MORBIDITY IN NIGERIAN LOCAL CATS AFTER ILEOCOLIC VALVE OR ILEOCOLIC VALVE AND ILEAL RESECTION

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Abstract

The morbidity of excision of the ileocolic valve (Group A), and the ileocolic valve with thirty percent (30%) distal ileal segments (Group B) were evaluated and compared in six adult local cats anaesthesized with xylazine (1.4mg/kg) and ketamine hydrochloride (22mg/kg). A non-significant fall ($P > 0.05$) in the haemogram (PCV, Hb, RBC, and WBC), total serum proteins (albumin and globulin) and body weights were recorded among cats in groups A and B, following six weeks of post-operative monitoring. Samples of feces from both groups were non-bloody, non-mucoid and have normal to soft consistency with evidence of improvement over time. The improvement in fecal consistency, body weight and haematological picture over the period of post-operative management was adjudged to be consistent with adaptive changes in the residual intestinal segments. The observed clinical features are discussed in relation with those of massive intestinal resection in cats, dogs and humans. It was concluded that ileocolic valve resection produced little or no detrimental effects on bowel functions of local cats, and local cats could tolerate ileocolic valve with thirty percent (30%) distal ileal resection provided the proximal intestinal segments are intact.

Introduction

Ileocolic valve and distal ileal resections are indicated in surgical management of intussusceptions (Joy and Patterson, 1978; Garcia *et al.*, 1997; Brown and Dibaise 2004; Eyarefe *et al.*, 2008), strangulation obstructions (Pyne and Jones 1993; Fernando *et al.*, 2009), tumours (Barker *et al.*, 1993), and colonic obstructions (Bright, 1998), in animals and man (Gruessner and Sharp, 1997; Villengas-Alvarez *et al.*, 1997). The ileocolic valve is generally known to delay the transit time of ingesta (Argenzio, 1993), prevents movement of colonic contents retrograde, and reflux of bacteria from the colon into the small intestine (Verga *et al*, 1996; Herdtz, 1997). Therefore its resection could result in diarrhoea with concomitant fluid and electrolyte loss. Also, the receptor for vitamin B_{12} intrinsic factors are concentrated in the ileum (Barker *et al.*, 1993), and located in the brush border of the ileal enterocytes (Johnson, 1997). The ileum therefore is generally involved in the absorption of bile salt, bile acid and vitamin B_{12} (Spiro, 1970; Barker *et al.*, 1993; Johnson, 1997). Vitamin B_{12} and folic acid are important in haemopoiesis, especially in red blood cell nuclear maturation (Ettinger, 1995). Ileal resection may therefore affect haemopoiesis and result in aneamia. These functions of ileocolic valve and the ileal segments had made surgeons to exercise caution in their excision. However, since the ileum is less metabolically active than the jejunum, it might be expected to possess greater adaptive capabilities than the jejunum (Spiro, 1970). Studies in man have postulated the safe excision of the ileocolic valve in children (Verga *et al.*, 1996). Currently, opinions vary on the need to preserve the ileocolic valve in the treatment of feline megacolon by subtotal colectomy (Bright, 1998). This study was therefore designed to evaluate the effects of ileocolic valve, plus 30% distal ileal resection, as there is a dearth of information on the morbidity of this procedure in local cats in Nigeria.

Materials and Methods

Experimental Animal

Six adult local cats with body weights ranging between 1.7kg and 2.3kg were used. They were household pets kept for hunting rats. Cats were housed in the cattery unit of the Veterinary Teaching Hospital, University of Ibadan, Ibadan, Nigeria, and fed with a local diet formulation of cooked fish, maize starch and palm oil, and provided with clean water *ad libitum*. The animals were dewormed with mebendazole (22mg/kg) and praziquantel (15mg/kg) per os. Oxytetracycline (14mg/kg) was administered for five days against bacteria and haemoprotozoans infections and acclimatized for six weeks. They were confirmed healthy based on the results of physical and clinical examinations before the commencement of the experiment. The trial was carried out in accordance with the guidelines for care and use of experimental animals established by the ethical committee of the University of Ibadan.

Experimental Design

A simple design involving six local cats randomized into two trial groups to evaluate the effects of ileocolic valve resection (group A, n= 3), and ileocecal valve with thirty percent (30%) distal jejuno-ileal resection (group B, n=3) on haematology, serum protein and bowel functions was carried out .

Anaesthetic Protocol

On the day of the experiment, each cat was weighed and premedicated with (0.1%) atropine sulphate and (2%) xylazine (Chelazine® Chenelle pharmaceutical, United Kingdom) at intramuscular dose rates of 0.04 mg/kg and 0.4 mg/kg body weight respectively.

Ten (10) minutes later, surgical anaesthesia was induced with 5% ketamine hydrochloride (ketamine® Hans-Lembeke pharmaceutical, Germany) through the intramuscular route at a dose rate of 22 mg/kg body weight. Supplemental doses of the anaesthetic agents were injected as required in the course of the surgical procedure.

Operative Procedure

The ventral abdomen of the anaesthesized cat was prepared routinely for aseptic surgery. Through a ventral midline coeliotomy, the small intestine was exteriorized and the ileocolic junction identified.

The ileocolic valves of cats in Group A (ileocolic valve resection alone) were excised as described by Gazet, (1964). Continuity of the residual intestinal segments was ensured through an end to side anastomosis as described by Ellison, (1998). The small intestine of cats in Group B (Ileocolic valve with 30% distal jejuna-ileal segment) was measured and resected. The resected lengths were calculated from percentage of measured intestinal length, and the anastomoses done as earlier described (Eyarefe *et al.*, 2001). The abdominal incision was closed routinely and postoperative management of both groups was carried out as indicated for patients with intestinal resection, (Joy and Patterson, 1978; Eyarefe *et al*, 2008).

Measurements

Five milliliters (5ml) of venous blood was collected via the jugular venupuncture from each animal into plain tubes and those containing ethylene diamine tetraacetic acid (EDTA) to obtain serum and blood samples respectively. The samples were collected before surgery (day 0), and at day 5, 10, 15, 20 post surgery and then processed. Packed cell volume (PCV), Haemoglobin (Hb) concentration, Red blood cell (RBC) and total leucocyte (WBC) values were determined as described by Jain, (1986).The mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) were calculated from the PCV, Hb concentration and RBC counts (Jain, 1986). Five hundred WBC were differentiated on Giemsa-stained thin blood smears and absolute values calculated from their percentile distribution using total white blood cell counts. Globulin and albumin/globulin ratio were determined as described by Coles (1986). The body weights were determined with a weighing balance (Model MP 25, CMS weighing equipment Ltd, England) at 5 days intervals for 30 days. The presence or absence of pyrexia was determined with a rectal digital thermometer (AAA medical equipment and hospital supplies Ltd, England) while appetite and fecal characteristics were scored as earlier described (Eyarefe *et al.*, 2001).

Data Analysis

The mean of values obtained from blood haemogram and serum proteins, and body weights from day zero (pre-operation) were compared with those of post operative days using Student's t and Duncan's multiple range tests at 95% ($p < 0.05$) levels of confidence.

Results

Clinical observations

Pyrexia: Fever was absence in both groups studied. All the cats maintained their body temperatures within the normal range for local cats (Table 1).

Appetite

Cats in group A maintained normal appetite after an initial mild increase in appetite in the first two weeks post-resection while those in group B had increased appetite throughout the study period (Table 1).

Diarrheoa

There was mild to moderate increase in faecal volume in the first and second weeks. This was higher in the Ilçal and Ileocolic valve Resection (IIVR) than in Ileocolic Valve Resection alone (IVR). IVR produced a temporary alteration in faecal volume between days 1 and 9, while IIVR produced mild yellowish diarrhoea which lasted for a longer duration (Table 1 and 2).

Blood, mucous, undigested food particles

Blood, mucous, undigested food particles were absent in the faeces of both groups (Table 1).

Feacal Colour

Group A cats passed green faeces only in the first week while group B cats passed yellow for a longer period (Table 1).

Haematology

There was a gradual fall in the haematological values of groups A and B in the first 2 weeks and a gradual increase thereafter. However, the mean of these parameters as well as MCV and MCHC were within normal range for tropical cats (Table 3 and 4). The IIVR group however had a leukocytic (especially neutrophilic) response (Table 4).

Body weight changes

There was a mild fall in body weight of both groups following surgery. This was more severe in group B than in group A. Cats in group A, regained their initial body weight within the period of the study, while cats in group B had a gradual increase in body weight but could not regain their initial body weight within the period of the study (Table 5).

Table 1: Post-operative clinical observations and faecal characteristics of groups A and B cats

Weeks →	Groups	0	1st	2nd	3rd	4th	5th	6th
Fever (T°)	A	-	-	-	-	-	-	-
	B	-	-	-	-	-	-	-
Increased Appetite	A	-	+	+	-	-	-	-
	B	-	+	+	+	+	+	+
Fecal Characteristics		0	1st	2nd	3rd	4th	5th	6th
Diarhoea	A	-	++	+	-	-	-	-
	B	-	+	+	+ / -	+ / -	+ / -	+ / -
Blood	A	-	-	-	-	-	-	-
	B	-	-	-	-	-	-	-
Mucous	A	-	-	-	-	-	-	-
	B	-	-	-	-	-	-	-
Undigested food particles	A	-	-	-	-	-	-	-
	B	-	-	-	-	-	-	-
Colour	A	Normal	Green	Normal	Normal	Normal	Normal	Normal
	B	Normal	Yellow	Yellow	Normal/ Yellow	Normal/ Yellow	Normal/ Yellow	Normal/ Yellow

Legend
+ = present
+0 = Absent

Table 2: Faecal consistency scores in groups A and B cats

Days	0	1-3	4-5	7-9	10-12	13-15	16-18	19-21	22-24	25-27
A	1	3	3	2	1	1	1	1	1	1
B	1	4	3	4	3	3	1,3	1,3	1,3	1,3

Legend
1 = Normal, solid, well-formed faeces like pre-operative
2 = Well-formed faeces, but not solid like pre-operative
3 = Pasty soft faeces
4 = moderately watery faeces

Table 3: Haemotological and serum protein changes in group A cats

Days	0	5	10	15	20
PCV (%)	35.00 ± 1.53^{ab}	23.33 ± 0.33^{c}	27.00 ± 0.58^{bc}	28.00 ± 0.00^{bc}	29.33 ± 0.33^{ab}
RBC ($X10^6/\mu l$	7.8 ± 49^{ab}	4.67 ± 0.09^{c}	5.6 ± 0.12^{bc}	6.0 ± 0.12^{bc}	6.37 ± 0.15^{ab}
Hb (mg/ μl)	11.50 ± 0.51^{ab}	7.60 ± 0.29^{c}	8.33 ± 0.03^{bc}	8.527 ± 0.03^{bc}	9.57 ± 0.034^{ab}
MCV (fl)	45.57 ± 0.21^{ab}	50.0 ± 0.64^{a}	48.2 ± 0.02^{ab}	46.44 ± 0.94^{ab}	46.10 ± 0.72^{ab}
MCHC (g/dl)	32.85 ± 06^{a}	32.58 ± 1.34^{a}	30.89 ± 0.56^{ab}	30.60 ± 0.12^{ab}	32.61 ± 0.97^{a}
Total WBC ($X10^3$/ml)	7.73 ± 0.74^{c}	5.10 ± 1.50^{c}	9.90 ± 1.27^{c}	$7.67 \pm 1.33b^{c}$	7.70 ± 0.82^{c}
Seg.neutrophil ($X10^3/\mu l$)	3.87 ± 0.37^{a}	3.11 ± 0.92^{a}	4.98 ± 1.19^{a}	$4.20 \pm .063^{a}$	4.38 ± 0.37^{a}
Lymphocytes ($X10^3/\mu l$)	3.79 ± 0.36^{a}	1.95 ± 0.56^{b}	4.48 ± 0.50^{c}	3.42 ± 0.75^{a}	2.94 ± 0.49^{a}
Eosinophils ($X10^3/\mu l$)	0.07 ± 0.01^{c}	0.06 ± 0.01^{c}	0.10 ± 0.01^{bc}	0.07 ± 0.01^{c}	0.07 ± 01^{c}
Serum Protein					
Total Proteins (mg/ dl)	2.67 ± 0.09^{b}	6.13 ± 0.24^{a}	6.00 ± 0.12^{ab}	5.90 ± 0.06^{ab}	5.87 ± 0.03^{ab}
Albumin (A) (mg/dl)	2.67 ± 0.07^{ab}	2.87 ± 0.15^{ab}	2.87 ± 0.09^{ab}	2.93 ± 0.03^{a}	2.80 ± 0.06^{ab}
Globulins (G) (mg/dl)	3.17 ± 0.12^{abc}	3.27 ± 10.12^{ab}	3.13 ± 0.03^{abc}	2.97 ± 0.03^{c}	3.07 ± 0.03^{abc}
A/G Ratio	0.83 ± 0.09^{bc}	0.088 ± 0.04^{ab}	0.91 ± 0.02^{ab}	0.99 ± 0.01^{a}	0.91 ± 0.03^{ab}

Data presented as mean $\pm$ standard error of mean. Mean values in different columns with different superscripts are statistically significant ($P < 0.05$).

Table 4: Haemotological, and serum protein changes of group B cats

Days	0	5	10	15	20
PCV (%)	38.67 ± 088^{a}	36.67 ± 5.49^{ab}	30.33 ± 2.85^{ab}	27.67 ± 4.06^{bc}	26.50 ± 9.50^{bc}
RBC ($X10^6/\mu l$)	8.63 ± 0.15^{a}	7.50 ± 1.23^{ab}	6.27 ± 0.80^{ab}	5.93 ± 1.0^{bc}	5.64 ± 2.47^{bc}
Hb (g/dl)	12.14 ± 0.77^{a}	11.37 ± 1.71^{ab}	8.53 ± 0.07^{bc}	8.77 ± 1.41^{bc}	8.70 ± 2.90^{bc}
MCV (fl)	45.25 ± 0.71^{ab}	49.23 ± 1.47^{ab}	48.85 ± 2.08^{ab}	47.23 ± 1.74^{ab}	49.04 ± 4.60^{ab}
MCHC(g/dl)	31.34 ± 1.40^{ab}	30.99 ± 0.19^{ab}	28.58 ± 2.41^{b}	31.62 ± 1.01^{ab}	33.11 ± 0.95^{a}
Total WBC ($X10^3/\mu l$)	31.34 ± 1.40^{ab}	30.99 ± 0.19^{ab}	28.58 ± 2.41^{b}	31.62 ± 1.01^{ab}	33.11 ± 0.95^{a}
Seg. Neutrophils ($X10^3/\mu l$)	7.47 ± 1.59^{a}	3.99 ± 0.73^{a}	7.06 ± 2.41^{a}	16.47 ± 10.87^{a}	14.77 ± 5.07^{a}
Lymphocytes ($X10^3/\mu l$)	0.23 ± 0.04^{ab}	0.08 ± 0.01^{c}	0.19 ± 0.03^{abc}	0.27 ± 0.09^{a}	0.30 ± 0.14^{ab}
Eosinophils ($X10^3/\mu l$)	$0.23 \pm .04^{ab}$	0.08 ± 0.01^{c}	0.19 ± 0.03^{abc}	0.27 ± 0.09^{a}	0.30 ± 0.14^{ab}
Serum Proteins					
Total. Proteins (mg/dl)	5.90 ± 0.00^{ab}	5.97 ± 0.12^{ab}	6.07 ± 0.03^{ab}	6.07 ± 0.03^{ab}	6.05 ± 0.05^{ab}
Albumins (A) (mg/dl)	2.90 ± 0.00^{ab}	2.67 ± 0.07^{ab}	2.93 ± 0.03^{ab}	2.97 ± 0.03^{ab}	2.90 ± 0.10^{ab}
Globulins (G) (mg/dl)	3.00 ± 0.00^{bc}	3.30 ± 0.15^{a}	3.13 ± 0.03^{abc}	3.10 ± 0.006^{abc}	3.15 ± 0.15^{abc}
A/G/Ratio	0.97 ± 0.00^{abc}	0.81 ± 0.05^{c}	0.94 ± 0.02^{abc}	0.96 ± 0.03^{abc}	0.92 ± 0.08^{abc}

Data presented as mean ± standard error of mean. Mean values in different columns with different superscripts are statistically significant ($P < 0.05$).

Table 5: Body weight (Kg) changes in group A and B cats

Days	0	5	10	15	20	25	30
A	1.90 ± 0.20^{a}	1.80 ± 0.20^{a}	1.80 ± 0.20^{a}	1.82 ± 0.19^{a}	1.83 ± 0.19^{a}	1.95 ± 0.20^{a}	1.95 ± 0.19^{a}
B	1.78 ± 0.04^{a}	1.65 ± 0.05^{a}	1.65 ± 0.03^{a}	1.65 ± 0.03^{a}	1.65 ± 0.05^{a}	1.73 ± 0.03^{a}	1.73 ± 0.03^{a}

Data are presented as mean ± standard error of mean Mean values in different columns with different superscripts are statistically significant ($P < 0.05$).

Discussion

The severity of the disturbance of the Gastro-intestinal tract (GIT) functions and the overall morbidity following intestinal resection has been linked with the anatomy and physiology of the resected bowel portion, as well as the length of bowel resected (Joy and Patterson, 1978; Williams and, Burrows, 1981). Diarrhoea, weight loss, and changes in blood parameters in IIVR as compared with IVR were observed in this study (Tables 1-5)

Mild to moderate increase in faecal volume was observed in the first week and was higher in IIVR than IVR group (Table 1 and 2). The observed diarrhoea in IIVR and IVR groups was consistent with findings in man after similar resections, (Verga, *et al.*, 1996). IVR produced a temporary alteration in faecal volume from day1- 9, while the mild yellowish diarrhoea produced by the IIVR lasted for a longer duration (Table 1and 2). This suggests that IIVR poses a more serious challenge to GIT function than IVR. The changes in faecal colour following the resection of the ileal segment have been attributed to a compromised bile salt re-absorption (Anderson, 1975), and incompletely metabolized bilirubin due to short transit time of ingesta across the jejunum (Guilford, 1993). The increased colonic level of bile salts may have been important in the causation of the mild to moderate diarrhoea in IIVR due to bile salt induced reduction in water absorption for a longer duration (Mekhjian *et al*, 1971); Barker *et al*, 1993), as well as "jejunal hurry" following ileal resection (Joy and Patterson, 1978, Eyarefe *et al.*, 2001) as a result of the abolishment of the speed breaker effect of the ileocolic valve (Williams and Burrows, 1981). The mild episode of diarrhoea in the IIVR group in comparison with those of massive bowel resected patients (Joy and Patterson 1978; Eyarefe *et al.*, 2001, Eyarefe *et al.*, 2008), may be attributed to the presence of a greater absorptive surface (70% proximal small intestine) in the IIVR group which enabled a better contact time between ingesta (Weser *et al*, 1979, Payne and Jones, 1993), and proximal small intestine mucosal cell brush border, trophic hormones, and pancreatic enzymes which resulted in improved digestion and absorption (Fehlmann, 1978, Williams and Burrows, 1981, Herdtz, 1997). The absence of these factors in massive bowel resected patients has been implicated in the causation of maldigestion and malabsorption, and, severe diarrhoea in these patients (Payne and Jones, 1993, Eyarefe *et al.*, 2001 Brown and Dibaise, 2004, Eyarefe *et al.*, 2008).

Fat malabsorption and steatorrhea although, prominent features in Short Bowel Syndrome (SBS) (Joy and Patterson 1978, Williams and Burrow 1981) was not observed in this study since the jejunal segment where most of the fat is absorbed was intact (Argenzio, 1993).

However, with a continued fecal bile salt loss, and possible liver depletion of bile salt (Williams and Burrows, 1981; Argenzio, 1993), fat malabsorption and fat-soluble vitamin deficiency may follow prolong morbidity (Weser, 1979; Argenzio, 1993).

Bacterial overgrowth associated with IVR excision reported by Barker *et al*, (1993), which would have prolonged the period of diarrhea in both groups was not observed in this study. The IIVR group however had a leukocytic (especially neutrophilic) response (Ettinger, 1995), although values were not significant ($p > 0.05$, Table 3 and 4).

Weight changes have been observed in IVR in cats (Gazet, 1964) and IIVR in rats (Schimpl *et al*, 1999). The weight changes observed in this experiment were not significant ($p > 0.05$, Table 5). Ettinger, (1995) had defined clinical weight loss as loss of up to 10% of the total body weight. None of the animals used in this study lost up to this amount of body weight (Table 5) within the 30 days duration. The initial fall in body weight observed in both groups may be due to catabolic weight loss associated with stress of surgery and wound healing (Gazet, 1964; Ettinger, 1995); and as a direct consequence of the diarrhoea (Eyarefe *et al.*, 2001).

The packed cell volume, red blood cell counts, and haemoglobin concentration of groups A and B followed similar patterns of reduction in the first 2 weeks (Table 3 and 4). However, the mean of these values as well as MCV and MCHC were within normal range for tropical cats as documented by Nottidge *et al.*, (1999). Anaemia is a less consistent finding in massive intestinal resection and SBS (Payne and Jones. 1993). Megaloblastic anaemia, a poorly understood phenomenon associated with maturation defects in vitamin B_{12} and folic acid deficiency (Johnson (1997) was not seen in this study as may be expected with ileal resection. This may be due to the fact that the liver had a stock of vitamin B_{12} to last for a longer period (Johnson, 1997).

The cessation of diarrhoea and improvement of fecal nature, as well as weight gain with time, may have been a result of intestinal adaptation (Williams and Burrows 1981; Eyarefe *et al.*, 2001). Similar adaptation has been observed in human patients following limited ileal resection in infants (Davies *et al* 1999).

Since it is apparently impossible for residual intestine to take on any function for which it had no capacity preoperatively (Joy and Patterson, 1978), adaptation following IIVR may suggest that 30% distal small intestinal resection did not totally remove the ileum, nor abolished ileal function.

Adaptation following loss of the ileocolic valve was rapid (10 days) with respect to the faecal changes. This shows that ileocolic valve resection produces little or, no detrimental effects in the local cats, as observed in man (Verga *et al.*, 1996). Although, resections of the ileal segment and ileocolic valve are important in the pathophysiology of SBS, ileal resection alone may not produce SBS in cats. Also, cats may tolerate ileal resection accompanied by ileocolic valve resection especially when the proximal (jejunal) segment is intact.

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