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Reconstruction of large ventro-lateral hernia in a buffalo with acellular dermal matrix: a method for treating large hernias in animals - a case report

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KUMAR, N., D. D. MATHEW, A. K. GANGWAR, V. REMYA, M. A. MUTHALAVI, S. K. MAITI, A. K. SHARMA: Reconstruction of large ventro-lateral hernia in a buffalo with acellular dermal matrix: a method for treating large hernias in animals. Vet. arhiv 84, 691-699, 2014.

ABSTRACT

A buffalo, 4 years of age presented with a history of a large swelling in the ventral abdominal region. The case was diagnosed as ventro-lateral hernia. Since the size of the hernial ring was about 15 cm in diameter, hernioplasty was performed using an acellular rabbit dermal matrix. The animal made an uneventful recovery.

Key words: hernia, buffalo, acellular matrix

Introduction

Abdominal wall defects in animals secondary to trauma, infection, or previous surgery are typically large. Surgical correction is the most effective treatment to restore the integrity of the abdominal wall and to prevent incarceration and strangulation of herniated abdominal contents. Tense suture application to approximate and close the defect may lead to wound dehiscence and recurrence of the condition.

Despite improved surgical techniques, repair of these defects is a clinical challenge for veterinary surgeons. Literature on human surgery emphasises the use of prosthetic materials for hernioplasty when the size of the hernial ring exceeds 3 cm in diameter (KINGSNORTH and LEBLANC, 2003; VENCLAUSKAS et al., 2008). Non-absorbable synthetic mesh is one of the most widely used prosthetic materials for reconstruction of abdominal wall hernias. This material allows for a tension free repair, which significantly

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reduces the hernia recurrence rate compared with primary suture repair (BURGER et al., 2004). However, there are many complications in the form of mesh infection, adhesions to underlying viscera, fistula formation, mesh extrusion and foreign body reaction associated with the use of synthetic mesh material for abdominal wall reconstruction (FALAGAS and KASIAKOU, 2005). It has been observed that synthetic degradable materials have not provided sufficient strength during the degradation process (TYRELL et al., 1989). However, natural origin decellularized biomaterials provide sufficient tensile strength (GILBERT et al., 2006).

To overcome these synthetic mesh-related complications, biomaterials, derived from animal sources, may be preferred for the surgical repair of these abdominal wall defects. Biological biomaterials are considered superior to synthetic materials for the repair of abdominal wall defects, owing to their ability to minimise adhesion formation, provide a better framework for fibroblast proliferation and neovascularisation. Moreover, their multidirectional fibrous structure helps in better suture retention, complete absorption and becomes replaced by host tissue (CLARKE et al., 1996). However, biological biomaterials in their native form tend to be more immunogenic and hence are decellularised to minimise their immunogenicity (GILBERT et al., 2006). GULATI and COLE (1994) observed less immunogenicity and better tolerance of acellular grafts in rats and rabbits. Acellular dermal matrix (ADM) grafts have been used by several researchers for the reconstruction of abdominal wall defects in rabbits (GANGWAR et al., 2006; SINGH et al., 2008; EBERLI et al., 2010; NGO et al., 2011) and rats (KAYA et al., 2006) with excellent results. Although results of the preclinical animal studies have been promising, use of acellular dermal grafts for the reconstruction of abdominal hernias in clinical situations is limited. In clinical cases, acellular dermal matrices have been used to repair hernias in goats (KUMAR et al., 2012b) and large ventral hernias in horses (KUMAR et al., 2013).

The present case study describes the successful use of an acellular dermal matrix for the reconstruction of large ventro-lateral hernia in a buffalo, a new method for treating large hernias in animals.

Materials and methods

A buffalo 4 years of age presented to the Surgery Unit of the Referral Veterinary Polyclinic, Indian Veterinary Research Institute, Izatnagar, Uttarpradesh, India with a history of large swelling in the ventral abdominal region on the right side over the past 15 days (Fig.1). According to the owner, the animal fell on a blunt wooden pole one month previously that was used to secure the animal. Since then the swelling had been gradually increasing in size. Palpation at the ventral abdomen revealed a painless, reducible hernia with a discernable ring. The size of the hernial ring was about 15 cm in diameter. The animal was slightly inactive with reduced appetite. Defecation and urination were quite

normal. The case was diagnosed as ventro-lateral hernia and surgical correction of the condition was prescribed. At the time of presentation, the animal had normal temperature, respiration and pulse-rates.

Fig. 1. A large ventro-lateral hernia at the right side of abdominal wall in a buffalo (arrow)

Preparation of ADM. Rabbit skin was decellularised as per the technology filed for patent (Indian Patent Application No. 2148 DEL / 2009) with some modifications. In brief, the skin of the rabbit was collected and immediately preserved in ice-cold sterile phosphate buffered saline (PBS, pH 7.4) containing a broad spectrum antibiotic (Amikacin-1 mg/mL), and a proteolytic inhibitor (0.02% EDTA). In laboratory, it was shaved and washed thoroughly with sterile PBS to remove all the adherent blood and debris. The skin was de-epithelialised using 0.25% enzymes and 2 M sodium chloride solution for 8 hours. After de-epithelisation, the dermis was decellularised using 1% ionic biological detergent for 48 hours. The skin was subjected to continuous agitation in a horizontal orbital shaker, at the rate of 180 rotations per minute during the deepithelialisation and decellularisation process, to provide better contact of tissue with chemicals. To confirm the acellularity of the prepared matrix, microscopic examination was conducted after Haematoxylin and Eosin (H&E) staining of the representative samples. Following decellularisation, the prepared ADM was washed six times (2 hours each) with sterile PBS to remove the residual chemicals and stored in PBS solution containing 0.1% amikacin solution at -200 C. The buffalo was kept off feed for 24 hours and deprived of water for 8 hours prior

to anaesthesia. Meloxicam (0.5 mg/kg body weight) and ceftriaxone sodium (20 mg/kg body weight) were intravenously administered approximately 1 hour prior to surgery.

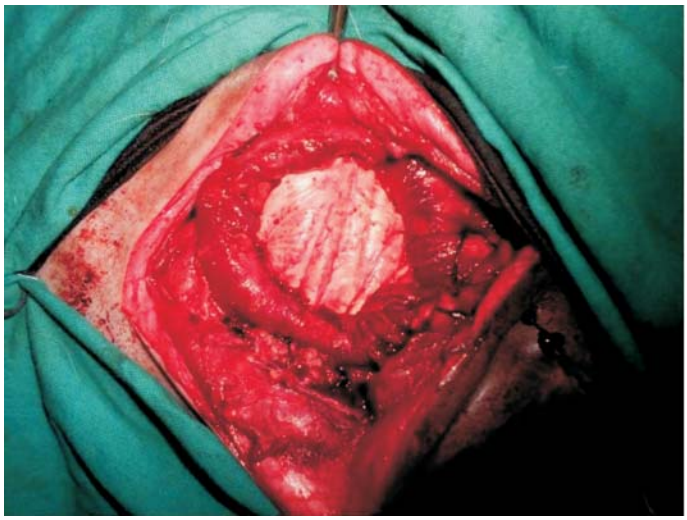

Fig. 2. Application of acellular dermal matrix for closing the hernial ring using inlay technique

Fig. 3. Ventral abdomen was dressed with a sterile bandage to protect the surgical site (arrow)

Fig. 4. On day 45 postoperatively abdominal wall was normal in appearance (arrow)

Surgical methodology. The animal was prepared aseptically for surgery by clipping and shaving the area. The animal was placed in left lateral recumbency, keeping the right side up for the surgery. The surgery was performed under local infiltration analgesia, using a 2% lignocaine solution. To expose the hernial sac, an elliptical skin incision was made that spanned the length of the hernia and extended 2 cm beyond the cranial and caudal margins of the hernial ring. Forcipressure was used to control subcutaneous haemorrhage, if any. The hernial sac was dissected from the overlying skin and dissection was continued laterally to expose the hernial ring and the external sheath of the rectus abdominis muscle. The hernial sac was opened and contents such as the small intestine, omentum, or fat were repositioned into the abdominal cavity. The ADM graft material, exceeding the defect by 2 cm in all directions, was adjusted for adequate closure of the hernial ring. An appropriately sized piece of ADM graft with a pre-placed horizontal mattress suture of number 2 surgical silk with long ends, attached to its cranial, caudal and mid-lateral edges, was introduced into the abdomen through the hernial ring. The ADM was oriented within the abdomen and the suture ends were retrieved on an external sheath of rectus abdominis muscle, using a non-traumatic needle. Each suture was tied with the knots resting on the external sheath of the rectus abdominis muscle, thus provisionally securing the ADM to the peritoneum (Fig. 2). While the graft was being implanted, the surgical site was lavaged periodically with sterile PBS containing 0.1% amikacin. The subcutaneous tissues were closed in two layers, using number 2-0 chromic catgut placed in a simple

continuous suture pattern. The skin incision was then closed using number 2 surgical silk suture material in a horizontal mattress suture pattern. After surgery, the ventral abdomen was compressed with a sterile bandage to protect the surgical site from the external environment and to minimise postoperative oedema (Fig. 3). The wound was dressed daily using povidone iodine solution and application of fly repellent-curative ointment. Injection Cefotaxim and Injection Meloxicam were administered for five post-operative days. The skin sutures were removed on day 15 postoperatively. The animal made an uneventful recovery. On day 45 postoperatively, normal appearance of abdominal wall was observed (Fig. 4).

Results and discussion

The animal recovered from the condition. There were no complications of graft rejection and recurrence. On day 45 postoperatively the abdominal wall was normal in appearance (Fig. 4). The use of synthetic prosthesis for the repair of hernioplasty is a recommended procedure when the hernial ring size is more than 3 cm in diameter. The use of prosthesis helps reduce the tension on the suture line (VENCLAUSKAS et al., 2008; BURGER et al., 2004). The acellular matrices are biologically compatible and they degrade slowly after implantation and are later replaced and remodeled by the host extracellular matrix (PARIENTE et al., 2001). The allogenic/ xenogenic tissue grafts, because of the presence of cells, tend to be immunogenic later, leading to rejection. The acellular matrix is produced by efficiently removing all cellular and nuclear material in order to reduce antigenicity, while minimizing any adverse effect on the composition, biological activity and mechanical integrity of the remaining extra cellular matrix (GILBERT et al., 2006). Among all the protein biomaterials, collagen is potentially useful with its unique biocompatibility and biodegradable properties (LIN and LIU, 2007). This collagen rich acellular matrix possesses the appropriate mechanical properties and induces appropriate interaction with the host cells, that results in the regeneration of functional tissues (VEZZONI et al., 2001). Acellular dermal grafts have been used for the repair of abdominal wall defects in experimental animals (GANGWAR et al., 2006) as well as in clinical cases in goats (KUMAR et al., 2012b) and horses (KUMAR et al., 2013).

The abdominal wall hernia was successfully repaired with a ADM graft using this technique. The animal had an uneventful recovery without clinical signs of wound dehiscence, infection, or recurrence of hernia, except for a mild inflammatory oedema during the first week after surgery. The oedema reduced as the healing progressed. The integrity of the ADM graft was never lost or rejected up to at least 6 months after hernioplasty. Acellular tissue matrices are biocompatible, slowly degrade upon implantation and are replaced and remodelled by the extracellular matrix proteins synthesised and secreted by ingrowing host cells (PARIENTE et al., 2001). ELCE et al.,

(2005) reported a relatively high incidence of post-operative complications associated with retroperitoneal placement of a synthetic mesh material, such as tearing of the internal abdominal oblique muscle and incisional swelling and drainage. However, in the present study, no post-operative complications were observed after retroperitoneal placement of ADM, up to at least 6 months after their repair. Similar results were reported by KUMAR et al. (2012a) following the use of acellular aortic matrix for reconstruction of abdominal hernias in buffaloes. The acellular matrix possesses the appropriate mechanical properties and induces appropriate interaction with the host cells that results in the regeneration of functional tissues (VOYTIK-HARBIN et al., 1998).

Conclusion

The present study revealed that an acellular dermal matrix proved to be a good biocompatible biomaterial having good tensile strength for the reconstruction of hernia. The matrix can be used clinically in other species of animals.

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SAŽETAK

Bivol u dobi od četiri godine bio je primljen sa znakovima velike otekline u ventralnom abdominalnom području. Postavljena je dijagnoza ventrolateralne kile. Budući da je veličina hernijalnog prstena bila promjera oko 15 cm, provedena je hernioplastika primjenom kunićjeg acelularnog dermalnog matriksa. Životinja se oporavila bez komplikacija.

Ključne riječi: bivol, kila, liječenje