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A Study on Crop Repair by Using Different Ingluviotomy Techniques in Pigeon

Rashid Hussain[1], Naveed Hussain[1], Nasir Iqbal[1*], Ayesha Sadiq[3], Sadaf Aslam[1], Zubair Luqman[2], Hamza Jawad[2]

[1]Department of Veterinary Surgery and Pet Sciences, University of Veterinary and Animal Sciences, Lahore, Punjab, Pakistan; [2]Faculty of Veterinary and Animal Sciences, The Islamia University of Bahawalpur, Bahawalpur, Punjab, Pakistan; [3]Department of Pathology, University of Veterinary and Animal Sciences, Lahore, Punjab, Pakistan.

Abstract | Pigeons signify the resourceful class of vertebrates. Their crop is a thin muscular expansion of esophagus which temporarily stores food. Traumatic rupture of the filled crop is common because when expanded to skin, even a small concussion can result in its injury. This project was designed to identify the best and reliable technique for crop rupture repair, with least surgical and post-surgical complications. The study was carried out on 30 apparently healthy pigeons weighing between 275 gm to 350 gm. They were divided into three groups i.e. Group A, B and C comprising ten pigeons each and were numbered as A1-A10, B1-B10 and C1-C10. Ingluviotomy techniques were performed group wise as: for group A-Single Layer closure; group B-Double Layer closure and group C-with surgical glue. Clinical parameters were observed at variable intervals from day 1 to day 30 post- surgery. In vital body signs, temperature ($P \leq 0.05$) revealed significant difference between groups whereas pulse rate and respiration showed non-significant difference ($P \geq 0.05$). Liquid, food intake was superior in group B than group A and C; moreover, group C showed better intake than group A. Droppings were initially watery, which gradually converted from semi-solid to normal with passage of time in all groups. Weight gain/loss, ($P \leq 0.05$) revealed significant difference between groups; weight gain was highest in group B, moderate in group C and lowest in group A. Wound healing and leakage evaluations, showed excellent healing with least leakage and associated mortality in group B, whereas groups A and C showed variable leakages with greater mortality in group A than C.

Keywords | Crop, Rupture, Suturing techniques, Surgical glue, Leakage

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***Correspondence** | Nasir Iqbal, Department of Veterinary Surgery and Pet Sciences, University of Veterinary and Animal Sciences, Lahore, Punjab, Pakistan; **Email:** Nasir.iqbal@uvas.edu.pk
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INTRODUCTION

Pigeons signify the well-known and resourceful class of vertebrates. Pigeons have order *Columbiformes* and family *Columbidae* having five subfamilies. It has 42 genera and 308 species (Baptista et al., 1997; Perrins, 2003; Sibley et al., 2001). Their digestive system is smaller in size which plays an important role in flight due to its lighter weight. Anterior digestive system includes beak, esophagus, crop, proventriculus and ventriculus. The crop is an expansion of esophagus and a thin muscular pouch which temporarily stores and softens the food. Stomach can be divided into two chambers proventriculus (glandular stomach) and ventriculus or gizzard (muscular stomach) (Ninu et al., 2019). First food enters in proventriculus, where it receives digestive enzymes, later to gizzard which functions as teeth and breaks down the food to maximize the surface area for chemical digestive processing (Brugger, 1991; Caviedes-Vidal et al., 2007). Esophagus of a pigeon has three segments, which are pre-crop, crop and post-crop. The crop is the dilatation of esophagus, which stores food (Cotton et al., 2017) There may be different forms of the

crops: In chicken, crop is of simple spindle shaped and has one pouch but in pigeons it has two pouches. Entrance to the crop is controlled by a sphincter that opens only after the ventriculus is filled (Sladakovic et al., 2017). The epithelium of the pigeon's digestive system is made up of the endoderm (Matsushita, 1996).

After swallowing food enters the crop where storage of food occurs and is also kept warm and moist allowing amylases and related enzymes to be released which help in pre-digestion and softening of food (Kierończyk and Bartosz, 2016). From crop, food is slowly passed to the proventriculus which is first part of the stomach. Here HCl is released by parietal cells which lowers pH and converts pepsinogen to its active form pepsin that is used to break down proteins (Kumar et al., 2016). Then food is passed into the last portion of stomach i.e. gizzard where food further breaks down by muscular churning. Afterwards, via pyloric sphincter food enters into the duodenum, where pancreas secretes enzymes like lipases, amylases and nucleases by pancreatic duct which helps in breakdown of triglycerides, glycogen, and nucleic acids, respectively. Due to absence of gall bladder in pigeons, liver passes bile directly into small intestine, which helps to emulsify fat. Eventually food is passed to large intestine which is short portion and acts as connection between small intestine and cloacae, where waste is excreted. Rupture of the crop due to injury is very common in pigeons because when crop is filled with food, it expands and touches the skin, then even a small concussion can result in its injury. Trichomoniasis lesion sometimes may be the cause of the rupture. Young ones are more susceptible to rupture due to ingestion of foreign objects, especially if they are underfed. Palpation of a persistent lump in the crop, food retention, delayed crop emptying and regurgitation are associated clinical signs. The definitive signs and diagnosis can be reached by biopsy or flexible endoscope (Hernandez-Divers et al., 2007). Crop rupture in neonates which are being hand-feed, may occur due to penetration from improper or careless gavage tube feeding. Feeding tube associated ruptures are frequently reported emergency cases now a day at most pet clinics, which should be treated at earliest because the bird will not be able to eat or drink due to this injury. The defects should be thoroughly cleaned and sutured well in time (Stocker, 2013).

Keeping in mind the crop related surgical anomalies and bird owners sentiments that are eagerly looking for most suitable crop-rupture repairs, this project has been designed to identify the best and reliable crop repair technique, with least surgical and post-surgical complications.

Table 1: Comparative mean values of temperature for group A, B And C.

Days	Temperature (°F)		
	Group A	Group B	Group C
	Mean ± S.D	Mean ± S.D	Mean ± S.D
1	108.14± 0.76	107.52 ± 0.76	108.65± 0.89
3	108.84± 0.61	107.02 ± 0.53	107.97± 0.80**
5	108.54± 0.74*	106.93± 0.33	107.64 ± 0.97
10	108.14± 0.86*	106.85± 0.49	107.34± 0.74**
15	107.84± 1.19*	106.91± 0.52	107.17± 0.88
20	107.20± 1.25	106.70± 0.38	106.92± 0.67
25	106.85± 0.83	106.34± 0.40	107.07± 0.71
30	106.71± 1.23	106.37± 0.55	107.13± 0.95

*Dead bird of group A. ** Dead bird of group C.

Table 2: Comparative mean values of pulse for group A, B and C.

Days	Pulse (Beats / min)		
	Group A	Group B	Group C
	Mean ± S.D	Mean ± S.D	Mean ± S.D
1	181.4±5.80	180.2±4.82	180.6±5.68
3	178.7 ± 5.39	178.8 ± 4.59	178.8 ± 5.34**
5	176.9 ± 6.48*	181.4 ± 5.81	175.6 ± 5.57
10	178.2 ± 5.63*	178.6 ± 4.52	177.9 ± 4.80**
15	172.6 ± 5.12*	179.1 ± 5.32	179.1 ± 5.18
20	179.1 ± 4.14	179.7± 3.91	176.4 ± 4.26
25	172.4 ± 3.31	180.4 ± 4.65	175.7 ± 5.65
30	182.2 ± 5.52	181.7 ± 5.46	179.2 ± 3.56

*Dead bird of group A; ** Dead bird of group C.

Table 3: Comparative mean values of respiration for group A, B and C.

Days	Respiration (Beats / min)		
	Group A	Group B	Group
	Mean ± S.D	Mean ± S.D	Mean ± S.D
1	43.9 ± 3.03	43.2 ± 3.54	42.8 ± 4.10
3	42.5 ± 3.82	42.6 ± 3.12	42.9 ± 3.78**
5	45.4 ± 3.10*	41.8 ± 3.19	42.9 ± 2.96
10	42.8 ± 2.84*	42.5 ± 2.68	41.7 ± 2.65**
15	41.5 ± 2.94*	41.7 ± 2.74	42.1 ± 3.68
20	44.6 ± 4.82	43.6 ± 3.12	42.6 ± 3.52
25	42.5 ± 3.12	39.9 ± 5.43	43.7 ± 5.12
30	43.7 ± 3.35	42.9 ± 3.78	41.6 ± 4.17

*Dead bird of group A; ** Dead bird of group C.

MATERIALS AND METHODS

The present study was conducted to compare the different suturing techniques for Ingluviotomy in pigeons

(*Columbalivia domestica livia domestica*). Thirty Pigeons weighing between 275 gm to 350 gm were taken and kept in experimental cages of Surgery Section department of clinical medicine and surgery of University of Veterinary and Animal Sciences, Lahore. These pigeons were divided into three experimental groups i.e. Group A, B and C comprising ten pigeons each. These pigeons underwent complete clinical examination prior to surgery to check their health status. Following Ingluviotomy techniques were performed in groups like Group A have Single Layer closure, Group B has Double Layer closure and Group C-Closure with glue.

Preoperative evaluation

A thorough physical examination of each bird was done. The hydration status of each bird was evaluated by examining the oral mucosa and tenting the skin over the shank. The bird's head and neck, feathers and skin, trunk and cloacae was examined carefully to find out any anomaly. All birds were dewormed with fenbendazole (Hunter-Holland) at the dose rate of 10-50 mg/kg. Throughout the experimental study period birds were kept in cages. Feed and water was withheld 5-8 hours prior to surgery.

Site and surgical instruments preparation

For provision of an adequate sterile field the surgical area was defeathered around the thoracic inlet. After the surgical area was prepared using the povidone Iodine 1% (Betadine Solution) around the thoracic inlet, drapes was applied in order to perform surgery with recommended protocol. All the instruments that were used in this surgical process were sterilized by autoclaving them at 121 degree Celsius for 15 minutes at 15 pounds per square inch pressure.

Anesthesia

General anesthesia was induced by injection of xylazine (Xylaz, Farvet-Holland) and ketamine (Ketamine, Roxmedica) at the dose rate 8 mg/kg and 30 mg/kg intramuscular, respectively.

Surgical approaches

To perform Ingluviotomy bird is placed in dorsal recumbency with head elevated and esophagus occluded with moist cotton or gauze to prevent aspiration. The skin is incised with blade no. 22 over lateral sac of the crop. The crop is incised in avascular area approximately half of the desired length because crop easily stretches.

Ingluviotomy techniques to be practiced were:

Single layer closure: The skin and the ingluviotomy incision were closed together with simple interrupted suturing pattern using absorbable suture no. 4/0 Vicryl (Ethicon, Johnson and Johnson-International).

Double layer closure: Closure is accomplished using the simple interrupted pattern. The skin is closed separately over the ingluviotomy incision using 4/0 Vicryl (Ethicon, Johnson and Johnson-International) for crop closure and 4/0 Vicryl (Ethicon, Johnson and Johnson-International) for skin closure.

Closure with glue: In this technique glue (Dermabond, ETHICON, INC.) is used to close the wound.

Post-operative management: After the successful completion of surgical procedure, the operated birds were shifted to recovery room of surgery section, University of Veterinary and Animal Sciences, Lahore-Pakistan and the vigilant observation was made for post-operative complication. The operated birds were provided with adequate fluid therapy i.e. Ringer Lactate at the dose rate of 10-20 ml per kg body weight subcutaneous to ensure proper rehydration and renal function. The birds were administered with injectable antibiotic Cefotaxime sodium (Inj.Claforan, sanofi-aventis) at the dose rate of 75–100 mg/kg body weight intramuscular till 5th day of operation. For analgesia ketoprofen (Inj.Profenid, Sanofi-aventis) at the dose of 2 mg/kg body weight was administered for first four days intramuscularly. The bird was initially provided with liquid diet on 3rd day post-surgery which was replaced with semi solid from day 5. Later the bird was kept on normal routine balanced diet from day 10. Dressing with pyodine solution was practiced on daily basis till the wound healed.

Parameters evaluated: The parameters that has to be evaluated are Physical parameters including temperature, pulse and respiration, food and water intake along with defecation, body weight gain, leakage evaluation, healing time and post-mortem findings of fibrosis in Group A, B and C.

Statistical analysis

Healing Period and Leakage Evaluation were analyzed by Chi-square test. Physical parameter and Body weight gain/loss were analyzed by Analysis of Variance by using Mini Tab.

RESULTS

Temperature

Temperature was observed at different days from day 1 to day 30 in all groups (Table 1). The pigeon of group A, showed more temperature than the group B and C. The bird of group B showed less temperature variation and was normal after few days of surgery. The birds of group C also showed fever and rise in temperature but it was less than the birds of group A. The calculated P-value for the groups is P=0.000 which indicates significant difference between groups.

Table 4: Liquid, food intake and defecation for group A, B and C.

Days	Liquid Intake			Food Intake			Defecation		
	A	B	C	A	B	C	A	B	C
1	No	No	No	Off Feed	Off Feed	Off Feed	Absent	Absent	Absent
3	Minor	Minor	**Minor	Off Feed	Off Feed	** Off Feed	Absent	Watery	**Absent
5	*Minor	Minor	Minor	*Minor	Minor	Minor	*Watery	Semi/S	Watery
10	*Minor	Normal	**Minor	* Minor	Normal	**Minor	*S. solid	Normal	**S. solid
15	*Normal	Normal	Normal	*Normal	Normal	Normal	*Normal	Normal	Normal
20	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal
25	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal
30	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal

* Dead bird of group A; ** Dead bird of group C.

Pulse

Pulse rate of birds were observed at different days from day 1 to day 30 in all groups. The P-value P=0.094 which shows non-significant difference between groups and is portrayed in Table 2.

Respiration

Respirations of birds were observed at different days from day 1 to day 30 in all groups. The P-value for temperature was P=0.126 which shows non-significant difference between the groups and is described in Table 3.

Liquid, food intake and defecation

Table 4 revealed liquid, food intake and defecation was observed in all the groups from day 1 today 30. In initial days of post operation liquid and food intake was less which gradually improved with the passage of time till day 30. Defecation was also absent initially which gradually changed from watery to normal till the end of experiment.

Table 5: Mean Values for body weight (g) of Group A, B and C.

Days	Body Weight (grams)		
	Group A	Group B	Group C
	Mean ± S.D	Mean ± S.D	Mean ± S.D
1	296.62 ± 1.06	299.20 ± 0.92	296.25 ± 2.83
3	296.05 ± 1.84	297.27 ± 1.89	294.77 ± 1.79**
5	295.88 ± 2.05*	298.95 ± 0.90	294.09 ± 1.08
10	294.82 ± 1.97*	299.34 ± 1.88	293.23± 1.81**
15	291.73 ± 1.93*	299.91 ± 0.91	293.45± 1.66
20	292.37 ± 1.67	300.08 ± 1.56	294.19 ± 1.47
25	292.81 ± 1.35	300.25 ± 1.61	294.79 ± 1.18
30	293.45 ± 2.05	300.38 ± 1.76	± 1.34

*Dead bird of group A; ** Dead bird of group C.

Body weight

All pigeons were weighed before the clinical trials. Later they were re-weighed on day 1, 3, 5, 10, 15, 20, 25 and 30 to evaluate the effect of surgical procedure on body weight which has been seen in Table 5. The P-value for body weight between the groups was P=0.000 which shows significant difference between the groups.

Healing period

In order to evaluate the three Ingluviotomy closure techniques in terms of healing period, observation were taken at day 1, 5, 10, 15, 20 and 30, which showed following results.

Table 6 reveals that in Group A at day 1 there was zero percent wound healing in all the pigeons while on day 5 the healing was in progress in 20% of the total birds, no wound healing percentage was 70% and the dead percentage was 10. At day 10, 80% of the birds were in healing phase, no wound healing percentage was zero and the dead percentage was 20. At day 15, 20% of the birds were completely healed while 50% were in healing phase and the dead percentage was 30. At day 20, 30% of the birds were completely healed while 40% bird were in healing phase, no wound healing percentage was zero and the dead percentage was 30. At day 30,30% of the birds showed complete healing while 40% bird were still in healing phase, the dead percentage was 30.

In group B at day 1 there was zero percent wound healing in all the pigeons while on day 5 the healing in progress was 70% of the total birds, no wound healing percentage was 30% and the dead percentage was zero. At day 10, 10% of the birds were completely healed 80% of the birds were in healing phase, no wound healing percentage was 10% and the dead percentage was zero. At day 15 total of60% of the birds were completely healed while 40% in healing phase, no wound healing and the dead percentage was zero. At day 20 total of 80% of the birds were completely healed, 20% were in healing phase, no wound healing and dead percentage was zero. At day 30 total of 80% of the birds were completely healed while 20 % bird in healing phase,

percentage of no wound healing and the dead was zero.

Table 6: Wound healing in days in group A, B and C.

Bird No.	Group A						Group B						Group C					
	Wound Healing Time (Days)																	
	1	5	10	15	20	30	1	5	10	15	20	30	1	5	10	15	20	30
I	2	3	3	1	1	1	2	3	3	1	1	1	2	3	2*	2*	3	1
II	2	2	3	3	3	3	2	2	3	1	1	1	2	2	3	3	3	3
III	2	0	0	0	0	0	2	3	3	1	1	1	2	2	3	3	1	1
IV	2	2	3	3	3	3	2	3	3	1	1	1	2	2	2*	2*	2*	1
V	2	2	3	0	0	0	2	3	3	3	1	1	2	2	3	1	1	1
VI	2	2	3	3	1	1	2	2	3	3	1	1	2	0	0	0	0	0
VII	2	2	3	3	3	3	2	2	2	3	3	3	2	2	2	2	2	2
VIII	2	3	3	1	1	1	2	3	3	1	1	1	2	2	2	3	3	3
IX	2	2	0	0	0	0	2	3	1	1	1	1	2	2	0	0	0	0
X	2	2	3	3	3	3	2	3	3	3	3	3	2	3	1	1	1	1

Dead: 0; Wound healed: 1; Wound not healed: 2; Healing in progress: 3.

In group C at day 1 there was zero percent wound healing in all the pigeons while on day 5 the healing was in progress in 20% of the total birds, no wound healing percentage was 60% and the dead percentage was 10 %. At day 10, 10% of the birds were completely healed 30% of the birds were in healing phase, no wound healing percentage was 20% and the dead percentage was 20 and wound dehiscence was 20%. At day 15, 20% of the birds were completely healed, 30% of the birds were in healing phase, no wound healing percentage was 10%, dead percentage was 20% and wound dehiscence was 20%. At day 20, 30% of the birds were completely healed, 30% of the birds were in healing phase, no wound healing percentage was 10% , dead percentage was 20% and wound dehiscence was 10%. At day 30 50% of the birds were completely healed, 20% birds were in healing phase, no wound healing percentage was 10%, dead percentage was 20 and wound dehiscence was zero percent.

Leakage

In group A at day 1 there was zero percent leakage in all the pigeons while on day 5the leakage percentage was 40% while 50% birds show no leakage and dead percentage was 10. At day 10 the leakage percentage was 10% while 60% birds show no leakage and dead percentage was 30. At day 20, zero percent of the birds showed leakage while no leakage percentage was 70% and the dead percentage was 30.

Note: Due to fragile nature of birds, to minimize radiation exposure, days for leakage were reduced than usual experimental design.

In group B at day 1 there was zero percent leakage was noticed in all the pigeons while on day5 the no leakage percentage was 90% while leakage percentage was 10% and the dead percentage was zero. At day 10 totals of 90% of the birds were showed no leakage while 10% showed leakage and the dead percentage was zero. At day 20 total of 100% of the birds were showed no leakage, leakage percentage was zero percent and the dead percentage was zero.

Note: Due to fragile nature of birds, to minimize radiation exposure, days for leakage were reduced than usual experimental design.

In group C at day 1 there was 10 % leakage from wound and no leakage percentage was 90 % in all the pigeons while on day 5, 50 % of the total birds showed no leakage while leakage percentage was 40 % and the dead percentage was 10 %. At day 10 only 50 % of the birds were showed no leakage while 30% showed leakage and the dead percentage was 20. At day 20 '50 % of the birds showed no leakage, leakage percentage was 30 % and the dead percentage was 20.

Note: Due to fragile nature of birds, to minimize exposure, days for leakage were reduced than usual.

Post-mortem findings

Post-mortem finding has been seen in Table 7. Fibrosis Parameters at Post-mortem (Healing)
Minimum= Good, Moderate= Average, Severe= Poor
Stenosis Parameters at Post-mortem (Crop Lumen Narrowing)
1st degree = Minimum, 2nd degree= Moderate, 3rd degree = Severe

DISCUSSION

Crop is the pivotal organ of the bird's body. The primary function of the crop is the storage of food (Guzman and David, 2016). When the crop is full, it becomes more prominent as well as slight pendulous and more prone to trauma. Such wounds lead to the crop fistula formation in birds. Feeding tube being the main culprit nowadays, the crop rupture is the most frequently reported emergency case now a day by pigeon lovers 'at pet clinics. The defects should be thoroughly cleaned and sutured well in time (Stocker, 2013). Crop rupture mostly occurs in neonates being hand-fed as being more fragile and most susceptible to injuries. One of the most common sources of crop rupture is penetration from improper or careless gavage tube feeding (Cotton et al., 2017). Fortunately, crop has a good blood supply and heals well (Ziswiler and Farner, 1972). Ingluviotomy was performed by making an incision

Table 7: Post mortem finding of fibrosis in group A, B and C.

Bird No.	Group A		Group B		Group C	
	Fibrosis	Crop Stenosis	Fibrosis	Crop Stenosis	Fibrosis	Crop Stenosis
I	Minimum	1st Degree	Minimum	1st Degree	Minimum	1stDegree
II	Moderate	2nd Degree	Minimum	1st Degree	Moderate	2ndDegree
III	Dead at day 5	Dead at day 5	Minimum	1st Degree	Minimum	1stDegree
IV	Moderate	2ndDegree	Minimum	1st Degree	Severe	3rd Degree
V	Dead at day15	Dead at day15	Minimum	1st Degree	Minimum	1stDegree
VI	Minimum	1stDegree	Minimum	1st Degree	Dead at day 5	Dead at day 5
VII	Moderate	2ndDegree	Severe	3rd Degree	Severe	3rdDegree
VIII	Minimum	1stDegree	Minimum	1st Degree	Moderate	2ndDegree
IX	Dead at day10	Dead at day 10	Minimum	1st Degree	Dead at day 10	Dead at day10
X	Severe	3rdDegree	Minimum	1st Degree	Minimum	1stDegree

Fibrosis Parameters at Post-mortem. Minimum: Good quality of healing; Moderate: Average quality of healing; Severe: Poor quality of healing; Stenosis Parameters at Post-mortem; 1st degree: Minimum narrowing of crop lumen; 2nd degree: Moderate narrowing of crop lumen; 3rd degree: Severe narrowing of crop lumen.

on left lateral cervical region over the crop to minimize disruption of vasculature and complications associated with tube feeding in recovery period. The present study was conducted to compare the different suturing techniques along with glue for *Ingluviotomy in pigeons* (*Columbalivia domestica*). These pigeons were divided into three experimental groups i.e. Group A, B and C comprising ten pigeons each. In group A comprising of ten (10) pigeons underwent single layer closure with the help of absorbable suture material (Vicryl®) 4-0 using simple continuous suture pattern.

Temperature, pulse and respiration were observed at different days from day 1 to day 30 in all groups. The pigeon of group A, showed more variation in temperature, pulse and respiration as compared with the group B and C. The bird of group B showed less variation in temperature, pulse and respiration and was normal after few days of surgery. The birds of group C also showed fever and rise in temperature but it was less than the birds of group A and showed more variation in temperature, pulse respiration than birds of group B.

Pigeons in Group A showed poor healing in overall period. At day 1 there was zero percent wound healing in all the pigeons while on day 5 the healing was in progress in 20% of the total birds, no wound healing percentage was 70% and the dead percentage was 10. At day 10 only 80% of the birds were in healing phase, no wound healing percentage was zero and the dead percentage was 20. At day 15 only 20% of the birds were completely healed while 50% were in healing phase and the dead percentage was 30. At day 20, 30% of the birds were completely healed while 40% bird were in healing phase, no wound healing percentage was zero and the dead percentage was 30. At day 30 only 30% of the birds showed complete healing while 40% bird were still in healing phase, the dead percentage was 30. In term of leakage, at day 1 there was zero percent leakage in all the pigeons while at day 5 the leakage percentage was 40% while 50% birds show no leakage and dead percentage was 10. At day 10 the leakage percentage was 10% while 60% birds show no leakage and dead percentage was 30. At day 20, zero percent of the birds showed leakage while no leakage percentage was 70% and the dead percentage was 30. These results were similar to the findings of (Komnenou et al., 2003) that studied the complications after crop repair i.e. leakage and adhesion formation.

In group B, experimental study, comprising of ten (10) pigeons which underwent double layer closure with the help of absorbable suture material (Vicryl®) 4-0 using simple interrupted suture pattern. Closure was done in two layer fashion i.e appostion of rutptured crop edges and skin individually. Pigeons in Group B showed significant good healing during the research period. At day 1 there was zero percent wound healing in all the pigeons while on day 5 the healing in progress was 70% of the total birds, no wound healing percentage was 30% and the dead percentage was zero. At day 10, 10% of the birds were completely healed 80% of the birds were in healing phase, no wound healing percentage was 10% and the dead percentage was zero. At day 15 total of 60% of the birds were completely healed while 40% in healing phase, no wound and the dead percentage was zero. At day 20 total of 80% of the birds were completely healed, 20% were in healing phase, no wound healing was zero. At day 30 total of 80% of the birds were completely healed while 20 % bird in healing phase, percentage of no wound healing and the dead was zero. In term of leakage, at day 1 there was zero percent leakage was noticed in all the pigeons while on day 7 the no leakage percentage was 90% while leakage percentage was 10% and the dead percentage was zero. At

day 10 totals of 90% of the birds were showed no leakage while 10% showed leakage and the dead percentage was zero. At day 20 total of 100% of the birds were showed no leakage, leakage percentage was zero percent and the dead percentage was zero.

In group C, experimental study comprising of ten (10) pigeons which underwent closure using adhesive glue (Dermabond® Ethicon) showed good apposition but it was less than that of double layer closure. In term of wound healing, at day 1 there was zero percent wound healing in all the pigeons while on day 5 the healing was in progress in 20 % of the total birds, no wound healing percentage was 60% and the dead percentage was 10 %. At day 10, 10% of the birds were completely healed 30 % of the birds were in healing phase, no wound healing percentage was 20% and the dead percentage was 20 and wound dehiscence was 20%. At day 15 only 20% of the birds were completely healed 30% of the birds were in healing phase, no wound healing percentage was 10%, dead percentage was 20% and wound dehiscence was 20%. At day 20 only 30% of the birds were completely healed, 30% of the birds were in healing phase, no wound healing percentage was 10%, dead percentage was 20% and wound dehiscence was 10%. At day 30, 50% of the birds were completely healed, 20% birds were in healing phase, no wound healing percentage was 10%, dead percentage was 20 and wound dehiscence was zero percent. While in term of leakage, At day 1 there was 10 % leakage from wound and no leakage percentage was 90 % in all the pigeons while on day 5, 50% of the total birds showed no leakage while leakage percentage was 40% and the dead percentage was 10 %. At day 10 only 50% of the birds were showed no leakage while 30% showed leakage and the dead percentage was 20. At day 20 only 50% of the birds showed no leakage, leakage percentage was 30% and the dead percentage was 20 %. These results were similar to the findings reported by (Nagpal et al., 2004; Marshall et al., 2013).

In term of post-mortem evaluation fibrosis and narrowing of lumen was more in group A while in Group B healing was good and group B birds showed less narrowing of the lumen and also fibrosis was less. In group C narrowing of lumen was less but fibrosis was more and it also showed dehiscence of wound.

The result of present study stated that wound healing was better and faster in pigeons which underwent ingluviotomy closure technique with double layer closure with the help of absorbable suture material (Vicryl®) 4-0) in term of physical parameters, leakage and postmortem evaluation as there were less possibilities of leakage as well as wound contamination were also minimal.

In present study, it was noticed that postoperative care duration was greater in single layer ingluviotomy technique due to dehiscence of suture line along with pus formation due to simultaneous contamination by pressure from crop contents. This resulted in development of infection accompanied with high fever, hereby increasing the postoperative care duration. This is similar to the findings or results of (Komnenou et al., 2003; Adamcak et al., 2000).

The verdict-based explanations for better and reliable results using the double layer closure technique for ingluviotomy technique is that this procedure enables proper apposition of crop edges. Besides this, there is more vascular supply in the crop area which enhances faster and reliable healing of crop repair. To summarize and conclude my findings, it can be stated that this study clearly signifies that across the globe, the double layer closure technique is quiet effectual and reliable ingluviotomy technique in terms of healing period and postoperative care duration as compared to crop repair through single layer closure or using adhesive glue.

AUTHORS CONTRIBUTION

Rashid Hussain, Naveed Hussain, Nasir Iqbal, Sadaf Aslam = Experimental Trial and Revision. Ayesha Sadiq, Zubair Luqman, Hamza Jawad= Formatting, Setting and Revision.

CONFLICT OF INTEREST

The authors have declared no conflict of interest.

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