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AUGMENTATION OF LARGE UMBILICAL HERNIORRHAPHY BY USING ONLAY DOUBLE-LAYERED POLYESTER MESH IN BUFFALO CALVES

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ABSTRACT

Umbilical hernias are a common surgical disorder in buffalo calves and can vary in their causes and treatment. While herniorrhaphy is a reasonable option for smaller hernias, larger hernias with diameters greater than three finger widths typically require the use of prosthetic materials for a successful and tension-free repair. This study aimed to evaluate the effectiveness of using a double layer polyester mesh to repair umbilical hernias in ten buffalo calves with a large hernia ring of a diameter of 7-11 cm. The study found that the use of a double layer of polyester mesh was successful in repairing hernias without any complications. Ultrasonographic examination was performed daily to assess the healing progress of the hernias. The use of a mesh allowed for tension-free repair and reduced the risk of recurrence. This technique may be a useful alternative for repairing larger umbilical hernias in buffalo calves. Overall, this study highlights the importance of using appropriate techniques for repairing umbilical hernias in buffalo calves, particularly when dealing with larger hernias. The use of prosthetic materials, such as a double-layer polyester mesh, can provide a successful and tension-free repair, reducing the risk of complications and recurrence.

Keywords: Umbilical hernia, Herniorrhaphy, Polyester mesh, Buffalo calves, Abdominal surgery.

INTRODUCTION

Hernias, defined as a protrusion of body cavity contents through an opening in the body wall, are a common defect in domestic animals, including buffalo calves (Moustafa & Hamed, 2020). Umbilical hernias in Buffalo calves occur due to failure of normal umbilical ring closure or accidental trauma, resulting in the protrusion of abdominal contents into the subcutis (Ávila *et al.,* 2013; Kumar *et al.,* 2017; Moustafa & Hamed, 2020). The genetic factors, type of collagen fibers, and their tensile strength play a significant role in the occurrence and severity of hernias in buffalo calves (Herrmann *et al.,* 2001; Leipold *et al.,* 1998). Young calves with umbilical cord contamination and infection may lead to delayed umbilical ring scaring and are a predisposing factor for

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hernias (Herrmann *et al.,* 2001). Excessive traction and close cutting of the umbilical cord increase the incidence of hernias in calves (Rahman *et al.,* 2017). Umbilical hernias in ruminant calves occur with an average frequency of 1.8-82% of the umbilical pathologies (Herrmann *et al.,* 2001; Spadola *et al.,* 2022; Virtala *et al.,* 1996). Large umbilical hernial rings greater than 3 cm were about 15% of the recorded umbilical hernia (Spadola *et al.,* 2022). Various surgical techniques for hernia treatment have been described. Closed and open herniorrhaphy are recommended for simple and small (not more than 3 cm) hernial rings (Farman *et al.,* 2018; Spadola *et al.,* 2022; Sutradhar *et al.,* 2009). Hernioplasty with the application of biological or synthetic mesh is recommended for large hernias (Farman *et al.,* 2018). Surgical synthetic meshes, such as polypropylene, polyester, nylon, polytetrafluoroethylene, or steel, have been used for the repair of large abdominal wall defects, but their high cost may limit their use in calves (Doijode & Beerappa, 2019; Elango *et al.,* 2017). Polyester surgical mesh is a prosthetic material commonly used in hernia repair surgeries. It provides durable support for weakened or damaged tissue, promoting proper healing while minimizing the risk of recurrence. Its biocompatibility and strength make it a reliable option for various surgical procedures, including hernia repairs in both humans and animals (Elkasapy *et al.,* 2022; Rosen, 2009). Various techniques for hernioplasty, such as sublay, in-lay, and onlay, have been described (Melkemichel *et al.,* 2022; Pereira & Gururaj, 2023). Surgical techniques for hernia repair in animals offer various options, each with unique advantages and considerations. The sublay technique involves placing the prosthetic mesh between the abdominal wall layers and the peritoneum, reducing intra-abdominal contact and promoting tissue ingrowth for robust reinforcement (Issa *et al.,* 2021). Conversely, the inlay technique situates the mesh directly within the hernia defect, providing targeted support without disturbing surrounding tissues (Chavan *et al.,* 2014). In contrast, the onlay technique positions the mesh directly on the abdominal wall surface over the hernia, potentially increasing the risk of complications, but may be suitable for specific cases, such as smaller hernias, or when combined with other techniques (Venkatarao Gopinath H *et al.,* 2018). The onlay mesh technique is the easier technique (Melkemichel *et al.,* 2022). Tissue reaction and seroma are a common finding with onlay mesh uses (Pereira & Gururaj, 2023). The purpose of this study was to investigate the outcome of using onlay economic double-layer polyester mesh in typical herniorrhaphy of buffalo calves' large umbilical hernias.

MATERIALS AND METHODS

The current study was ethically approved by the research ethics committee of the faculty of veterinary medicine, New Valley University. All methods were performed per the relevant ARRIVE guidelines and regulations.

Animals and case presentation

The study enrolled twenty buffalo calves (15 females, 5 males) diagnosed with umbilical hernias at a polyclinic. Their average age was 7.65 months, with a mean weight of 108.295 kg. Among them, eighteen calves exhibited reducible hernias, while two presented with irreducible ones, with an average hernial ring diameter of 8.84 cm. Ten calves (9 females, 1 male) underwent traditional herniorrhaphy and comprised Group 1, whereas the remaining ten calves (7 females, 3 males) utilized onlay mesh application following standard herniorrhaphy, constituting Group 2.

Surgical procedures

Before surgery, food was withheld from the animals for 24 hours. During the surgical procedure, flunixin meglumine (Finadyne, MSD, USA) was administered intravenously at a dose of 2.2 mg/kg, and a prophylactic dose of penicillin-streptomycin (Penstrep, Norbrook, Ireland) was given intramuscularly at doses of 8 mg/kg and 10 mg/kg, respectively. The animal was positioned in dorsal recumbency, and the

ventral abdomen was clipped. Anesthesia was induced via intramuscular injection of xylazine HCl (Xylaject, Adwia, Egypt) at a dose of 0.3 mg/kg body weight, followed by infiltration of 15-20 ml of 2% lidocaine (Lidocaine, Hospira InC., USA) at the surgical site in a ring block pattern. The animal was carefully positioned in dorsal recumbency, and the ventral abdomen was shaved, aseptically prepared, and draped to maintain sterility.

Herniorrhaphy

The technique was applied to 10 buffalo calves (*n=10*) in group 1. A circular incision was made around the hernial sac, and a sharp and blunt dissection was performed to separate the skin and fascia from the underlying body wall layers. Following exposure of the internal hernial sac, the muscular ring is incised to create a circular opening into the peritoneal cavity, allowing for exploration and reduction of herniated contents. The hernial sac is excised as needed until it reaches full thickness of healthy muscular tissue. The body wall was closed using non-absorbable silk number 1 sutures in an interrupted horizontal mattress pattern. The surgical site was inspected for bleeding. Skin is sutured with number 1 silk in a vertical mattress pattern.

Herniorrhaphy with onlay mesh application

The technique was applied to 10 buffalo calves (*n=10*) in group 2. An elliptical incision was performed around the external hernia sac, employing both sharp and blunt dissection to separate the skin and fascia from the underlying muscles. Upon visualizing the internal hernial sac, an incision of the muscular ring was executed to establish a circular aperture into the peritoneal cavity, facilitating comprehensive inspection and reduction of any hernial contents. The hernial sac was dissected and excised as required until reaching full-thickness, healthy muscular tissue. The body wall was then closed using non-absorbable silk number 1 sutures (Silk, GMS, Egypt) in the form of an interrupted horizontal mattress configuration. A pre-autoclaved commercial grade non-prosthetic, soft, knitted, non-degradable, skin-friendly polyester mesh, folded into a double layer, was utilized. It was positioned beyond the margin of the skin or subcutis, then sutured to the underlying muscles with multiple simple interrupted sutures using number 0 silk (Silk, GMS, Egypt) in an onlay technique. The surgical procedure is illustrated in Figure 1.

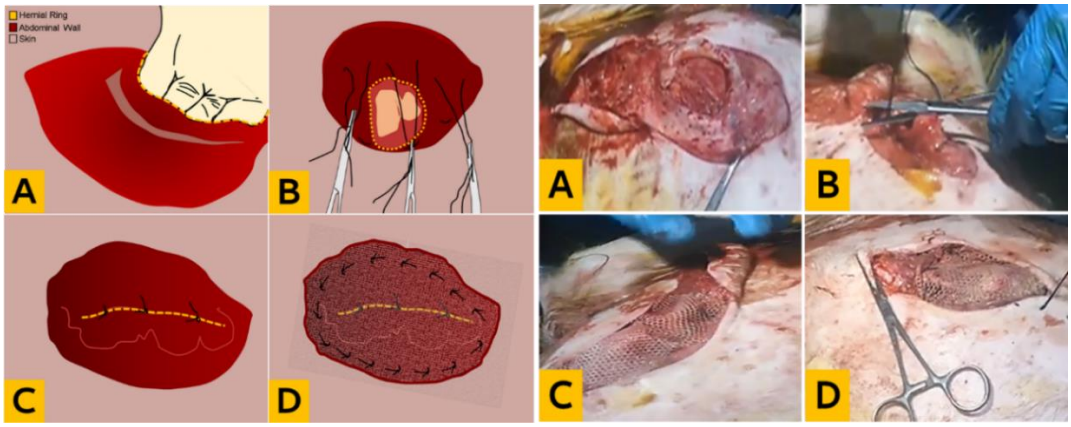

Figure 1: Herniorrhaphy and onlay mesh implant. a) presentation of the hernia; b) application of multiple horizontal mattresses, c) closure of the hernia ring, and d) implantation of onlay polyester mesh.

Postoperative management

After surgery, the wound was sprayed with antibiotic spray (Oxy-G, Adwia, Egypt), and sterile adhesive dressing gauze was applied. Daily wound management was conducted for 2 weeks following the procedure. Postoperative care included administering flunixin meglumine (Finadyne, MSD, USA) at a dosage of 2.2 mg/kg body weight given intravenously, as well as penicillin-

streptomycin (Penstrep, Norbrook, Ireland) at a dosage of 8 and 10 mg/kg body weight given intramuscularly. Daily dressing of the suture line was performed using a 5% povidone iodine solution (Betadine, Nile Co., Egypt). The skin sutures were removed 10-14 days postoperatively.

Surgical procedure evaluation

For local surgical site complications, the evaluation process spanned four months and encompassed assessments of general health status, feasibility of the procedure, average healing time, and postoperative complications. The assessment was conducted through gross evaluation and ultrasonographic examination every 5 days, continuing for up to 4 months postoperatively. General health parameters, including fever and anorexia, were assessed in the first 7 days postoperative. Feasibility was defined as the ability to conduct the procedure easily, considering the operative time consumed from the start of the skin incision up to the end of the last skin stitch and the materials and tools required. The average healing time was estimated from postoperative day one until complete resolution of the surgical site, as identified grossly and ultrasonographically. The assessment of surgical wounds encompassed the evaluation of specific criteria, including the presence of seroma, wound infection, and recurrence.

Statistical analysis

A descriptive statistical analysis was conducted, using R Core Team (2020), an independent T test was conducted and data were plotted as mean ± S.E., with data considered significantly different at p value ≤ 0.05.

RESULTS

This study endeavors to assess the efficacy of integrating an onlay mesh application in conjunction with conventional herniorrhaphy for the resolution of umbilical hernias in a sample of 10 buffalo calves (Figure 2), compared to the typical herniorrhaphy procedure in the other 10 buffalo calves.

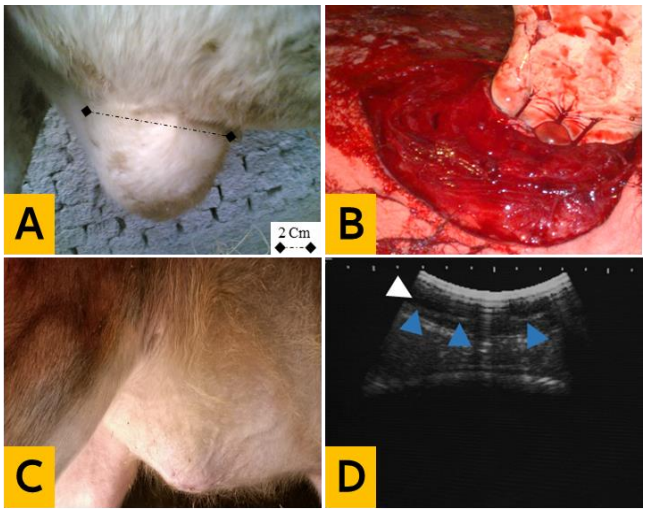

Figure 2: Augmentation of herniorrhaphy with onlay mesh application before and after surgery. A) presentation of an animal with an umbilical reducible hernia. B) evaluation of the hernial ring. C) gross evaluation of the surgical site three weeks post operative. D) ultrasonographic image of the surgical site showing the mesh line (blue arrowheads) and seroma beneath the mesh (white arrow).

A variation in general health status was noted between the two groups. Calves in group 2 showed a significant increase in anorexia, while fever was not significant between groups. Both techniques were feasible. General surgical tools were adequate to perform both procedures. No additional tools were used in Group 2. The mean operative

time for herniorrhaphy Group 1 was 32.5±4.7 minutes. The mean operative time was 47.4±3.8 minutes in Group 2. Significant variation in healing time was noted between groups. The mean healing time was 21±3.64 days in group 1. The mean healing time in group 2 was significantly higher and recorded 45±6.3 days. There is non-significant variation between groups in seroma formation, wound infection, and recurrence. Echography confirmed seroma in all calves 10 days postoperatively. The edema reduced daily till reached a complete resolution 15 days after surgery. In group 2, the mesh was visible through ultrasonography as a thin 2 mm hyperechoic line, which was followed by an ultrasound beam attenuation. In all cases, the mesh remained stable, and the use of non-absorbable suture materials for herniorrhaphy or mesh fixation resulted in no complications. Recurrence was recorded in one case in Group 1, while there was no recurrence in Group 2. The results, which are illustrated in Figure 3, provide a visual representation of the findings.

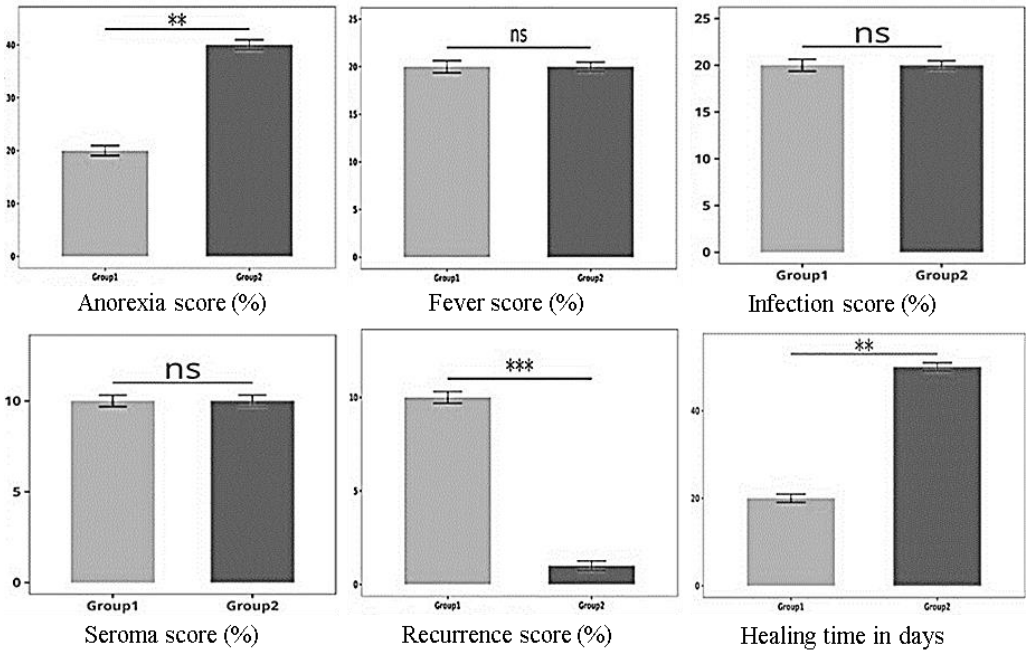

Figure 3: Post operative local and systemic assessments. Means considered significantly different at p value ≤ 0.05.

DISCUSSION

The current study compared the conventional technique of herniorrhaphy to the augmentation of herniorrhaphy with the application of an onlay commercial polyester mesh. All procedures were performed successfully. The hernioplasty procedure was significantly more time consuming than the typical herniorrhaphy procedure, as reported by (Luijendijk *et al.,* 2000). Although sublay-mesh application is recommended in large hernias (Rhemtulla & Fischer, 2018). Results of the current study revealed that onlay-mesh applications to augment suture closure of the hernia are applicable and add value to prevent recurrence. This result is supported by findings in large hernias (Pereira & Gururaj, 2023), or small hernias in humans (Melkemichel *et al.,* 2022) and in cattle (Farman *et al.,* 2018). The lightweight knitted synthetic non-degradable mesh used in the current study, displayed no recurrence, indicating biocompatibility and high tensile strength. Although the mesh was of commercial grade, it showed the ability to be used medically after sterilization without further complications. Similar studies demonstrated the use of mosquito mesh for inguinal hernia in humans (Clarke *et al.,* 2009; Rouet *et al.,* 2018; Sørensen &

Rosenberg, 2012; Stephenson & Kingsnorth, 2011). Folding the mesh into a double layer is thought to improve mesh strength and decrease irritation. A report by Kaya et al. (2020) verified the preferability of dual degradable mesh for hernia repair (Saad *et al.,* 2019). Strong mesh is thought to be more efficient, especially in highly active buffalo calves. Ultrasonographic imaging of the operative site indicated mild edema for up to two months postoperatively and the formation of adequate fibrous tissue. These findings indicate slower long-term healing than scores in traditional herniorrhaphy. Similar results were reported in humans with one week apart (Johansson *et al.,* 1999). Long recovery may be due to irritation and post herniorrhaphy pain (Ergönenç *et al.,* 2017). The application of an onlay-mesh together with herniorrhaphy is designed to provide additional support to the repaired abdominal muscles, thereby preventing recurrence due to potential suture rupture, knot slippage, or failure of the abdominal muscle to heal. A similar idea was demonstrated to prevent further incisional hernia in humans (Tansawet *et al.,* 2020; Van den Dop *et al.,* 2024) and in pigs (Stephens *et al.,* 2023). This method is thought to be considered for buffalo calves, especially in rural areas where accurate and long-term postoperative follow-up can be challenging. We believe that this work is a pioneer for buffalos' calves onlay mesh use along with typical herniorrhaphy, rather than other studies that investigated the onlay mesh application without herniorrhaphy with good recovery rates (Kassam *et al.,* 2014; Kiranjeet *et al.,* 2012). The non degradable prosthetic mesh is almost woven (Cobb *et al.,* 2009; Deeken & Lake, 2017), the mesh used here was knitted with large pores. This study's outcomes showed that knitted wide pore mesh was adequate for the procedure as recommended by Elango *et al.* (2017). However, due to the hydrophilic properties of the polyester mesh used, a non-significant amount of seroma is believed to be recorded for longer periods than in typical herniorrhaphy. Seroma and edema as also reported in equine (Vilar *et al.,* 2009). Ultrasonographic imaging of the operative site in our study revealed the continuation of mild edema for up to two months postoperatively and the formation of adequate fibrous tissue at the surgical site. Klinge and Klosterhalfen (2012) stated that the meshes with large pores reduce the rate of infection as they harbor less infection compared to the small and micro meshes. This statement is aligned with the results of the current study. There is no significant difference between the conventional primary closure technique and use of knitted large-pore polyester mesh. The use of the mesh showed minimal adhesions. Similar findings were previously reported in human, goats, and equines (Cobb *et al.,* 2009; Vilar *et al.,* 2011). The use of knitted commercial polyester mesh is more cost-effective than prosthetic mesh (Stephenson & Kingsnorth, 2011).

CONCLUSIONS

In conclusion, this study compared the augmentation of herniorrhaphy with the onlay application of a double-layer commercial-grade polyester mesh to typical herniorrhaphy. Our findings revealed non-significant differences between the groups, although the mesh application demonstrated technical feasibility. Further research is needed to investigate the sublay and inlay applications of the mesh.

Conflict of interest

The authors declare no conflict of interest.

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التقييم السريري لإصلاح الفتاق السري الكبير في عجول الجاموس باستخدام الشبكة البوليسترية ذات الطبقتين والتثبيت من الخارج

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الفتاقات السرية هي إصابة جراحية شائعة في عجول الجاموس حيث تتنوع أسبابها وطرق علاجها الجراحية. في حين يعتبر اجراء لأم عضلات البطن بخياطتها جراحياً خيارًا جيداً وناجحاً للتنفيذ للفتاقات الصغيرة، الا ان الفتاقات الأكبر حجماً، التي يزيد قطرها عن ثلاثة أصابع تتطلب غالبً استخدام شبكة جراحية لإجراء إصلاح ناجح وخالٍ من الشد على عضلات البطن. جراحياً يمكن تثبيت الشبكة الجراحية داخل البطن او في حواف الفتق او من خارج البطن وتحت الجلد. هدفت هذه الدراسة إلى تقييم فعالية استخدام شبكة منسوجة من مادة البوليستر ذات طبقتين لإصلاح الفتحات السرية في عشرة عجول جاموس بأحجام فتاقات تتراوح من ٨- ١١ سم في القطر من خلال تثبيتها على عضلات البطن من الخارج في منطقة الفتاق وتحت الجلد مباشرة ومقارنة هذه الطريقة بالطريقة التقليدية لخياطة الفتاق. تم إجراء فحص بالموجات فوق الصوتية على فترات مناسبة لتقييم عملية الالتئام بالإضافة الي التقييم السريري. أظهرت الدراسة أن استخدام طبقتين من الشبكة البوليسترية نجح في إصلاح الفتاقات دون أي مضاعفات. كما أن تثبيت الشبكة من الخارج وتحت الجلد تميز بالسهولة وسرعة التنفيذ وبدرجة عالية من الأمان سمح استخدام الشبكة بإجراء إصلاح خالٍ من الشد على عضلات البطن وقلل خطر حدوث مضاعفات او انتكاس الفتاق على عكس المجموعة الأخرى حيث انتكست حالة واحدة. بشكل عام، تسلط هذه الدراسة الضوء على أهمية استخدام شبكة البوليستر ذات الطبقتين وانها مناسبة لإصلاح الفتاقات السرية في عجول الجاموس، خاصة عند التعامل مع كبيرة الحجم منها. حيث انها توفر لأم ناجح وخالٍ من الشد، مما يقلل من خطر حدوث المضاعفات أو الانتكاس وعليه فقد تكون هذه التقنية إضافة مفيدة لإصلاح الفتاق السري الكبير في عجول الجاموس.