar R, Prasad B, Singh J, Sharma SN, Kohli RN. Bovine diaphragmatic hernioplasty using autologous skin grafts. Mod Vet Pract. 1979;60(11):907-908. https://pubmed.ncbi.nlm.nih.gov/390360/.
20. Kumar V, Kumar N, Mathew DD, Gangwar AK, Saxena AC, Remya V. Repair abdominal wall hernias using acellular dermal matrix in goats. J Appl Anim Res. 2013;41(1):117-120. DOI: 10.1080/09712119.2012.738222
21. Mahdi AK, AL-Bayati AH. Evaluation of two biological matrices for repairing of ventral hernia in bucks. Iraqi J Vet Med. 2018;42(2):21-32. DOI: 10.30539/iraqijvm.v42i2.282
22. Abdulmawjood YF, Thanoon MG, Ibrahim SM, Alsofy JH. Histopathological study about the effect of nano magnesium oxide and platelet-rich fibrin on the healing of induced radial fracture in dogs. Iraqi J Vet Sci. 2022;36:123-130. DOI: 10.33899/ijvs.2022.135761.2516
23. Bader OA, Eesa MJ. Effect of nano-magnesium oxide and harmonic scalpel on lung lobectomy healing in dogs: Clinical and cytokine study. Iraqi J Vet Sci. 2021;35(4):649-656. DOI: 10.33899/IJVS.2021.127611.1514
24. Al-Hyani OH. Histological comparison between histoacryl and suturing to close lung wounds in dogs. Iraqi J Vet Sci. 2023;37(3):751-758. DOI: 10.33899/IJVS.2023.136382.2578
25. Filippi R, Schwarz M, Voth D, Reisch R, Grunert P, Perneczky A. Bovine pericardium for duraplasty: Clinical results in 32 patients. Neurosurg Rev. 2001;24:103-107. DOI: 10.1007/PL00012392
26. Mazzanti A, Raiser AG, Pippi NL, Alves AS, Faria RX, Alievi MM, Braga FA, Salbego FZ. Diaphragmatic hernioplasty in dogs with bovine pericardium preserved in supersaturated sugar solution. Arq Bras Med Vet Zootec. 2003;55:677-684. DOI: 10.1590/S0102-09352003000600005
27. Maizato MJ, Pires MD, Canzian M, Higa OZ, Pitombo RN, Leirner AA. Histological evaluation of biocompatibility of lyophilized bovine pericardium implanted subcutaneously in rats. Artif Organs. 2008;32(4):268-271. DOI: 10.1111/j.1525-1594.2008.00541.x
28. Neethling WM, Glancy R, Hodge AJ. Mitigation of calcification and cytotoxicity of a glutaraldehyde-preserved bovine pericardial matrix: Improved biocompatibility after extended implantation in the subcutaneous rat model. J Heart Valve Dis. 2010;19(6):778-785. https://pubmed.ncbi.nlm.nih.gov/21214104/.
29. Badylak SF. Regenerative medicine and developmental biology: The role of the extracellular matrix. Anat Rec. 2005;287(1):36-41. DOI: 10.1002/ar.b.20081
30. D Amore L, Ceci F, Mattia S, Fabbi M, Negro P, Gossetti F. Adhesion prevention in ventral hernia repair: An experimental study comparing three lightweight porous meshes recommended for intraperitoneal use. Hernia. 2017;21:115-123. DOI: 10.1007/s10029-016-1541-3

31. Welch BT. Peritoneal-pericardial diaphragmatic hernia in a 6-year-old male intact pug dog. Can Vet J. 2021;62(1):69-72. https://pubmed.ncbi.nlm.nih.gov/33390604/.
32. Schreinemacher MF. Abdominal wall hernia repair: Intraperitoneal mesh and adhesions [Ph.D. dissertation]. USA: Maastricht University. 2015; 197-200 . DOI: 10.26481/dis.20150410ms
33. Zedan IA, Alkattan LM, Aliraqi OM. An evaluation of Aloe vera leaves gel with polypropylene mesh to repair of ventro-lateral abdominal hernia in rams. Iraqi J Vet Sci. 2022;36:19-25. DOI: 10.33899/ijvs.2022.134989.2430
34. Borrazzo EC, Belmont MF, Boffa D, Fowler DL. Effect of prosthetic material on adhesion formation after laparoscopic ventral hernia repair in a porcine model. Hernia. 2004;8:108-112. DOI: 10.1007/s10029-003-0181-6
35. Prabhu S, Armes JE, Bell D, Justo R, Venugopal P, Karl T, Alphonso N. Histologic evaluation of explanted tissue-engineered bovine pericardium (CardioCel). Semin Thorac Cardiovasc Surg. 2017;29(3):356-363. DOI: 10.1053/j.semtcvs.2017.05.017
36. Lee JK, Ryu YH, Ahn JI, Kim MK, Lee TS, Kim JC. The effect of lyophilization on graft acceptance in experimental xenotransplantation using porcine cornea. Artif Organs. 2010;34(1):37-45. DOI: 10.1111/j.1525-1594.2009.00789.x
37. Adams DH, Tilney NL, Collins Jr JJ, Karnovsky MJ. Experimental graft arteriosclerosis. Transplant. 1992;53(5):1115-1118. DOI: 10.1097/00007890-199205000-00026
38. Zhang J, Qi X, Luo X, Li D, Wang H, Li T. Clinical and immunohistochemical performance of lyophilized platelet-rich fibrin (Ly-PRF) on tissue regeneration. Clin Implant Dent Relat Res. 2017;19(3):466-477. DOI: 10.1111/cid.12473
39. Kapan S, Kapan M, Goksoy E, Karabicak I, Oktar H. Comparison of PTFE, pericardium bovine and fascia lata for repair of incisional hernia in rat model, experimental study. Hernia. 2003;7:39-43. DOI: 10.1007/s10029-002-0096-7
40. Limpert JN, Desai AR, Kumpf AL, Fallucco MA, Aridge DL. Repair of abdominal wall defects with bovine pericardium. Am J Surg. 2009;198(5):60-65. DOI: 10.1016/j.amjsurg.2009.01.027
41. Karrouf G, Zaghloul A, Abou-Alsaud M, Barbour E, Abouelnasr K. Prosthetics and techniques in repair of Animal's Abdominal wall. Sci. 2016:1-8. DOI: 10.1155/2016/9463186
42. Erdag G, Morgan JR. Allogeneic versus xenogeneic immune reaction to bioengineered skin grafts. Cell Transplant. 2004;13(6):701-712. DOI: 10.3727/000000004783983594
43. Eesa MJ, Alkattan LM, Mohammed FM. Repair of large hernia by polymer graft in goats. Iraqi J Vet Sci. 2007;21(1):125-131. DOI 10.33899/ijvs.2007.5612
44. Valenzuela NM, McNamara JT, Reed EF. Antibody-mediated graft injury: Complement-dependent and complement-independent mechanisms. Curr Opin Organ Transplant. 2014;19(1):33. DOI: 10.1097/MOT.0000000000000040.
45. Milde R, Ritter J, Tennent GA, Loesch A, Martinez FO, Gordon S, Pepys MB, Verschoor A, Helming L. Multinucleated giant cells are specialized for complement-mediated phagocytosis and large target destruction. Cell Rep. 2015;13(9):1937-1948. DOI: 10.1016/j.celrep.2015.10.065
46. Amato G, Puleio R, Rodolico V, Agrusa A, Calò PG, Di Buono G, Romano G, Goetze T. Enhanced angiogenesis in the 3D dynamic responsive implant for inguinal hernia repair ProFlor. Artif Organs. 2021;45(8):933-942. DOI: 10.1111/aor.13926
47. AlSadi I, Abass BT, Kader NH. A comparative experimental study of the use of tunica vaginalis and pericardium as allografts for hernioplasty in sheep. Iraqi J Vet Sci. 2005;19(1):57-70. DOI: 0.33899/IJVS.2005.37360
48. Al-Hyani OH, Al-Jobory AK, Bader OA, Al Kennany ER. Hernioplasty of induced diaphragmatic hernia in dogs via a comparative study between implantation of polypropylene mesh and latissmus dorsi muscle. Al-Anbar J Vet Sci. 2012;5(2):30-39. https://www.iasj.net/iasj/pdf/081eb4466d77b4f0.

تقييم كفاءة التامور البقري المجفف بالتجميد والجلد البقري اللاخلوي في علاج فتق الحجاب الحاجز في الكلاب

أسامة حازم الحياني[1]، سحر محمد إبراهيم[1] وعبد الله مزاحم الصائغ[2]

[1]فرع الجراحة وعلم تناسل الحيوان، كلية الطب البيطري، جامعة الموصل، الموصل، [2]قسم صحة المجتمع، كلية الصحة والتقنيات الطبية شيخان، جامعة دهوك التقنية، دهوك، العراق

الخلاصة

تم تصميم هذه التجربة لتقييم كفاءة استخدام كلا من تامور قلب الأبقار المجفف بالتجميد وجلد الأبقار اللاخلوي في إصلاح الفتق الحجابي في الكلاب. تم استخدام اثني عشر كلبًا بالغًا محليًا. في جميع حيوانات التجربة تم استحداث فتحة الفتق في الحجاب الحاجز عن طريق إزالة قطعة دائرية قطرها حوالي خمس سم. ثم بعد ذلك قسمت الحيوانات إلى مجموعتين متساويتين. في المجموعة الأولى، تم إغلاق الفتق الحجابي باستخدام التامور البقري المجفف بالتجميد بينما في المجموعة الثانية تم الترقيع باستخدام جلد البقر اللاخلوي. لتقييم نتائج التجربة تم الاعتماد على التغيرات العيانية والنسيجية المرضية في اليومين الخامس عشر والثلاثين بعد الجراحة. أظهرت النتائج العيانية وجود التصاقات مختلفة الشدة في منطقة إصلاح الفتق حيث كانت الالتصاقات أكثر شدة مع حيوانات المجموعة الثانية مقارنة بالمجموعة الأولى. بينما أظهرت التغييرات النسيجية المرضية للمجموعة الأولى تكوين أنسجة حبيبية بكمية كبيرة وأكثر نضجًا مع القليل من ارتشاح الخلايا الالتهابية مع تكوين أوعية دموية جديدة بنسبة جيدة مقارنة بالمجموعة الثانية التي كشفت عن تكوين نسيج حبيبي متوسط وتكوين اقل للأوعية الدموية مع ارتشاح أكثر شدة للخلايا الالتهابية. الاستنتاج، يمكن استخدام كل من التامور البقري المجفف بالتجميد وجلد الأبقار اللاخلوي لإصلاح فتق الحجاب الحاجز في الكلاب على الرغم من أن التامور البقري المجفف بالتجميد يعد هو الخيار الأفضل على الرغم من تكلفته العالية.