POLYPROPYLENE MESH FOR THE REPAIR OF EXTERNAL ABDOMINAL HERNIA IN BUFFALOES: CLINICAL, HEMATOLOGICAL, BIOCHEMICAL AND ERYTHROCYTIC ANTIOXIDANTS FINDINGS

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ABSTRACT

This study was undertaken to investigate the effectiveness of polypropylene mesh (PPM) for the repair of external abdominal hernias in buffaloes. PPM was used for the repair of external abdominal hernias in ten Jaffarabadi buffaloes having mean weight of 388.5 kg and mean hernial ring size of 117.279 cm^2. Clinical, hematological, biochemical and erythrocytic antioxidants parameters were evaluated before and on post-implantation days 7 and 15 to assess efficacy of the repair. With the exception of one case, healing was uneventful. Hematological, biochemical and erythrocytic antioxidants findings were unremarkable. Polypropylene mesh shows excellent repair efficiency for external abdominal hernia repair in buffaloes without serious complications.

Keywords: *Bubalus bubalis*, buffaloes, abdominal hernias, antioxidants, polypropylene mesh

INTRODUCTION

External abdominal hernias are fairly common surgical condition of buffaloes. It results from trauma or weakness of abdominal muscles (Kingsnorth and LeBlanc, 2003). The only effective treatment is surgery to restore the integrity of such defects and prevent incarceration and strangulation of herniated contents (Ober *et al*., 2008). Tight suturing to approximate and close defects exceeding 3 cm in diameter can lead to wound dehiscence, recurrence and non-healing (Matthews *et al*., 2003). A prosthetic material is required to achieve a tension-free closure and reduction in postoperative pain, length of recovery period and hernia recurrence rates (Amid, 1997). In animals, various types of synthetic meshes have been used with varying results (Moorman and Jann, 2009; Singh *et al*., 2012; Kumar *et al*., 2014; Giusto *et al*., 2016). In this study, yet another synthetic polypropylene mesh was evaluated for the repair of external abdominal hernias in buffaloes.

MATERIALS AND METHODS

Animals

The study was conducted on ten buffaloes clinically affected with abdominal hernias (Figure 1A and 1C). The breed, sex, and age of the animal,

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the location and cause of the hernias, and the size of the external abdominal hernia are given in Table 1. Mean weight of animals was 388.5 kg, and mean age 51.9 months. Presence of hernias was confirmed by palpation, radiographic and ultrasonographic examinations. Mean size of the hernial ring was 117.279 cm^2 (calculated using formula πr^2, where r is radius of the hernial ring). All owners granted written informed consent prior to hernioplasty.

Surgery and implantation

Preoperatively, an intramuscular injection of antibiotic (10 mg/kg amoxicillin-sulbactum) and analgesic (0.3 mg/kg meloxicam) was administered to each buffalo. Animals were sedated with an intravenous injection of 0.2 mg/kg diazepam and positioned in dorsal or lateral recumbency depending upon location of hernias. Circular infiltration analgesia around the hernia was performed using 2% lidocaine hydrochloride and surgical site was aseptically prepared. The hernial sac was exposed through an elliptical skin incision and separated from the overlying skin. Dissection was continued laterally to expose the hernial ring and the external sheath of the rectus abdominis muscle. The unopened, isolated hernial sac was inverted into the abdomen. A space was created by separating the parietal peritoneum from the internal sheath of the rectus abdominis muscle. An appropriately sized PPM (Dolphin, Futura Surgicare Pvt. Ltd., Bangalore, India) with preplaced horizontal mattress nylon sutures with long ends was introduced between a parietal peritoneum and internal sheath of the rectus abdominis muscle. After orientation of the mesh, the suture ends were retrieved using a non-traumatic needle. Each of the sutures was tied with knot resting on the external sheath of the rectus abdominis muscle (Figure 1B). Similar procedure was followed for ventro-lateral hernioplasty with exception of introduction of mesh between parietal peritoneum and transverse abdominis muscle and tying of knots on the external abdominis muscle (Figure 1D). Excess skin was excised and subcutaneous tissues were closed in standard fashion using number 2 chromic catgut. The skin incision was then closed using number 2 nylon suture material in a horizontal mattress suture pattern.

Postoperatively, the ventral abdomen of each animal was moderately compressed with a sterile bandage to protect the surgical site from the external environment and to minimize postoperative edema. Animals were continued on the antibiotic (amoxicillin-sulbactum combination 10 mg/kg once a day intramuscularly) for five days and analgesic (meloxicam 0.3 mg/kg once a day intramuscularly) for further three days. The bandage was replaced daily for 12 days, at which time the suture line was dressed with dilute povidone iodine solution. Sutures were removed 12 days after surgery, when cutaneous wound showed normal healing. Further evaluation was carried out on the basis of following parameters.

Clinical evaluation

Body temperature, and as well as respiratory, heart and pulse rates were recorded before and on post-implantation day 7 and 15. In addition, animals were observed daily for local or systemic complications, including dehiscence, infection and recurrence at least up to 6 months.

Hematological evaluation

The complete blood count (CBC) and erythrocyte sedimentation rate (ESR) were performed evaluated before and on post-implantation day 7 and 15. Hematological parameters like hemoglobin (Hb), packed cell

volume (PCV), total erythrocyte count (TEC), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), total leukocyte count (TLC), differential leukocyte count and platelet count were estimated using automated hematology analyzer (Abacus Junior Vet 5, Diatron, Hungary). ESR was estimated manually using Wintrobe's method.

Biochemical evaluation

Serum biochemical parameters were estimated before and on post-implantation day 7 and 15. Total protein (TP), albumin, glucose, aspartate aminotransferase (AST), alanine aminotransferase (ALT), lactate dehydrogenase (LDH), alkaline phosphatase (ALP), creatine kinase (CK), creatinine, cholesterol, triglyceride, high-density lipoprotein (HDL), low-density lipoprotein (LDL), urea, urea nitrogen, and gamma-glutamyl transferase (GGT) levels were measured by standard absorptive spectrophotometric methods using commercial test kits supplied from Diatek (India) with an automatic serum biochemical analyzer (Dia-CHEM 240 plus, China). Albumin-globulin ratio (A:G) was calculated mathematically from estimated albumin and total protein contents from sera.

Antioxidants evaluation

Erythrocytic antioxidants were estimated before and on post-implantation days 7 and 15. One milliliter of erythrocytic hemolysate was prepared from 20 µL of heparinized blood by adding 980 µL of 1X RBC lysis buffer (Himedia, Mumbai, India). Reduced glutathione (GSH) concentration in erythrocytic hemolysate was determined using published method (Ellman, 1959). Catalase activity in erythrocytic hemolysate was estimated spectrophotometrically using double beam UV spectrophotometer (UV2900, Fusiontek, China) at wavelength of 240 nm after appropriate dilution, as described by Aebi (1984). Decomposition of H_2O_2 was followed directly by the decrease in absorbance per minute and it was taken as a measure of the catalase activity.

Statistical analysis

Data were analyzed by one way analysis of variance. Results were expressed as the mean ± standard error (SE) of mean. The pair-wise comparison of means was carried out using Tukey's multiple range test. A difference with value $P<0.05$ was considered statistically significant.

RESULTS AND DISCUSSION

Clinical evaluation

Body temperature, and as well as respiratory and heart rates did not change significantly ($P>0.05$) on day 7 and 15 as compared to their respective day 0 values. All the animals remained slightly anorexic and dull for first 2 days after the operation. Food and water intake were normalized by the postoperative day 3. Polypropylene mesh was either implanted between parietal peritoneum and internal sheath of the rectus abdominis muscle (in 5 buffaloes) or between parietal peritoneum and transverse abdominis muscle (in 5 buffaloes) without serious complication. With the exception of buffalo number 10, in all the buffaloes surgical wounds healed by primary intention. Swelling was recorded on postoperative day one, and thereafter swelling at the operated site continued to decrease gradually and completely subsided on day

7. Neither signs of infection nor excessive tissue reactions were seen at any time commit postoperatively. However, in buffalo number 10 suture breakdown due to swelling and visualization of implanted mesh at surgical site was observed on day 7. This resulted in persistent sinus and pus discharge. Health status of animal was further detoriated and died on post-implantation day 20. A telephone survey carried out six months postoperatively indicated that all the nine animals were in good health and performing well. Our results were similar to that of published reports after use of polypropylene mesh for hernioplasty in horses and cattle (van der Velden and Klein, 1994; Moorman and Jann, 2009; Giusto *et al*., 2016). Uncomplicated healing observed in the present study might be due to inert nature of polypropylene mesh.

Hematological evaluation

Hematological findings of buffaloes with PPM implant on day 0, 7 and 15 are shown in Table 2. We observed nonsignificant ($P>0.05$) change in Hb, PCV, TEC, MCV, MCH, MCHC, TLC, lymphocytes, monocytes, neutrophils, basophils, eosinophils and platelet count on day 7 and 15 as compared to preoperative (day 0) value. However, the ESR value was significantly ($P<0.05$) increased on postoperative day 7 as compared to preoperative (day 0) value. ESR is generally increased in response to inflammation. In the present study, a significant increase in ESR value on postoperative day 7 might be due to surgical trauma induced inflammation.

Biochemical evaluation

Serum biochemical findings of buffaloes with PPM implant on day 0, 7 and 15 are shown in Table 3. Serum total protein, albumin, globulin, A:G, glucose, urea, urea nitrogen, creatinine, cholesterol, triglyceride, HDL, LDL, ALP, LDH, CK, ALT, AST and GGT level did not changed significantly ($P>0.05$) on day 7 and 15 as compared to their day 0 value, indicating uncomplicated healing.

Antioxidants evaluation

GSH level and catalase activity in erythrocytic hemolysate of buffaloes with PPM implant on day 0, 7 and 15 are shown in Table 4. GSH and catalase act as important antioxidant enzymes in mammalian erythrocytes. The catalytic activity of these enzymes allows transformation of superoxide anion (O_2^-) into hydrogen peroxide and water, thereby reducing formation of free radicals and related oxidative stress (Preville *et al*., 1999). We observed nonsignificant ($P>0.05$) changes in GSH level and catalase activity in erythrocytic hemolysate of buffaloes with PPM implant on post-implantation days compared with pre-implantation value, indicating absence of oxidative stress following implantation.

CONCLUSION

Polypropylene mesh shows excellent repair efficiency and biocompatibility for external abdominal hernia repair in buffaloes without serious complications.

Figure 1. A: Preoperative appearance of umbilical hernias in buffaloes.
B: Intraoperative images showing PPM placement between parietal peritoneum and internal sheath of the rectus abdominis muscle, and sutures knot resting on external sheath of the rectus abdominis muscle.
C: Ventro-lateral hernias in buffaloes.
D: Introduction of PPM between parietal peritoneum and transverse abdominis muscle and tying of knots on the external abdominis muscle.

Table 1. History, types, side, ring size and contents of cases with hernia.

Sr. no.	Breed	Age (months)	Sex	Weight (Kg)	Type of hernia	Ring size (cm^2)	Contents
1	Jaffarabadi	08	F	125	Umbilical	63.585 (r = 4.5 cm)	Intestine
2	Jaffarabadi	60	F	500	Ventral	113.04 (r = 6 cm)	Intestine
3	Jaffarabadi	72	F	450	Left ventro-lateral	78.5 (r = 5 cm)	Intestine
4	Jaffarabadi	10	F	150	Umbilical	28.26 (r = 3 cm)	Intestine
5	Jaffarabadi	03	F	60	Umbilical	78.5 (r = 5 cm)	Intestine
6	Jaffarabadi	84	F	550	Right ventro-lateral	153.86 (r = 7 cm)	Intestine
7	Jaffarabadi	72	F	500	Right ventro-lateral	78.5 (r = 5 cm)	Intestine
8	Jaffarabadi	96	F	575	Ventral	200.96 (r = 8 cm)	Intestine
9	Jaffarabadi	30	M	400	Right ventro-lateral	176.625 (r = 7.5 cm)	Intestine
10	Jaffarabadi	84	F	550	Right ventro-lateral	200.96 (r = 8 cm)	Intestine

Table 2. Hematologic findings (mean ± SE) in buffaloes with PPM implant on day 0, 7 and 15.

Sr. no.	Parameters	Day		
		0	7	15
1	Hemoglobin (g/dL)	11.96±0.46^{a}	12.01±0.49^{a}	12.00±0.39^{a}
2	PCV (%)	35.87±1.36^{a}	40.41±3.17^{a}	35.99±1.16^{a}
3	TEC (x10^{6}/µL)	11.27±0.58^{a}	12.63±1.38^{a}	12.51±0.40^{a}
4	MCV (fL)	48.4±3.26^{a}	47.2±3.61^{a}	44.7±3.28^{a}
5	MCH (pg)	13.59±0.75^{a}	14.00±0.49^{a}	13.37±0.52^{a}
6	MCHC (g/dL)	29.16±1.28^{a}	30.05±1.48^{a}	30.42±1.07^{a}
7	TLC (x10^{3}/µL)	13.03±0.79^{a}	12.36±1.75^{a}	16.25±1.43^{a}
8	Lymphocytes (%)	56.64±4.89^{a}	52.85±5.0^{a}	61.38±4.74^{a}
9	Monocytes (%)	3.68±0.42^{a}	3.57±0.59^{a}	3.76±0.40^{a}
10	Neutrophils (%)	39.14±5.97^{a}	42.68±6.38^{a}	34.49±3.51^{a}
11	Basophils (%)	0.05±0.03^{a}	0.03±0.03^{a}	0.00±0.00
12	Eosinophils (%)	0.46±0.04^{a}	0.46±0.07^{a}	0.44±0.08^{a}
13	Platelets (x10^{3}/µL)	331.20±34.16^{a}	325.00±18.70^{a}	350.0±29.94^{a}
14	ESR (mm/h)	49.20±6.11^{ab}	60.70±8.70^{b}	35.00±4.47^{a}

Small superscript (alphabet) indicates level of significance ($P<0.05$) at different intervals.

Table 3. Biochemical findings (mean ± SE) in buffaloes with PPM implant on day 0, 7 and 15.

Sr. no.	Parameters	Intervals		
		0 day	7 day	15 day
1	Total protein (g/dL)	6.60±0.29[a]	7.04±0.33[a]	7.05±0.30[a]
2	Albumin (g/dL)	2.57±0.03[a]	2.53±0.09[a]	2.63±0.10[a]
3	Globulin (g/dL)	4.03±0.29[a]	4.51±0.30[a]	4.42±0.29[a]
4	A:G ratio	0.67±0.051[a]	0.58±0.043[a]	0.62±0.053[a]
5	Glucose (mg/dL)	92.10±12.51[a]	95.80±11.65[a]	96.90±10.26[a]
6	Urea (mg/dL)	44.74±6.13[a]	39.35±4.67[a]	46.52±5.24[a]
7	Urea nitrogen (mg/dL)	20.91±2.87[a]	18.39±2.18[a]	21.73±2.45[a]
8	Creatinine (mg/dL)	1.45±0.11[a]	1.55±0.08[a]	1.65±0.14[a]
9	Cholesterol (mg/dL)	157.0±9.54[a]	140.0±17.43[a]	143.4±18.36[a]
10	Triglyceride (mg/dL)	31.5±9.54[aA]	30.6±5.17[aA]	38.6±5.79[aA]
11	HDL (mg/dL)	49.04±2.18[a]	39.49±4.54[a]	70.32±28.44[a]
12	LDL (mg/dL)	34.98±3.12[a]	31.82±4.05[a]	30.15±3.97[a]
13	ALP (IU/L)	145.76±24.03[a]	97.23±20.44[a]	130.82±37.29[a]
14	LDH (IU/L)	1276.29±161.59[a]	1270.13±186.68[a]	1560.14±229.49[a]
15	CK (IU/L)	807.48±192.03[a]	581.83±168.11[a]	705.54±208.77[a]
16	ALT (IU/L)	45.3±6.38[a]	38.61±7.89[a]	55.69±9.80[a]
17	AST (IU/L)	150.05±10.84[a]	163.04±17.85[a]	184.89±32.56[a]
18	GGT (IU/L)	7.18±1.05[a]	5.67±0.82[a]	7.06±0.89[a]

Small superscript (alphabet) indicates level of significance (P<0.05) at different intervals.

Table 4. Erythrocytic antioxidants levels (mean ± SE) in buffaloes with PPM implant on day 0, 7 and 15.

Sr. no.	Antioxidants	Intervals		
		0 day	7 day	15 day
1	GSH (mmol/L)	4.59±0.53[a]	4.71±0.64[a]	6.27±1.09[a]
2	Catalase (U/ml)	3.89±0.48[a]	3.83±0.43[a]	4.39±0.71[a]

Small superscript (alphabet) indicates level of significance (P<0.05) at different interval.

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