Small ruminants plays major role in the maintenance of rural farmer’s family stability by providing cash income through milk, meat, skin and wool (Lateef et al., 2005). Haemonchus contortus commonly known as twisted stomach worm or barber pole worm, is a most pathogenic blood-sucking gastrointestinal nematode found in the abomasum of small ruminants (Mortensen et al., 2003), notably sheep and goat; but...
**H. placei** is usually affect cattle. These nematodes are economically most significant because it causes insidious loss of production, weight loss and even mortality in lambs (Fentahun and Luke, 2012) and important emerging anthelmintic resistance parasite (Mortensen et al., 2003). These parasites are more prevalent in the tropical and warmer temperate countries, particularly where there is good rainfall in the summer season (Sissay et al., 2007; Santín-Durán et al., 2008; Qamar et al., 2009). The acute and debilitating form of disease is most commonly seen in young animals while adult animals are resistant to infection (Onyenwe et al., 2005; Santín-Durán et al., 2008). The most common clinical signs are failure to thrive, weight loss, anemia, hypoproteinemia, sub-mandibular edema (bottle jaw), ascites, diarrhea, lethargy and death (Kelkele et al., 2012; Tehrani et al., 2012).

Adult male worms are 10–20 mm long and uniformly reddish-brown in colour and female worms are 18–30 mm long and are easily identified by the ‘barber pole’ appearance of the white ovaries and uteri twisting for the length of the worm around a red blood-filled intestine (Love and Hutchinson, 2003). The adult worms and fourth stage (L4) larvae are the vigorous blood-sucking nematodes, movement of the worm causes wounds and secretion of anti-coagulants causes continuous haemorrhage from the abomasal wall results in severe anemia and reduced productivity in acute condition (Tehrani et al., 2012). Each worm can suck about 0.05 ml blood per day in sheep (Burke et al., 2007; Ijaz et al., 2009). Therefore in acute condition animals may be found dead without showing any clinical signs. However in chronic condition animals show pale conjunctivae and mucous membranes, diarrhoea, lethargy, muscular weakness, and edema particularly on lower mandibular region and lesser extend to ventral abdomen. The diagnosis of haemonchosis is usually based upon clinical signs and faecal examination (Getachew et al., 2007; Tehrani et al., 2012).

A 10 months old non-descript, female emaciated sheep was brought to Clinics of Medicine, IVRI with the history of anorexia, weight loss, and dark colour diarrheic feces voiding for past 2 days and the animal was treated by local veterinarian. On clinical examination, sheep was found to be weak, severe emaciation, lateral recumbent position and pale conjunctival mucous membrane. The animal was died after treatment and sent for Post mortem examination Facility, Division of Pathology, IVRI.

A well detailed post mortem examination of sheep was conducted to know the cause of the death. First, the animal was examined carefully on the external surface of the body and the internal organs were examined, and the organs showing macroscopic lesions were systematically recorded.

The affected organs such as pieces of abomasum and intestine were collected in 10% neutral buffered formalin (NBF) for histo-pathological examination. Other organs like liver, spleen, lung, kidney, heart, lymph node and brain were also collected in 10% NBF. Feces were collected in suitable container in normal saline for identification of eggs. Parasites were collected 10% NBF for specific parasitic species identification.

![Figure 1: Hind-quarter of the animal is soiled with faeces due to diarrhoea, gaping of the anus and loss of lustre of hairs](image)

It is based on differences in specific gravity of parasite eggs and that of fecal debris. Two gram of the fecal sample was taken in cylinder and 10 ml of flotation solution (saturated salt solution; specific gravity-1.27) was added. An emulsion was made by mixing the flotation solution with the feces. The fecal emulsion was strained through a metal tea strainer into second container and is poured into a 15 ml centrifuge tube. The flotation solution was added until a meniscus is formed in a test tube. A glass cover slip is placed over the meniscus and allowed to remain for 10–15 minutes. The cover slip was removed and placed liquid side down, on a glass slide. The slides were examined under the microscope in low power (10X) for screening of entire area and then high power (40X) objective lens can be used to confirm a diagnosis.
The worms were washed in normal saline solution and processed with lactophenol solution for optimum clearing. Worms were identified under low power microscope based on the standard taxonomical keys provided by Soulsby (1982).

Tissue samples of 1 to 2 mm thickness were dehydrated in graded alcohol and cleared in xylene and embedded in paraffin blocks. The 4-5 µ thick serial sections were taken with rotator microtome on clean grease free slides and subjected for haematoxylin and eosin (H&E) staining (Luna, 1968).

Nutritional status of cadaver was poor (emaciated), dry skin and loss of luster of hairs were noticed. Hind-quarter of the animal is soiled with faeces due to diarrhea and gaping of the anus were noticed (Figure 1). Conjunctival, buccal and vaginal mucous membrane were pale and anemic condition (Figure 2).

The carcass was pale in colour and hide bound condition (Figure 3). Gelatinization of subcutaneous fat was noticed and subcutaneous fat was not in appropriate amount. The prescapular lymph node was pale, edematous and gelatinization of fat around the lymph node was noticed. The thoracic cavity contains approximately 500 ml of fluid (Figure 4). The abdominal cavity was filled with straw yellow colour fluid (approx. 500-750 ml) (Figure 4). Internal organs were pale in colour. The Lungs were appeared pale and emphysematous and heart was pale and gelatinization of epicardial fat was noticed (Figure 5). Abomasal mucosa was severely congested and showed numerous pin point petechial haemorrhages. Numerous minute hair like haemonchous worms (+++) were present in the abomasums (Figure 6). Abomasal contents were watery and partially covered with free blood. Small intestinal mucosa was congested, watery contents, pin-point to ecchymotic hemorrhages (Figure 8) while serosa was pale in colour (Figure 7) and thickened intestinal wall was noticed. Mesenteric lymph node was enlarged, edematous and pale in color (Figure 7). Caecal mucosa was congested; pin-point hemorrhages and few whipworms were attached with mucosa (+) (Figure 9). Multiple tiny cysts filled with straw yellow colour fluid were present in the left lateral border of the spleen (Figure 10). Liver was swollen with rounded borders, hard in consistency and multiple different size calcified masses were noticed on the surface which had produced hard and gritty sound while cutting (Figure 11). Gall bladder was distended with bile and thickening of wall was noticed. Kidneys were pale in color and congested cortico-medullary junction.
Figure 5: Lungs were pale and emphysematous and heart was pale and gelatinization of epicardial fat

Figure 6: Abomasal mucosa was severely congested; pin point petechial haemorrhages and numerous minute hair like Haemonchus contortus worms (green arrows) were present

Numerous Haemonchus contortus eggs (+++ ) of thin-shelled, oval shape with equal poles, edges mombate and morula not fully filled the cavities of the eggs were identified (Figure 12). The eggs are approximately 70 – 85 µm in length and 41 - 48 µm in width. Few whip worm (Trichuris ovis) eggs (+) of dark brown colored, thick-walled, barrel shape with unsegmented embryo, no blastomeres and transparent polar plugs at both ends were found (Figure 13). Adult H. contortus worms were identified based on morphology (Soulsby, 1982). Male H. contortus worms are 10 to 20 mm long and are even reddish in colour. Female H. contortus

Figure 7: Intestine was pale in colour due to anaemia. Mesenteric lymph node was enlarged, edematous and pale in color.

Figure 8: Small intestinal mucosa was congested, petechial to ecchymotic haemorrhages, thickened intestinal wall and watery intestinal contents

Figure 9: Caecal mucosa was congested; pin-point hemorrhages and few whipworms (arrow) were attached with mucosa
Figure 10: Multiple tiny cysts filled with straw yellow colour fluid were present in the left lateral border of the spleen.

Figure 11: Liver was swollen with rounded borders, hard in consistency and multiple different size calcified masses (green arrows) were noticed.

Figure 12: Numerous *H. contortus* eggs- thin-shelled, oval shape with equal poles, edges mombate and morula not fully filled the cavities of the eggs.

Figure 13: Whip worm (*Trichuris ovis*) eggs- dark brown colour, thick-walled, barrel shape with unsegmented embryo and transparent polar plugs at both ends.

Figure 14: Female *H. contortus* worms- white uteri and ovaries winding around the red blood-filled intestine give a twisted or barber pole appearance.

Figure 15: Anterior end of *H. contortus* was characterized by small funnel shaped buccal capsule and spine like pair of cervical papillae.
**Figure 16:** Posterior end of female *H. contortus* was characterized by knob type vulval flap (blue arrow) which covers the vulva and the uteri are fully packed with oval eggs (green arrow).

**Figure 17:** Posterior end of male *H. contortus*-copulatory bursa with well-developed asymmetrical dorsal lobes supported by inverted ‘Y’ shaped dorsal rays. Spicules are equal, short and end in knobs and are provided with barbs near the tip.

**Figure 18:** Abomasum showed haemorrhages, oedema, severe congestion of blood vessels in lamina propria and desquamation in the apical border of the villi.

**Figure 19:** Prominent eosinophilic infiltration in the mucous and gastric glands of abomasum and infiltration of mononuclear cells especially lymphocytes.

**Figure 20:** Thickening of abomasal mucosa due to hyperplasia of mucous and gastric glands.

Worms are 18 to 30 mm long and the white uteri and ovaries winding around the red blood-filled intestine give a twisted or barber pole appearance (Figure 14). The anterior end of *H. contortus* was characterized by small funnel shaped buccal capsule, spine like pair of cervical papillae and transversely striated cuticle (Figure 15). Posterior end of female *H. contortus* was characterized by vulval flap which covers the vulva and it is small cuticular knob type (Figure 16). The posterior end of male *H. contortus* was characterized by copulatory bursa with well-developed asymmetrical dorsal lobes supported by inverted ‘Y’ shaped dorsal rays. Spicules are equal, short and end in knobs and are provided with barbs near the tip (Figure 17).

Lungs showed mild emphysema and cellular infiltration in inter alveolar septa. Heart showed separation and mild degeneration of cardiac muscle fibres due to edema. Abomasum showed hemorrhages, edema, se-
vere congestion of blood vessels in lamina propria and desquamation in the apical border of abomasal villi (Figure 18). Prominent eosinophilic infiltration in the mucous and gastric glands of abomasum and some even penetrated to the sub mucosa, and infiltration of mononuclear cells especially lymphocytes (Figure 19). Thickening of abomasal mucosa due to hyperplasia of mucous glands was noticed (Figure 20). Small intestine showed highly congested capillaries in sub mucosa and thickened muscular layer (Figure 21). Apical border of caecal villi was desquamated, mononuclear cell infiltration and congested blood vessels were noticed. Spleen showed thick capsule, hemosiderosis, depletion of red bulb area and prominent trabeculae (Figure 22). Spleen also contains encapsulated cyst with homogenous eosinophilic material and cyst is lined by thick fibrous wall (Figure 23). Prescapular lymph node showed thick capsule, prominent trabeculae and depletion of lymphocyte in both cortical and medullary region (Figure 24). Liver showed congestion, mild bile duct hyperplasia, narrowing of bile duct lumen, degeneration of hepatocyte and mononuclear cell infiltration (Figure 25). Liver also showed homogenous basophilic calcified mass, lined by thick fibrous capsule (Figure 26). Glomerulus showed eosinophilic proteinaceous edematous fluid, atrophy of the glomeruli and mild infiltration of mononuclear cells (Figure 27). Tubular epithelium showed edema, mild degenerative changes and congestion of intertubular blood vessels. Mild edema was noticed in brain.

*Haemonchus contortus* is a major highly pathogenic and economically important gastrointestinal parasite of sheep and goats (Mortensen et al., 2003) and causes high morbidity, mortality, decreased production and economic loss due to cost of treatment and control measures (Githigia et al., 2001; Getachew et al., 2007; Qamar and Maqbool, 2012). In the study, gross lesions such as petechial haemorrhages due to the attachment and feeding of the parasite, and severe congestion in the abomasal mucosa were corresponded with the observation of McKenna (1998). In the present study, the carcass was pale, hide bound condition; gelatinization of subcutaneous tissue and mucous membrane were pale and anemic. These findings were corresponded with the observation of Courtney et al. (1984), Githigia et al. (2001), Zacharias et al. (2008) and Kelkele et al. (2012). The fluid was found throughout of the body cavities such as hydrothorax and hydroperitoneum (ascites) due to secondary to
Figure 24: Prescapular lymph node showed severe depletion of lymphocyte in both cortical and medullary region and prominent trabeculae

Figure 25: Liver showed mild bile duct hyperplasia, narrowing of bile duct lumen, degeneration of hepatocyte and mononuclear cell infiltration especially lymphocytes

Figure 26: Liver showed homogenous basophilic calcified mass (black arrows) which lined by thick fibrous capsule (green arrows)

Figure 27: Glomerulus showed eosinophilic protenacious edematous fluid and mild degenerative changes in the epithelium. Inset showing atrophy of the glomeruli

hypoproteinemia. Eosinophils responsible for pathogenesis during helminthic infection and are considered as first line of defence against parasitic infection, especially, haemonchosis. Eosinophilic infiltration was observed in the present study, which was agreement with the observation of Balic et al. (2000). The possible pathogenic mechanism responsible for cause of death in haemonchosis is hemorrhagic anaemia, hypoproteinemia and oedema of dependent parts due to vigorous blood sucking by both 4th stage larvae and adults (around 0.05 ml of whole blood/worm/day). To compensate the acute or chronic losses of plasma proteins and haemoglobin increased rate of RBC production occur results in depletion of iron stores leads to iron deficiency anaemia. In addition, diarrhoea results in fluid loss and dehydration leads to hypovolaemic shock (Scott et al., 1999; Mir et al., 2007; Zacharias et al., 2008; Kelkele et al., 2012). Liver showed degeneration of hepatocyte and mononuclear cell infiltration which has cause hypoproteinemia, anemia, and finally hypoxia condition.

Although fecal flotation examination is an important diagnostic tool to find out gastrointestinal parasitism, but H. contortus eggs cannot be distinguished easily from other parasites of strongylids family. In the present study, numerous H. contortus eggs (++) and also few whip worm (Trichuris ovis) eggs (+) were identified on the basis of morphology (Soulsby, 1982). Adult female H. contortus worm was identified based on vulval flap and male was identified by spicules and copulatory bursa. These findings were corresponded with the observation of Valderrabano et al. (2002) and Kumsa et al. (2008).
Haemonchus contortus is an important blood-sucking nematode which has produce anemia and hypoproteinaemia in small ruminants that may be fatal particularly to young animals. Anemia is the major feature responsible for pathogenesis haemonchosis infection. The present study clearly describes the clinical signs, gross lesions of haemonchosis and their correlation with histopathological findings and parasitological examination. In the present study, cause of death due to specifically acute H. contortus infection results in hemorrhagic anemia, hypoproteinemia, oedema of dependent parts, diarrhoea results in fluid loss and dehydration leads to hypovolaemic shock. The major activities for controlling haemonchosis infection includes rotational usage of different anti-helminthetic drugs, correct identification of parasitic species, correct usage of drug of choice, appropriate dosage of drug, change the grazing areas frequently to break the life cycle of parasite and rotational grazing methods.

REFERENCES

- Balic A, Bowles VM, Meesen EN (2000). The immunology of gastrointestinal nematode infections in ruminants. Adv. Parasitol. 45: 181-241. http://dx.doi.org/10.1016/S0065-308X(00)45005-0
- Burke JM, Kaplan RM, Miller JE, Terrill TH, Getz WR, Mobini S, Valencia E, Williams MJ, Williamson LH, Vatta AF (2007). Accuracy of the FAMACHA system for on-farm use by sheep and goat producers in the south eastern United States. Vet. Parasitol. 147(1-2): 89-95. http://dx.doi.org/10.1016/j.vetpar.2007.03.033 PMID:17482368
- Courtney CH, Parker CF, McCulre KE, Herd RP (1984). A comparison of the parturient rise in fecal egg counts of exotic and domestic ewes. Int. J. Parasitol. 14(4): 377-381. http://dx.doi.org/10.1016/0020-7519(84)90092-4
- Fentahun T, Luke G (2012). Small Ruminant Haemonchosis: Prevalence and Associated Determinants in Randomly Selected Restaurants and Hotels of Gondar Town, Ethiopia. Europ. J. Appl. Sci. 4(4): 168-172.
- Getachew T, Dorchies P, Jacquet P (2007). Trends and challenges in the effective and sustainable control of Haemonchus contortus infection in sheep-Review. Parasite. 14(1): 3-14. http://dx.doi.org/10.1051/parasite/200714003 PMID:17432053
- Githigia SM, Thamsborg SM, Munyua WK, Maingi N (2001). Impact of gastro-intestinal helminthases on production in goats in Kenya. Small Rumin. Res. 42(1): 21-29. http://dx.doi.org/10.1016/S0921-4488(01)00240-1
- Ijaz M, Khan MS, Avais M, Ashraf K, Ali MM, Khan MZU (2009). Infection rate and chemotherapy of various helminthes in diarrhoeic sheep in and around Lahore. J. Anim. Plt. Sci. 19 (1): 13-16.
- Kelkele FA, Tolossa YH, Kassa GM (2012). Experimental infection of Ethiopian highland sheep by different infective doses of Haemonchus contortus (L3): haematological and parasitological parameters, serum protein concentrations and clinical responses. Ethiop. Vet. J. 16(1): 41-57. http://dx.doi.org/10.4314/evj.v16i1.4
- Kumsa B, Tolaer A, Abebe R (2008). Vulvar morphology and sympathy of Haemonchus species in naturally infected sheep and goats of Ogaden region, eastern Ethiopia. Vet. Arhiv. 78(4): 331-342
- Lateef M, Iqbal Z, Jabba A, Khan MN, Akhtar MS (2005). Epidemiology of trichostrongylid nematode infections in sheep under raditional husbandry system in Pakistan. Int. J. Agric. Biol. 7(4): 596-600.
- Love SC, Hutchinson GW (2003). Pathology and diagnosis of internal parasites in Ruminants. University of Sydney, Australia.
- Luna G (1968). Manual of Histological Staining Method of the Armed Forces Institute of Pathology, 3rd ed. New York, McGraw-Hill Book Company.
- McKenna PB (1998). The effect of previous cold storage on the subsequent recovery of infective third stage nematode larvae from sheep faeces. Vet. Parasitol. 80(2): 167-172. http://dx.doi.org/10.1016/S0304-4017(98)00203-9
- Mir RA, Chishti MA, Zargar H, Ganie SA (2007). Clinicopathological changes in sheep experimentally infected with Haemonchus contortus. World. J. Agric. Sci. 3(5): 562-566.
- Mortensen LL, Williamson LH, Terrill TH, Kircher R, Larsen M, Kaplan RM (2003). Evaluation of prevalence and clinical implications of anthelmintic resistance in gastrointestinal nematodes in goats. J. Am. Vet. Med. Assoc. 223(4): 495–500. http://dx.doi.org/10.2460/javma.2003.223.495 PMid:12930089
- Onyenwe IW, Onwe C, Onyeabor A, Onunkwo JI (2005). Abattoir-Based Study of the Susceptibility of Two Natural Infected Breeds of Goat to Haemonchus contortus in Nsukka Area of Enugu State, Nigeria. Anim. Res. Int. 2(2): 342-345.
- Qamar MF, Maqbool A, Khan MS, Ahmad N, Muneer MA (2009). Epidemiology of haemonchosis in sheep and goats under different managemental conditions. Vet. World. 2(11): 413-417.
• Santín-Durán M, Alunda JM, Hoberg EP, de la Fuente C (2008). Age distribution and seasonal dynamics of abomasal helminths in wild red deer from Central Spain. J. Parasitol. 94(5): 1031-1037. http://dx.doi.org/10.1645/GE-1109.1 PMid:18576697

• Scott I, Dick A, Irvine J, Stear MJ, McKellar QA (1999). The distribution of pepsinogen within the abomasa of cattle and sheep infected with Ostertagia spp. and sheep infected with Haemonchus contortus. Vet. Parasitol. 82(2): 145-159. http://dx.doi.org/10.1016/S0304-4017(99)00006-0

• Sissay MM, Uggla A, Waller PJ (2007). Epidemiology and seasonal dynamics of gastrointestinal nematode infections of sheep in a semi-arid region of eastern Ethiopia. Vet. Parasitol. 143(3-4): 311-321. http://dx.doi.org/10.1016/j.vetpar.2006.08.026 PMid:16965858

• Soulsby EJL (1982). Helminths, Arthropods and Protozoa of Domesticated Animals. 7th (ed.), Bailliere Tindal, London 809 pp., illus. ISBN 0-7020-0820-6

• Tehrani A, Javanbakht J, Jani M, Sasani F, Solati A, Rajabian M, Khadivar F, Akbari H, Mohammadian M (2012). Histopathological Study of Haemonchus contortus in Herrik Sheep Abomasum. J. Bacteriol. Parasitol.3(5):144.http://dx.doi.org/10.4172/2155-9597.1000144

• Valderrabano J, Delfa R, Uriate J (2002). Effect of level of feed intake on the development of gastrointestinal parasitism in growing lambs. Vet. Parasitol. 104(4): 327-338. http://dx.doi.org/10.1016/S0304-4017(01)00638-0

• Zacharias F, Guimarães JE, Araújo RR, Almeida MA, Ayres MC (2008). Effect of homeopathic medicine on helminth parasitism and resistance of Haemancus contortus infected sheep. Homeopathy. 97(3): 145-151. http://dx.doi.org/10.1016/j.homp.2008.05.004 PMid:18657774