

Acknowledgement

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LIST OF ABBREVIATIONS

Abbreviations	Elaborations
%	Percent
°	Degree
AGASA	Anal Gland Adenosarcoma
ASAC	Anal Sac Adenocarcinoma
apprx	Approximately
cm	Centimetre
etc.	Etcetra
Fig	Figure
mm	Millimeter
ml	Milliliter

Clinical anatomy of anal gland of street dog (*Canis familiaris*) in Bangladesh

Abstract

This study was aimed to reveal the anatomical details of anal glands of street dog in Bangladesh. Three (two male & one female) mature and apparently healthy dogs were collected followed by euthanasia and were examined by maintaining proper legal and ethical procedures. The two anal glands in all three dogs were found at the ventro-lateral aspect of the anal opening. Left anal gland was somewhat smaller in size than the right one. Both left and right anal glands were 1.7 cm in length. The left anal gland was average 1.1cm in width and the right one was 1.3 cm in width on an average in three dogs. From the base of the tail to the apex of left and right anal gland were average 5.1 cm and 5.2 cm respectively. Apex of the left and right anal gland were average 3.2 cm and 3.0 cm away from the caudal end of left and right pin bone respectively. The fluid of the anal glands was yellowish and odorous. This study will help our clinicians to reveal the exact position of anal gland in any surgical condition of street dog if needed.

Key words: Street dog, anal gland, clinical anatomy

Chapter I

Introduction

Dogs and cats are the only domesticated animal, which are generally allowed to die a natural death. The average age of the dog is about 12 years, and of the cat 9 to 12, but instances are not uncommon of dogs living to 18 or 20 years of age, and of cats similarly (Boden, 2005). Out of these two species dog is the most widely used animal, which is fulfilling various purposes. Wherever people go, they bring their domestic animals with them; the result is the introduction of a number of domestic species to new habitats all over the world. Dog (*Canis familiaris*) has accompanied man all over the world since its domestication 15,000 years ago (Savolainen *et al.*, 2002) and today it is the most abundant canid on earth with great impact on the environment (Brickner, 2007).

During the process of domestication, dogs have been selected for a set of social and cognitive abilities (Hare *et al.*, 2002). Dogs serve people in many important ways like guarding property and domestic livestock, assisting the blind and other disabled people, performing search and rescue missions, acting as sled animals, detecting explosives and drugs etc. Clearly, dogs are useful and important domestic animals and pets. However, without proper care and handling street or feral dogs may become a nuisance and cause serious damage (Brickner, 2007).

All of the complications happen in domestic or household dog are also happen in street dog. Anal sacs are scent glands of the cat and dog located at four and eight o'clock and dog located at four and eight o'clock sac infection or impactions can be frustrating problems for both the dog owner and veterinarians (Durmus, 2005). There are two anal glands in the dog, situated below and to each side of the anus. They produce a malodorous fluid which possibly acts as a lubricant to aid defecation or as a means of territorial marking. Each gland has a duct opening just inside the anus. These ducts may become blocked by a grass seed or other foreign body, so that the secretions cannot escape and the glands swell; but more commonly there is infection. Irritation or pain then results. It may be necessary to manually express the glands to relieve the blockage, or to remove them surgically. Signs include yelping on sitting down, and tail-chasing; more commonly the dog drags itself along the ground ('scoots') or licks its hindquarters in a effort to obtain relief (Boden, 2005). The anal sacs are storage vessels for the secretions of the anal glands – thought to aid the territory marking of dogs and cats. The secretions are a foul smelling substance that normally will empty when the dog/cat passes a

bowel movement. They can also suddenly empty when the animal is scared or frightened (Bilton, 2011).

The majority of anal sac disease consists of impactions and infections, with neoplasia being an uncommon occurrence. Tumors in the perineal area, however, are common in the dog, with the majority being adenomas of the perianal glands. Perianal adenomas are seen most frequently in intact male dogs because of the tumor's testosterone dependence. Apocrine gland adenocarcinoma is the most common malignancy in this area in older female dogs. Anal sac disease in the dog is common and affects approximately 12% of the canine population (Bennett *et al.*, 2002). Apocrine gland anal sac adenocarcinoma (AGASA) is reported to be observed in 2% of all skin tumours in dogs and should always be considered in dogs with hypercalcaemia. Hypercalcemia is observed in 90% of the AGASA, earlier reported to be mainly observed in female. It is now reported equally in both sexes. AGASA is associated with early lymph node metastasis (pelvic and lumbar area) (72% of the dogs at the time of diagnosis) and late pulmonary metastasis (Brissot, 2006). The anal sacs are similar to the scent glands found in skunks. Apocrine gland adenocarcinoma of the anal sacs occurs at relatively low frequency in the dog, representing 17% of all perianal tumors and 2% of all skin tumors (Brissot, 2006).

However, there is a very few information about street dog of Bangladesh on clinical aspect. This study on clinical anatomy of anal gland of street dog in Bangladesh may help a surgeon or veterinarian to get an easier access to the recovery of complications related to the anal gland of street dog. In Bangladesh there are a huge number of street dog available all around the country. They are totally out of any care. In this study, it was tried to reveal the exact anatomy of anal gland of street dog in Bangladesh.

Objective:

To know the anatomy of anal gland of apparently healthy mature street dog in Bangladesh.

Chapter II

Review of Literature

2.1. Street dog (*Canis familiaris*)

Street dogs are ownerless native dogs (*Canis familiaris*) of mostly non descriptive nature which roam freely without human supervision (Das *et al.*, 2012).

Street dog (dog found in public places irrespective of the level of care and level of supervision imposed upon them) is one of the important inhabitants in the environment of Bangladesh. Its lives are led at outdoor environment. They usually live in unhygienic condition and readily come into contact with the humans and domesticated animals. Street dogs impose a burden on the community in a number of ways. Street dogs pose serious public health, socio-economic and animal welfare problems in many countries. A diverse range of zoonotic infections, including parasitic diseases are transmitted from the dog and cat to human (Ali *et al.*, 2011).

Developing countries like Bangladesh, the number of stray dogs that coexist with human being is high in most cities and villages which constitute a potential risk of infections for human beings (Robertson *et al.*, 2000).

The level of hygienic conditions, lack of veterinary supervision and less awareness concerning zoonotic diseases exacerbate the transmission of zoonotic diseases mainly by street dogs (Traub *et al.*, 2002).

For semi-wild animals, such as street dogs, no published information is available in Bangladesh or other regions of south-east Asia. Dog population is estimated to be 37.5 million in the south-east Asia region with an increase of about 10% annually. There are no available data for stray dog populations in Bangladesh. Numerous wildlife species are natural reservoirs of rabies virus and on rare occasions act as a source of transmission to humans (Khan *et al.*, 2011).

Free-roaming dog populations have emerged as both animal welfare and public health problems in developing countries. Free-roaming dogs face high mortality, malnutrition, starvation, disease, and abuse; account for 99 percent of cases of rabies transmission worldwide; and are associated with more than sixty other zoonotic diseases. Additional social problems with free roaming dogs include road accidents, fighting, noise, biting children, fecal contamination, spread of rubbish, and uncontrolled breeding (Jackman *and Rowan*, 2007).

Globally, Bangladesh ranks third in the number of human deaths from rabies. Although dogs are the principal known transmitters of rabies and knowledge of dog populations is essential for effective national control and proper planning, dog control programs are scarce in Bangladesh (Hossain *et al.*, 2013).

2.2. Gross anatomy of anal gland of dog

Anal glands are sac like structures – dogs and cats have a pair and they are located next to the anus at about four o'clock and eight o'clock orientation. Anal glands produce a watery fluid with a strong unpleasant smell. When the dog or cat defecates, the contents of the anal glands are normally expressed onto the faecal material. It is thought that each animal has its own smell so that this acts as a territory marking device wherever the animal defecates (Rochedale, 2009).

Anal sacs are also called anal glands even though they technically are not truly glandular in structure. These two small repositories of foul smelling material technically are small pouches lined with cells whose job it is to continually produce an oily semi-liquid substance that is stored within the sac. One study indicated that anal sac disorders affect about 12% of dogs. One theory states that anal sac contents, when excreted with the passing stool or by anal sphincter muscle contraction, act as a powerful territorial scent marker somewhat akin to humans posting a “No Trespassing sign”. Another theory states that the anal sac material lubricates hard stool, which makes passage easier. Some dogs may be born with very narrow channels that lead from the sacs to the edge of the anus, thereby obstruction the flow of anal sac material. There is no age or sex predisposition to anal sac pathology (Dunn, 2007).

Anal sacs are located on either side of dog's anus, between external and internal sphincter muscles. Depending on the dog, they range in size from that of a pea to a lima bean. Sebaceous glands within the lining secrete a foul-smelling liquid. Under normal circumstances, the sacs empty on their own during bowel movements via a pair of ducts. This natural routine emptying serves as a means of olfactory communication and establishing territory. Each dog possesses his own unique scent, which is why ritualized dog-to-dog greetings include copious rear-end sniffing. When a dog presents his rear for information gathering, the muscle movements involved in raising the tail apply pressure to the sac, prompting the release of additional scent. Anal sac scent marking is also what makes dogs so interested in each others' feces. Under normal circumstances, dogs successfully manage their anal sacs all on their own to the extent that many owners never even realize they exist.

When problems develop, however, they are difficult, if not impossible to ignore, and can quickly go from bad to worse, so it's important to know what to look for and how best to respond to signs of trouble (Colman, 2011).

The perianal region of dogs contains multiple structures and glands, some of which are unique to the area. Anal sacs or perianal sinuses are paired, lateral, cutaneous, anal diverticula lined by a cornified, stratified squamous epithelium. Anal sacs are present in carnivores and many rodents. Dogs have apocrine tubular anal sac glands that open into the anal sacs. Sebaceous glands in the region are typical but may not be associated with hairs. Canine perianal or circumanal glands are nonpatent masses of parenchymal cells. They are sometimes referred to as hepatoid glands because of their histologic resemblance to hepatocytes. These glands are thought to be nonsecretory, abortive or modified sebaceous glands (Esplin *et al.*, 2003).

The anal sacs are two structures situated either side of the anus in the dog and cat. The sacs themselves are situated within the tissue, but the ducts (openings) are either just outside of the anus, or sometimes just within the anus itself. The anal sacs are storage vessels for the secretions of the anal glands – thought to aid the territory marking of dogs and cats. The secretions are (to us humans anyway!) a foul smelling substance that normally will empty when the dog/cat passes a bowel movement. They can also suddenly empty when the animal is scared or frightened (Bilton, 2011).

2.3. Diseases of Anal gland

The anal sacs can be affected by a number of conditions. These may include:

Impacted Anal Sacs: This is the most common problem we see. The sac is normal, but there is an abnormal build up of secretions with the sac. This can either be due to the fact that the secretion is very dry/hard, or can occur if the duct is blocked/narrowed. Dogs that have anal sac impactions will often “scoot” their bottom along the floor, or will have a tendency to try and lick their bottoms (Dunn, 2007).

Anal sacculitis: Anal sac problems generally present as impaction, infection, or abscess. Impaction is the most common problem and is the result of an accumulation of secretions in the anal sac that the dog is unable to express on his own. This is typically caused by a thickening of the secretions or because the ducts from which the secretions exit the body have become temporarily clogged. Impacted glands are most often caused by consistently soft

stool or after a short bout with diarrhea. When the stool is too soft, the sphincter muscle doesn't apply enough pressure to empty the sacs as the dog expels feces (Colman, 2011).

Anal sacs are scent glands of the cat and dog located at four and eight o'clock and dog located at four and eight o'clock sac infection or impactions can be frustrating problems for both the dog owner and veterinarians. Medical and surgical treatments are applied for treatment of anal sacculitis (Kenawy *et al.*, 1995).

Anal Sac Abscess: Often a follow on problem from an anal sac infection. An abscess forms which often bursts out through the skin adjacent to the anus. There may be more than one opening (fistula) and there is often leakage of anal sac material, pus and blood draining onto the coat or surrounding skin. There is often considerable pain with these, particularly as they are forming and before they actually burst (Dunn, 2007).

Anal gland adenocarcinoma: The anal glands can undergo neoplastic change and can become cancerous. Anal gland adenomas (benign) and anal gland adenocarcinomas (malignant) are two of the cancers seen in this area.

The ducts (tubes) that lead from the anal glands to the edge of the anus for expression of the fluid are very narrow. It is not uncommon for these ducts to become blocked, especially in small breed dogs. This may occur as a result of some inflammation around the anus or a thickening of the secretion due to infection. Soft feces or diarrhoea may also lead to overfull glands as they cannot be emptied by the pressure of the feces onto the anal sacs. Some individual variations in anatomy can also make emptying less efficient (Rochedale, 2009). Impacted anal glands are usually managed effectively with regular "expression" by our vets or nurses. Provided this does not need to be done too regularly, then this is an easy and safe way to manage the problem. Infections and abscesses will need antibiotics to help treat them. These are usually given as tablets but occasionally we will use a special syringe to push an antibiotic cream directly into the anal sac itself. This syringe doesn't have a needle attached, but has a fine flexible tube attached that we can gently insert down the duct and into the sac itself (Bilton, 2011). There is an operation that can be performed – called an 'anal sacculotomy' (Fossum *et al.*, 2007). This involves removing the whole sac through the skin around the anus. Although this is usually curative – particularly in cases with persistent anal sac impaction or recurrent anal sac infections, there is a very small chance of faecal incontinence after the surgery, and so this is only performed if conservative management is not suitable. If anal sac cancer is found, then this is one of the mainstays of treatment.

However follow up care may be required with further surgery or chemotherapy if a malignant type is found.

Anal gland disease is a common problem in cats and dogs. The anal glands, also called 'anal sacs,' can become impacted, infected, and abscessed. Affected pets may lick the anal area, 'scoot' along the floor, or have problems with defecation. Anal glands may also become infected and abscess. Bacteria make their way into the glands, probably through the ducts. This is a very painful condition, and the first sign you may see is that the animal attempts to bite or scratch when you touch the area near the tail (Fossum *et al.*, 2007).

Anal saccullectomy is a commonly performed surgical procedure in dogs. It is infrequently performed in cats. It is most often indicated for definitive treatment of chronic anal sacculitis. The anal sacs are intimately associated with the external anal sphincter; therefore, fecal incontinence resulting from damage to this muscle or its innervation is a potential complication of anal saccullectomy. Fistula formation and incisional infection are other possible complications. In general, the overall incidence of complications after anal saccullectomy is low (MacPhail, 2008).

Apocrine gland adenocarcinoma of the anal sac is a tumour that accounts for about 17% of perianal tumours in dogs. There is no sex predilection. It is a malignancy of older dogs with the average age of onset reported to be between 10 and 11 years. These tumours can occur in younger animals and anal sac palpation should be part of each annual physical examination. Benign tumours of the anal sac are very rare (Finora, 2002).

Anal gland carcinoma is a malignant tumor of apocrine secretor epithelium of anal sacs. It is commonly seen in dogs. 5-15 year-old female dogs constitute the risk group. Certain breed disposition is not reported even though it is common in English Cocker Spaniels, German Shepherds, English Springer Spaniels and mongrel dogs (Vural *et al.*, 2005).

Anal sac carcinomas are reported frequently in dogs and rarely in cats. In dogs, race predisposition is not mentioned however, unilateral occurrence in females and old animals is reported to be often (81%). Its increased incidence in castrated animals is also mentioned (Meuten, 2002).

Anal sac disease in the dog is common and affects approximately 12% of the canine population. The majority of anal sac disease consists of impactions and infections, with neoplasia being an uncommon occurrence. Tumors in the perineal area, however, are

common in the dog, with the majority being adenomas of the perianal glands. Perianal adenomas are seen most frequently in intact male dogs because of the tumor's testosterone dependence. The most common malignancy in the perineal area in older female dogs is anal sac adenocarcinoma (ASAC). These tumors arise from the apocrine glands of the anal sac.³ ASAC accounts for approximately 2% of skin tumors in the dog (Bennett *et al.*, 2002).

Perianal adenomas comprise more than 80% of all perianal tumors and are the third most common tumor in male dogs. Adenocarcinomas of anal sac apocrine glands are reported most often in female dogs and are aggressive tumors that often have associated hypercalcemia. Squamous cell carcinoma occurs most frequently in sun-damaged, lightly pigmented skin and is the second most common malignant skin tumor in dogs.³ Subungual squamous cell carcinoma has been reported to affect multiple digits of large-breed black dogs. Squamous cell carcinomas are also the second most common malignant tumor of the oral cavity of dogs, where tumors of the caudal tongue and tonsil have high metastatic potential. This report describes squamous cell carcinomas arising from the stratified squamous epithelial lining of the anal sac in five dogs (Esplin *et al.*, 2003).

Once the sacs have abscessed, they cannot be manually drained in an effort to produce relief, and the abscess must rupture through the adjacent skin to create a drainage tract. If the abscess does not rupture naturally, it must be lanced by a veterinarian. Often, infected or abscessed sacs are so painful that the dog must be anesthetized in order to be treated (Colman, 2011).

Chapter III

Materials and Method

3.1 Selection of area

Nearby residential area of Chittagong Veterinary and Animal Sciences University was selected for this study as there was abundant number of street dogs in that area.

3.2 Collection of dog

Three apparently healthy street dogs were selected randomly irrespective of sex. Among them two were male and one was female. They were ensured as mature street dog by their maturation and breeding behavior.

3.3 Restraining of Dog

The dog was approached with providing feed to it. Feed was provided to the dog for a while to restrain the dog fully. After full restraining, two fore limbs and the mouth of the dog was grasped by one person and it was tightly tied with gauze. Then the dog was kept in lateral recumbency by holding its two hind limbs in left hand, two fore limbs in right hand and pressing the head by the right elbow.

3.4 Euthanasia of the dog

After complete restraining, the right forelimb of the dog was upheld and cephalic vein was detected and blocked. After blocking the vein 4ml of Sedil[®] (Diazepam) was administered with a butterfly needle for sedation. Immediate after sedation the dog was administered 20ml of saturated solution of MgSo₄ through the same route for euthanasia. The dog died just after few seconds of administering of MgSo₄ solution. Death of the dog was confirmed by checking the pedal and palpebral reflexes. Then the dog was brought to the lab for further processing.

3.5 Preparation of the dog

After bringing the dog to the lab, it was kept in lateral recumbency on the dissection table. Then the anus and perianal region of the dog was cleaned & washed as far as possible to get proper environment for work. At first washing with normal water and then washing with antiseptic solution was done. After washing the area was made dry by soaking the region with dry, clean hygienic cotton cloth. Then shaving of the excessory hair at perianal region was done. Finally the dog was kept in ventral recumbency and the tail was upheld by tying it to a strand with a rope for easiness of working at anus region.

3.6 Dissection of anal glands

A round incision was made surrounding the anus with taking about 2.5cm radius. Skinning was done from the incised area to the anal opening making a circular skinned area. After skinning, the subcutaneous fat was gently removed without damaging adjacent structures. Additional bleeding was soaked with cotton. The first target was to reveal the outer skeletal muscle of external anal sphincter at both side of the anus. After removing all subcutaneous fat, the outer skeletal muscles of the both external anal sphincter were revealed. Then the anal sphincter muscles were excised from their origin to reveal the anal glands. The gland was not pressured in terms of keeping its contents intact within it. Then the attachment of anal glands with internal anal sphincter muscle was removed gently.

3.7 Measurement of related parameters

After full revealing of both anal glands they were soaked from outer side to remove extra fluids around them. Then with a clean and dry vernier scale the length of each gland from their base to the apex was measured and recorded. In the same way the width of each gland at their wider part was measured and recorded. With a normal measuring scale the distance between the base of the tail to the apex of each gland was measured and recorded. The length of from the apex of each gland to the end of each pin bone at both left and right side of the dog accordingly were measured and recorded. Then two copper wires of 10cm length and 1.5mm diameter with blunt end were inserted into the both gland through the openings of their ducts on ventro-lateral aspect of the skin of the anal opening. The wires were left in situ position and their shadow was drawn on a drawing paper. From the drawing of two inserted wires the angle between them was measured with an angle measuring scale. This angle indicates the position of the two glands



Fig. 1: Measurement of angle between two anal

Chapter IV

Results and Discussion

4.1 Anatomical Position of the anal glands

They were situated at the ventro-lateral aspect of the anal opening. Ducts of two glands were opened at the lateral margin of anocutaneous junction of the anus. Both glands were related dorsally to the outer skeletal muscle of external anal sphincter and ventrally to the inner smooth muscle of the internal anal sphincter. The apex of the left anal glands were average 5.1cm away from the base of the tail and the apex of the right anal glands were average 5.2cm (apprx) away from the base of the tail. Caudal end of left pin bone was average 3.2cm away from the apex of the left anal glands and the caudal end of the right pin bone was average 3.0cm (apprx) away from the apex of the right anal gland. The distance between apexes of the two anal glands was average 4.1cm.

4.2 Morphology of the anal glands

Shape of the anal glands: Left anal gland was conical in shape and the right anal gland was rounded in shape. Both glands were red in color. In normal condition, both glands were filled with fluid and flatulent in appearance.

Size of the anal glands: The length from the opening to the apex of both left and right anal gland was average 1.7cm. The left anal gland was 1.1cm wide at its broader part and the right anal gland was average 1.3cm wide at its broader part.

Angle between two anal glands: Angle between two anal glands was average 124° . This angle apparently indicates that the two glands are in a position like 4 and 8 o'clock of an analogue watch. This finding supports MacPhail, (2008). In an analogue clock the angle between 4 and 8 o'clock is absolutely 120° . The excretory duct of each anal gland was found open into the keratinized portion of the anal canal. The secretion of anal gland was yellowish in color, odorous containing fat like substances.

William *et al.* (2000) stated that the anal glands are located between the inner smooth muscle of the internal anal sphincter and the outer skeletal muscle of the external anal sphincter. In this study both anal glands of the dog was found in ventral relation with inner smooth muscle of internal anal sphincter and dorsal relation with outer skeletal muscle of external anal sphincter. From this anatomical position of the anal glands it can be assumed that the contraction of outer skeletal muscle of external anal sphincter causes excretion of anal sac

fluid during defecation. On the other hand, as because the fluid of anal gland is odorous, hence dog may use this fluid to make their territory.



Fig. 2: Left and right anal glands of dog *in-situ* position (L= Left anal gland, R=Right anal gland).



Fig. 3: Inner view of the glandular mucosa of anal gland.

Chapter V

Conclusion and Recommendation

Dog is intimately related with human civilization. In contrast with the socioeconomic condition of Bangladesh street dog constitutes a great importance from various aspects. This work on street dog will help a veterinarian to get an ease access to the recovery of anal gland complications in case of street dog of Bangladesh. But as because it was found that the anatomical feature of anal gland of street dog is almost similar to other exotic dog, so the findings of this study will also help a veterinarian in treating the complications of anal gland in exotic dog breeds also.

Further detailed study is needed to explore the anatomical and histological similarities or dissimilarities of anal gland of street dog with that of exotic pet dog.

References

- Ali, M.H., Begum, N., Azam, M.G. and Roy, B.C., 2011. Prevalence and pathology of mite infestation in street dogs at Dinajpur municipality area. *Journal of Bangladesh Agricultural University*, 9(1): 111–119.
- Aronson, L. and Slatter, D.E., 2003. Rectum and anus. In: *Textbook of Small Animal Surgery*, 3rd edn. Philadelphia: Saunders, 682-708.
- Bacha, W.J. and Bacha, L.M., 2000. Digestive System. In: *Color Atlas of Veterinary Histology*, 2nd edn. 351 West Camden Street Baltimore, Maryland. 114-150.
- Beck, A.C., Macpherson, F.M., and Wandeler, A., 2000. The human-dog relationship: A tale of two species. In: *Dogs, zoonoses and public health*. New York: CABI Publishing. 1–16.
- Bennett, P.F., DeNicola, D.B., Bonney, P., Glickman, N.W. and Knapp, D.W., 2002. Canine Anal Sac Adenocarcinomas: Clinical Presentation and Response to Therapy. *Journal of Veterinary Internal Medicine*. 16: 100–104.
- Bevilacqua, P.D., Paixao, H.H., Modena, C.M. and Castro, M.C.P.S., 2001. Urbanization of visceral leishmaniose in Belo Horizonte, Brazil. *Arquivo Brasileiro de Medicina Veterinaria e Zootecnia*. 53: 1-8.
- Bilton, W.B., 2011. Anal Sac Disease. www.biltonvets.co.uk, Accessed on 11th March, 2014 at 9.00pm.
- Boden, E., 2005. *Black's Veterinary Dictionary*, 21st edn. A & C Black Publishers Limited, 38 Soho Square, London W1D 3HB. 120.
- Brickner, I., 2007. The impact of domestic dogs (*Canis familiaris*) on wildlife welfare and conservation: a literature review. <http://www.tau.ac.il/lifesci/departments/zoology/>, Accessed on 23th January, 2014 at 5.00pm.
- Brissot, H., 2006. Apocrine Gland Anal Sac Adenocarcinoma in dog. www.omv.pt, Accessed on 11th March, 2014 at 9.30pm.
- Cohen, J.E. and Gurtler, R.E., 2001. Modeling household transmission of American trypanosomiasis. *Science*. 293: 694-698.
- Colaman, S., 2011. Detecting Canine Anal Sac Problems: The lowdown on problematic canine anal sacs. *Miniature Schnauzer Rescue Houston, Inc*. 3 (3): 1-4.
- Das, S., Alim, M.A., Sikder, S., Gupta, A.D. and Masuduzzaman, M., 2012. Prevalence and Worm Load of Enteric Helminthiasis in Stray Dogs of Chittagong Metropolitan, Bangladesh. *YYU Veteriner Fakultesi Dergisi*. 23 (3): 141-145.

- Dunn, T.J., 2007. Anal sacs in dogs and cats. Dog world magazine. 34: 28.
- Durmus, A.S., 2005. Treatment of anal Sacculitis In dogs. Indian Veterinary Journal. 83 : 214 – 215.
- Esplin, D.G., Wilson, S.R. and Hullinger, G.A., 2003. Squamous Cell Carcinoma of the Anal Sac in Five Dogs. Veterinary Pathology. 40: 332.
- Fekadu, M., 1993. Canine rabies. Onderstepoort Journal of Veterinary Research. 60: 421-427.
- Finora, K., 2002. Anal Sac Apocrine Gland Adenocarcinoma. <http://www.vectoronto.com>, Accessed on 10th December, 2013 at 7.00pm.
- Forchhammer, M.C. and Asferg, T., 2000. Invading parasites cause a structural shift in red fox dynamics. Proceedings of the Royal Society of London. Series B. Biological Sciences. 267: 779-786.
- Fossum, T.W., Hedlund, C.S., Johnson, A.L., Schulz, K.S., Seim, H.B., Willard, M.D., Bahr, A. and Carroll, G.L., 2007. Surgery in Anal Region. In: Small Animal Surgery, 3rd edn. Mosby, Inc., an affiliated of Elsevier Inc. 499, 501, 505, 511-515.
- Getty, R., 1967. Digestive System of the Dog. In: Sisson and Grossman's The Anatomy of Domestic Animals, 4th edn., W. B. Saunders Company, Philadelphia, USA. 1: 511.
- Grech, V., Mizzi, J., Mangion, M. and Vella, C., 2000. Visceral leishmaniasis in Malta- An 18 year paediatric population based study. Archives of Disease in Childhood. 82: 381-385.
- Green, J.S. and Gipson, P.S., 1994. Feral Dogs. In: The Handbook: Prevention and Control of Wildlife Damage. 35: 77-81.
- Hald, B. and Madsen, M., 1997. Healthy puppies and kittens as carriers of *Campylobacter* spp., with special reference to *Campylobacter upsaliensis*. Journal of Clinical Microbiology. 35: 3351-3352.
- Hare, B., Brown, M., Williamson, C. and Tomasello, M., 2002. The domestication of social cognition in dogs. Science. 298: 1634-1636.
- Hossain, M., Ahmed, K., Marma, A.S.P., Hossain, S., Ali, M.A., Shamsuzzaman, A.K.M. and Nishizono, A., 2013. A survey of the dog population in rural Bangladesh. Preventive Veterinary Medicine. 111: 134– 138.
- Hsu, Y., Severinghaus, L. and Serpell, L., 2003. Dog keeping in Taiwan: Its contribution to the problem of free-roaming dogs. Journal of Applied Animal Welfare Science 6 (1): 1–23.
- Jackmen, J. and Rowan, A., 2007. Free-Roaming Dogs in Developing Countries: The Benefits of Capture, Neuter, and Return Programs. The State of the Animals IV: 206.

- Kenawy, A.A., Karkoura, A., Kassem, M.M. and Anwar, M.A., 1995. Anal sacs complications in German Shephard and their remedy. *Assuit Veterinary Medicine Journal*. 33: 143.
- Khan, S.A., Epstein, J.H., Olival, K.J., Hassan, M.M., Hossain, M.B., Rahman, K.B.M.A., Elahi, M.F., Mamun, M.A., Haider, N., Yasin, G. and Desmond, J., 2011. Hematology and serum chemistry reference values of stray dogs in Bangladesh. *Open Veterinary Journal*. 1: 13-20.
- MacPhail, M., 2008. Anal Sacculectomy. www.compendiumvet.com, Accessed on 17th February, 2014 at 10.00pm.
- Meining, A., Kroher, G. and Stolte, M., 1998. Animal reservoirs in the transmission of *Helicobacter heilmannii*: Results of a questionnaire-based study. *Scandinavian Journal of Gastroenterology*. 33: 795-798.
- Meuten, D.J., 2002. Tumors, hyperplasia, and cysts of thyroid follicular cells. In: *Tumors of Domestic Animals*. 4th edn. Iowa State Press, Ames. 638-657.
- Moreno, J. and Alvar, J., 2002. Canine leishmaniasis: Epidemiological risk and the experimental model. *Trends in Parasitology*. 18: 399-405.
- Pain, S., 1997. The plague dogs. *New Science*. 154: 32-37.
- Peacock, D., 2005. Dog population survey-Bali, Indonesia. Yayasan Yudisthira (YYIS) and Humane Society International. Washington, D.C. Unpublished. www.fao.org, Accessed on 10th March, 2014 at 7.30pm.
- Reece, J.F., Salem, D.J. and Rowen, A.N., 2005. Dogs and dog control in developing countries. In: *The State of the Animals III*: 55-64.
- Robertson, I.D., Irwin P.J., Lymbry A.J., Thompson R.C.A., 2000. The role of companion animals in the emergence of parasitic zoonosis. *International Journal of Parasitology*. 30:1369-1377.
- Rochedale, U.R., 2005. Anal Glands. Rochedale Veterinary Surgery. www.rochedalevet.com, Accessed on 19 February, 2014 at 8.45pm.
- Savolainen, P., Zhang, Y., Luo, J., Lundeberg, J. and Leitner, T., 2002. Genetic evidence for an East Asian origin of domestic dogs. *Science*. 298: 1610-1613.
- Traub, R.J., Robertson, I.D., Irwin, P., Mencke, N. and Thompson, R.C., 2002. The role of dogs in transmission of gastrointestinal parasites in a remote tea-growing community in northeastern India. *American Journal of Tropical Medical Hygiene*. 67 (5): 539-545.

Vural, S.A., Hazirolu, R., Ozyildiz, Z., Ozsoy, S.Y. and Sirin, Y.S., 2005. Anal sac carcinoma in a dog. Ankara Üniv Vet Fak Derg. 52: 201-203.

World Health Organization (WHO), 2004. WHO expert consultation on rabies, first report. Geneva, Switzerland. <http://www.who.int/publications/en/>, Accessed on 20 January, 2014 at 6.00am.

Annex- I

Table 1: Measurement of anal glands of Dog I (male)

	Length(cm)	Width(cm)	From base of the tail to apex (cm)	From caudal end of pin bone to apex (cm)
Left anal gland	1.8	1.3	5.0	3.3
Right anal gland	1.8	1.4	5.0	3.1

Table 2: Measurement of anal glands of Dog II (Male)

	Length(cm)	Width(cm)	From base of the tail to apex (cm)	From caudal end of pin bone to apex (cm)
Left anal gland	1.6	1.0	5.2	3.2
Right anal gland	1.7	1.3	5.3	3.0

Table3 : Measurement of anal glands of Dog III (Female)

	Length(cm)	Width(cm)	From base of the tail to apex (cm)	From caudal end of pin bone to apex (cm)
Left anal gland	1.7	1.1	5.1	3.1
Right anal gland	1.7	1.3	5.2	3.1

Table 4: Average measurements of anal gland of both three dogs

	Length(cm)	Width(cm)	From base of the tail to apex (cm)	From caudal end of pin bone to apex (cm)
Left anal gland	1.7	1.1 (apprx)	5.1	3.2
Right anal gland	1.7 (apprx)	1.3 (apprx)	5.2 (apprx)	3.0 (apprx)