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Review article

A review on equine colic: Etiology, differential diagnosis, therapy, and prevention

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Abstract

Equines encompass various animals, such as horses, donkeys, ponies, mules, and zebra. These animals are means of transportation, leisure, source of meat, and income worldwide. Equine colic is among the equines' most important, common, and emergent health issues, particularly in horses. The complexity and anatomical characteristics rendered equines prone to equine colic. Different classifications for equine colic are known depending on cause, affected site, and duration. In the current study, we have exhaustively focused on etiological, clinical findings, clinical and laboratory diagnosis, and eventually, the treatment and control of equine colic. Such knowledge is lacking, and some reports discuss only one or few aspects. Because they are the most prevalent cause, we have focused on gastrointestinal disorders as a cause of colic. Moreover, recent approaches for diagnosis and prognosis were investigated mainly via the biomarkers analysis assay. Because of its importance, similarity to other equines, worldwide distribution, and plenty of available research, we mostly specified our description of horses as a model of equine animals. This review offers valuable insights for veterinarians and equine practitioners, potentially aiding in mitigating health risks and fatal consequences associated with colic in equines.

Keywords: Colic, Diagnosis, Equines, Horse, Intestine, Treatment

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Introduction

Colic refers to abdominal pain caused by disrupted peristaltic action of smooth muscle in the viscera. The most common out-of-all-hours call for equine practitioners is for colic syndrome. In most cases, medical treatment at home is sufficient to resolve the diseases. Hospital intensive care is necessary in 20% of cases. It affects many animal species, including humans, although equines such as horses, donkeys, ponies, and zebras are especially vulnerable (Straticò et al., 2022).

Horses rank among the most significant animals in human history; they have assisted in mining operations, been employed in battle, and as a mode of transportation. Thus, human-domesticated horses have continuously risen. For instance, horses are now a crucial part of animal-assisted therapy. Additionally, it is very important to find infectious diseases affecting humans and horses, especially when they are extremely contagious. In addition to infectious diseases, both parties are concerned about non-communicable diseases (NCDs), such as bone and joint affections or metabolic problems, which are dangerous to human and horse' health (Lönker et al., 2020).

Colic is distributed worldwide and occurs in different environments. The incidence rate ranges between 3.5 and 10.6 cases per 100 horses per year (Constable et al., 2017; Worku et al., 2017). The incidence of colic was 3.1%, which constituted 68.0% spasmodic colic, 27.8% impaction colic, and 4.2% displacement colic (Gitari et al., 2017). Arabian horses were more prone to colic than Standardbred and Thoroughbred horses. Horses without a constant water supply were more likely to get colic than horses with an appropriate quantity of water. The utilization of anti-parasitic drugs was found to be associated with a lower risk of colic when compared to horses that did not receive such medications regularly. Colic risk increased as whole-grain maize consumption increased; however, when all non-roughage concentrate feeds were mixed, colic risk decreased as concentrate intake increased. Age, dry food usage, and the type of caretaker in charge of the horse's daily care (owner or non-owner) all had significant interactions with colic incidence (Reeves et al., 1996; Curtis et al., 2019).

In a systematic review focused on risk factors analysis of colic in horses, Curtis et al. (2019) reported 19 based-studies in the USA, 16 in the UK, two studies were based in Sweden, two were based in Iran, and one study each conducted across a range of countries (Albania, Austria, Canada, Denmark, Greece, Egypt, Italy, Netherlands, Nigeria). In Egypt, the 12-month prevalence of colic conducted on working horses was 54.6%. Severe and moderate tapeworm infection levels were found in 3% and 26% of the horses tested. Horses with severe dental disease, stereotypic behavior, fed ground corn during the 'dry season,' or given an anthelmintic in the previous six months were more likely to have a history of colic in the previous 12 months (Salem et al., 2017).

Horses' distinct and intricate digestive systems render them as highly susceptible animals to a variety of colic conditions, such as gas (tympanic), spasmodic, impaction, displacement/entrapment, torsion (twisted gut), strangling, or sand colic, which can vary from mild to (Constable et al., 2017; Erwin et al., 2021).

Types of colic in equines

Generally, equine colic can be classified into three categories: according to the cause, target organ or location, and duration Figure 1.

1. Simple obstructive colic

A. Spasmodic colic

A functional intestinal disorder is the name given to this type of colic. It is rarely linked with mucosal histological abnormalities. It is ascribed to an increase in vagal tone, which causes an increase in gut peristalsis and a propensity to spasm. It is the

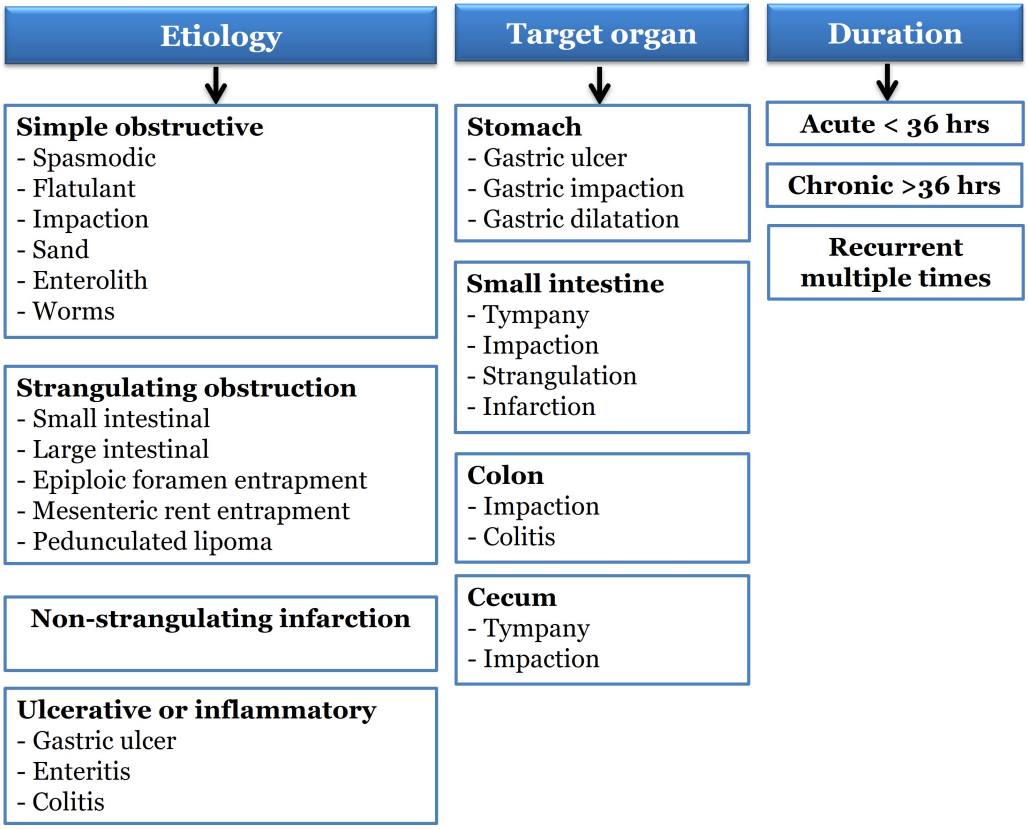

Figure 1: An illustration showing the types of colic in horses as indicated in three main categories based on cause, affected part or organ, and duration of colic.

most prevalent type of equine colic, accounting for 40% of cases. Spasmodic colic occurs in horses of all ages but is not recognized in young foals, and there is no obvious breed or gender predisposition. The underlying causes are rarely discovered. Weather changes, overexertion, excitement such as during thunderstorms, preparation for displaying, drinking cold water while heated, and sweating after work, feeding errors, feeding technique, and feed quantity and quality all predispose to spasmodic colic (Constable et al., 2017; Mair and Sherlock, 2023).

The intricate communication between the enteric, parasympathetic, and sympathetic nerve systems controls intestinal motility. The neurological modulation of horse motility has been the subject of extensive investigation recently, particularly to comprehend the function of the enteric nervous system. Much is still extrapolated from human knowledge despite these efforts. It is necessary to conduct additional scientific research on the neurological modulation of horse motility. One theory for the underlying reason is an imbalance in the input that the sympathetic and parasympathetic nerve systems send to the intestine. Sphincter tone rises, and propulsive motility decreases due to sympathetic (adrenergic) stimulation. Gastrointestinal motility is diminished due to parasympathetic (cholinergic) hypoactivity (Koenig and Cote, 2006).

Horse spasmodic colic is characterized by brief bouts of pain. The pain comes and goes, with the horse rolling, pawing, and kicking for a few minutes, then shaking and standing normally for a few minutes before the next round of discomfort. The horse's digestive sounds are frequently detectable from a distance. Auscultation yields loud, rumbling borborygomi. The pulse rate is moderately raised, around 60 beats per minute, with patchy sweating. The rectal examination is negative, and there is no diarrhea. The clinical signs usually disappeared spontaneously within a few hours (Constable et al., 2017; Mair and Sherlock, 2023).

B. Flatulent colic

It is induced by the consumption of succulent green feed or an obstructive condition that hinders the normal passage of ingesta and gases. Furthermore, intestinal impactions and displacements, stress or excitement decreasing gastrointestinal motility, feeding horses when weary, cold-water engorgement, and idiopathic intestinal tympany of unknown etiology can all cause flatulent colic. The clinical manifestations of flatulent colic are mostly determined by the rate of gas accumulation and the area of the gastrointestinal tract affected. The symptoms range from being off-feed to severe distress with intestinal distension. Flatulent colic in horses is characterized clinically by pawing, kicking the belly, frequent rising and lying down carefully, and patchy sweating. The rectal temperature, pulse rate, and respiration rate are all increased.

Cecal tympany produces right flank filling, but extensive colon gas accumulation causes bilateral distension. Although the peristaltic sound of the gut is diminished, fluids may be heard moving in gas-filled intestinal loops, giving a tinkling or metallic sound. A pinging sound associated with tightly distended fluid may be detected on simultaneous flicking and auscultation of the abdomen. The gas-filled loops of the intestine that fill the abdominal cavity make proper evaluation of its contents impossible on rectal examination. In primary tympany, much flatus is passed from the rectum (Constable et al., 2017; Mair and Sherlock, 2023).

C. Impaction colic

i. Gastric impaction

It can be caused by dental disorders, quick feed consumption, insufficient water consumption, and irregular stomach motility (old age). It is associated with acute, chronic, or recurring colic, inappetence, and increased heart and respiration rates. Long-term (chronic) colic can cause weight loss, intermittent colic discomfort, anorexia, dullness, and the passing of small volumes of hard and dry feces (Constable et al., 2017).

ii. Cecal impaction

Cecal impaction is the cause of colic in about 5% of horses treated in referral facilities. As a result, it is a far less prevalent cause of colic in field instances. There is no sex predilection to the disease, but Arabian, Morgan, and Appaloosa breeds may be at risk. Horses beyond the age of 15 are more vulnerable than horses under the age of 7 years old. Inspissated feed material may affect and distend the cecum, or there may be cecal distension

syndrome, in which fluid accumulates in the cecum (Sherlock and Eggleston, 2013; Velloso Alvarez et al., 2021).

Cecal distention manifests itself in two clinical disorders. First, the cecum is impacted and swollen with inspissated feed material, and the affected horse usually exhibits mild to severe abdominal pain that is often intermittent and lasts for 1-4 days. The affected horses have a decreased appetite and are moderately dull. The heart rate is between 40 and 60 beats per minute, with a diminished borborygomi sound in the bowel. There is no gastric reflux except in the later stages of the disease. A doughy lump was discovered in the right caudal abdomen during a rectal examination. Cecal distension occurred as a syndrome in the second form, as fluid accumulated in the cecum. That disease was far more severe, with significant abdominal discomfort, tachycardia, and indications associated with toxemia. Rectal examination revealed a cecum that was tightly distended due to fluid ingestion, and without surgical intervention, the results were cecal rupture and death (Sherlock and Eggleston, 2013; Velloso Alvarez et al., 2021).

iii. Large colon impaction

The impaction of large colons is one of the most common reasons for abdominal pain in horses. It is mainly caused by obstructed ingesta in the large intestine. Large colon impaction frequently occurs at constricted luminal diameter areas, such as the pelvic flexure or immediately proximal to the transverse colon in the right dorsal colon (Ellis et al., 2008). The true causes of massive intestine impaction are still unknown. Poor quality feed, poor dentition, parasite infection, old age, motility abnormalities, debility, overeating, indigestible feed, insufficient water intake, sand accumulation, enterolith development, non-strangulating displacement, and limited activity have all been linked to this condition (Constable et al., 2017). Massive gaseous distension occurs in the colon at more distal obstruction with protracted total obstruction. Gaseous distension generated by the obstruction can cause bloat and acute stomach pain by activating stretch receptors. Long-term affection may also experience direct pressure necrosis. The colonic distension compromised the colonic wall, resulting in eventual rupture and endotoxemia in the last stage of illness (Moore and Vandenplas, 2014).

Clinically, horses with large colon impaction frequently show a history of pain and decreased intestinal borborygmi sound. The primary manifestations of pain were stretching and lying down, with bouts of moderate severity occurring at intervals of up to a half-hour. The pulse and respiratory rates are both normal. Progressive anorexia and dehydration develop, especially if water consumption is limited; feces are also passed in little volumes, are hard, and are covered with thick and sticky mucus. On clinical investigations, intestinal noises are either absent or greatly reduced in intensity. The most prevalent and swollen site on rectal examination is the impaction of the pelvic flexure of the large intestine (Lopes and Pfeiffer, 2000). Medical treatment of large colon impacted with feed materials includes enteral and intravenous fluid therapy, stop feeding, and administration of cathartics and analgesics. However, surgical intervention is required in case of unresponsive medical treatment, which is beneficial in diagnosing the real cause of colic and the targeted area of GIT for surgery (Constable et al., 2017; Mair and Sherlock, 2023).

D. Sand colic

This condition is more likely to occur in horses that graze on sandy or heavily grazed pastures, as they may ingest sand and dirt along with their feed. Sand colic is more common in foals, weanlings, and yearlings because they are more likely to consume sand due to their feeding behaviors and curiosity. The swallowed sand or dirt is usually seen in the pelvic flexure, although it can also be found in the right dorsal colon and the cecum of the large intestines. Sand can cause colic symptoms comparable to other major colon impactions, and it frequently causes stomach distension. Diarrhea can occur when sand or debris irritates the intestinal lining. The weight and abrasion of the sand or dirt inflames the intestinal wall and can cause a decrease in colonic motility, and in severe cases, leads to peritonitis (Constable et al., 2017; Hassel et al., 2020).

Diagnosis is usually made by history taking, environmental factors, and auscultation of the ventral abdomen, radiography, ultrasonography, or fecal examination. Historically, laxatives such as liquid paraffin, oil, and psyllium husk have addressed the condition. Recently, veterinarians have used specialized synbiotics (pro and prebiotic) and psyllium combinations to treat instances. The most successful medicinal treatment is psyllium(Niinistö et al., 2018). It works by binding to the sand and assisting in its removal. However, numerous treatments may be required. Mineral oil is typically ineffectual since it floats on the impaction's surface rather than penetrating it. Horses should not be fed directly on the ground in sandy or desert places. One prevention method is to feed a pelleted psyllium for one week every 4-5 weeks (Constable et al., 2017; Hassel et al., 2020).

E. Enterolith and fecalith colic

It is a round' stone' of mineral deposits, most commonly ammonium magnesium phosphate (struvite), that forms within the horse's gastrointestinal tract. They can form around an ingested foreign substance, such as a small nidus of wire or sand. It is also termed phytobezoars, referring to the accumulation of indigestible ingested materials in the GIT. It can clog the gut when they shift from their initial location, generally in the right dorsal and transverse colon, but rarely in the small colon. When they migrate through the gastrointestinal tract, they may induce mucosal irritation or pain. Even if they are more prevalent in regions with sandy soil or where alfalfa hay is fed in large quantities, enteroliths or phytobezoars are not usually the cause of colic. Because of its high protein content, which is likely to enhance the levels of ammonia nitrogen in the colon, alfalfa hay is indicated to increase the risk. They might be more prevalent in horses who feed a lot of magnesium. The symptoms of chronic, low-grade, recurrent colic in horses with enteroliths can develop into acute colic and distention of the large intestine if the lumen is obstructed (Constable et al., 2017; Hassel et al., 2020).

Radiographs of the abdomen help in the diagnosis but may not show small enteroliths. During a rectal examination, enteroliths may occasionally be palpable, primarily if they are located in the small colon. When an enterolith is identified as the source of a horse's colic, surgery is needed to remove it, typically involving a pelvic flexure enterotomy and maybe an additional right dorsal colon enterotomy, to alleviate the colic symptoms. A horse's enterolith will often be circular if it has just one. On the other hand, the flat edges of numerous enteroliths frequently indicate to the surgeon that further stones should be sought. Colon rupture accounts for 15% of surgical risks, and 92% of recuperating horses live for at least a year following the operation. Fecaliths are ingestible hard formations that clog the GI tract and may require surgery to clear. These are typically found in miniature horses, ponies, and foals (Smith, 2001; Reed et al., 2009)

F. Worm impaction

The roundworms Parascaris spp. (*Parascaris quorum*) and tapeworms such as *Anoplocephala perfoliata* are the most common horse intestinal worm species (Gehlen et al., 2020). These parasites live in the small and large intestines and can cause diarrhea, thriftiness, and colic. Along with *Strongyle* infection, these worms have been reported to cause up to 81% of ileal impactions. On rectal examination, horses exhibit intermittent colic with moderate to severe indications and distended small intestinal loops over time. Verminous colic can be alleviated using potent anthelmintics such as oral administration of fenbendazole, fluid therapy, anti-spasmodic, and antibiotic medicines (Gehlen et al., 2020).

2. Strangulating obstruction

Strangulating obstructions exhibit all of the pathological characteristics of simple obstructions; they differ in that the blood supply is quickly compromised. Both arteries and veins can be impacted simultaneously or gradually, as with a simple occlusion, volvulus, intussusception or torsion, and intestine displacement via a hole, such as a hernia, a mesenteric rent, or the epiploic foramen, are common causes of strangulating blockage (Constable et al., 2017).

A. Small intestinal strangulating obstruction

Strangulation of the gut occurs when the intestinal lumen and blood supply are simultaneously blocked. While the strangulation of the intestinal lumen produces clinical symptoms similar to those of a simple blockage, the occlusion of the blood supply leads to a more rapid deterioration of the intestinal mucosa and the eventual development of endotoxemia (King and Gerring, 1988; Moore and Vandenplas, 2014). Strangulating blockage is classified as either hemorrhagic or ischemic. Because of the increased rigidity of artery walls in hemorrhagic strangulating blockage, the veins become clogged before the arteries. A darkish appearance in the affected colon and increased thickness as blood is pushed into the lesion are symptoms of this lesion. If the intestine is twisted tightly enough to occlude both arteries and veins, an ischemic strangulating blockage will result. Because of the complete lack of blood flow, the tissue implicated in an ischemic strangulating block appears pale and of normal or reduced thickness (Constable et al., 2017; Mair and Sherlock, 2023).

Clinically, there is frequently an almost immediate onset of severe abdominal discomfort in acute and total blockages of the small intestine, with intestinal ischemia due to volvulus, intussusception, or torsion. During this early period, there is still digestive sound and feces passing. The pulse rate ranges from 60 to 80 beats per minute, the respiratory rate is around 80 breaths per minute, and sweating is increased. It may take 8-12 hours for dilated loops of the intestine to be palpable on rectal examination; this is also when clinical and biochemical evidence of dehydration begins to manifest (Azizi and Masoudi, 2022). Furthermore, 12-24 hours after the obstruction begins, the pulse rate rises to 80-100 bpm, inflated intestine loops are palpated, gut noises and defecation cease, and the rectum is empty and sticky to touch. Dehydration becomes noticeable after 24 hours, although the pain does not worsen; however, the heart rate rises to 100-120 beats per minute. Intestinal loops are easily palpated rectally, and a lot of fluid is being evacuated by the stomach tube. Endotoxemia or intestinal rupture frequently results in death within 48 hours, and the terminal stage is one of severe endotoxic shock with or without intestinal rupture and per-acute widespread peritonitis (King and Gerring, 1988; Moore and Vandenplas, 2014).

In small intestine displacement without vascular involvement, the pain tends to be less intense, and analgesics effectively alleviate it. Vital signs may be moderately affected but do not deteriorate significantly over time. The pain may be intermittent or chronic, with moderate episodes of discomfort alternating with periods of uneasiness and no evidence of overt pain. In some circumstances, the length of colic may range from several days to many weeks. Because of the induced endotoxemia, the surgical interventions should be simultaneously accompanied by treatment of signs of endotoxemia. Hyperimmune sera from horses recovered from *Salmonella* Typhimurium or *E. coli* can reduce the severity of clinical signs of disease in horses with endotoxemia secondary to enterocolitis or colic. As a neutralizing agent for bacterial toxins, polymyxin can attenuate the effect of endotoxin and is used to prevent and treat endotoxemia (Bauquier et al., 2016). Flunixin meglumine or phenylbutazone are given for analgesia and to prevent endotoxin-induced increases in plasma prostaglandins. Antibiotics are often administered to horses with severe colic and evidence of toxemia because of presumed bacteremia (Constable et al., 2017; Mair and Sherlock, 2023).

B. Large intestinal strangulating obstruction

Colonic volvulus is a potentially fatal illness that affects horses as young as two days old and has no breed propensity. The case fatality rate varies according to the extent of the volvulus, with lower degrees of volvulus (>270°) having a 30% fatality rate and greater degrees of volvulus (>360°) having a 65% fatality rate (Constable et al., 2017). The disease was most common in mares, particularly those in late pregnancy or after foaling. The onset of discomfort is rapid, and the disease lasts from hours in horses with strangulating lesions to days in horses with 270-degree torsion. The horse forcefully throws itself to the ground as the agony progresses from mild to severe and intractable. Pain in horses with 360 degrees or more volvulus is frequently resistant to analgesics. Heart rate varies and may be less than 40 beats per minute in horses with severe disease; however, it is normally greater than 60 beats per minute and increases with disease severity. There is also abdominal distention, and abdominal auscultation demonstrates a lack of borborygmi and the presence of "pings" on simultaneous auscultation and percussion. Furthermore, there is no stomach reflux via a nasogastric tube. The temperature of the rectal cavity is within the normal range.

In seriously injured horses, the mucous membranes of the conjunctiva, vagina, and gums are dark red to blue, and the capillary refilling time (CRT) is greater than 3 seconds (Stephen et al., 2004). The inflated, gas-filled colon occupying the caudal abdomen may impede rectal examination. Death occurs within 12 to 24 hours in untreated situations from cardiovascular collapse. Similar interventions can be followed for small intestine strangulating obstruction for large intestine strangulating obstruction. This includes surgical operation and treatment of signs of endotoxemia, including the administration of hyperimmune sera, polymyxin, flunixin meglumine or phenylbutazone, and antibiotics (Constable et al., 2017; Mair and Sherlock, 2023).

C. Epiploic foramen entrapment

Through the epiploic foramen, a section of the small intestine or, in rare instances, the colon, may become lodged inside the omental bursa. The only possible treatment is surgery because the blood flow to this particular segment of the intestine is cut off instantly. This kind of colic has been linked to cribbing behavior, probably because of the elevated stomach pressure, and to older horses, possibly because the epiploic foramen enlarges as the liver's right lobe atrophies with age. Colic symptoms, including severe restlessness, rolling, tachycardia, and polypnea, are typically caused by a minor intestinal blockage (Constable et al., 2017; Salcedo et al., 2019).

D. Mesenteric rent entrapment

Sometimes, a small rent (hole) may develop in the mesentery, allowing a piece of bowel to enter through this opening. The gut enlarges first, as in epiploic foramen entrapment, since arteries do not occlude as easily as veins, causing edema (fluid buildup). As the gut enlarges, freeing itself from the entrapment site becomes progressively more challenging. Colic symptoms associated with this condition typically include moderate to severe abdominal pain, the development of endotoxemia, decreased gut sounds, an enlarged small intestine observable during rectal examination, and nasogastric reflux. Surgical intervention is generally necessary to address this issue effectively. Survival rates for mesenteric rent entrapment are typically lower than for other minor intestinal strangulating lesions, presumably because of hemorrhage, difficulties resolving the entrapment, and the length of intestine commonly implicated, with 50% of cases surviving until discharge (Constable et al., 2017; Salcedo et al., 2019).

E. Strangulating pedunculated lipoma

Lipomas are benign fatty tumors that can grow on the mesentery. As these tumors grow, the surrounding connective tissue can elongate into a stalk, which has the potential to encircle a portion of the intestine, typically the small intestine. This can result in the constriction of blood flow to the affected intestinal segment. The tumor creates a button that latches onto the tumor stalk, trapping it in place and necessitating surgery to remove it. This can be done by cutting the tumor's stalk, the gut is untwisted, and removing necrotized bowel tissues. If colic is detected early and treated promptly, there is a 50-78% chance of success. This type of colic is more typically associated with ponies and elderly geldings; 10 years or more are more likely due to fat distribution in this group of animals (Freeman and Schaeffer, 2001; Constable et al., 2017).

3. Non-strangulating infarction

It is a kind of colic caused mostly by parasitic infection (termed verminous colic), specifically, *Strongylus vulgaris*, which migrates to the cranial mesenteric artery and its branches, causing blood supply limitation or nerve supply injury to the colon. *Strongylus* species are the most common parasites identified in the lumen of the large intestine of horses, producing mucosal inflammation and consequent severe and chronic diarrhea, resulting in emaciation and death. Furthermore, *Strongylus vulgaris* larval migration was linked to repeated colic attacks, with the

larva migrating from the intestinal arteries to the cranial mesenteric artery. Horses suffering from verminous colic exhibit clinical indications of persistent and recurring colic despite having normal bowel sounds (Pihl et al., 2018).

The affected horse feeds infrequently and drinks very little water. Furthermore, the affected horses continually paw with one or both forelegs. The pulse and apparent mucus membrane color remained normal until the affected horses' physical condition dramatically worsened. The discomfort can last several days or weeks if the illness is not accurately detected and treated swiftly. Weight loss, weakness, acute or chronic diarrhea, pyrexia, subcutaneous edema, and colic are clinical indications of larva cyathostominosis in horses. Affected horses frequently have a normal appetite and water consumption. Rectal examination may reveal inflated loops of the intestine and firmly stretched mesentery, but the distention is neither severe nor widespread (Poulsen et al., 2023). If the horse is not too large, the cranial mesenteric artery's root can typically be palpated as a definite hard swelling in the midline level with the caudal pole of the left kidney. Such a kidney will be significantly larger, with a rough, knobbly surface, and it will usually be pulsated with each pulsation of the cranial mesenteric artery. For treatment, surgical operation will be required for excision of the necrotized part followed by anastomosis of healthy parts of affected GIT or blood vessels. In addition, medical treatment can be attempted for this type of colic using potent anthelmintics, fluid therapy, antispasmodic, and antibiotic medicines (Constable et al., 2017; Pihl et al., 2018).

4. Ulcerative or inflammatory colic

A. Gastric ulcer

Equine gastric ulcer syndrome is a disease that causes stomach ulcers in horses. Constraints, infrequent feedings, a high percentage of concentrated feed such as grains, overuse of nonsteroidal anti-inflammatory medications, and the strain of transporting and exhibiting are risk factors. Gastric ulcers have been associated with ingesting cantharidin beetles commonly found in alfalfa hay. These beetles are highly caustic when chewed and swallowed. Horses with gastric ulcers often exhibit colic signs shortly after feeding, especially when consuming high-grain feed (Vokes et al., 2023).

Additionally, they may display symptoms such as dullness, anorexia, and weight loss. Most ulcers can be treated with drugs that suppress the stomach's acid-producing cells. Antacids are less effective in horses than humans because horses continuously create stomach acid, whereas humans only make acid when they eat. Dietary control is essential. Bleeding ulcers that cause stomach rupture are uncommon (Helman and Edwards, 1997; Vokes et al., 2023).

B. Enteritis

Proximal enteritis is an inflammation of the duodenum and upper jejunum. It is also known as anterior enteritis or duodenitis-proximal jejunitis (DPJ). This condition can be triggered by infectious agents such as *Salmonella* and Clostridial species, but other factors like *Fusarium* infection or the consumption of high-concentration diets may also contribute to its development (Weese et al., 2001; Diab et al., 2012, 2013).

Inflammation of the gut causes massive discharges of electrolytes and fluid into its lumen, resulting in large volumes of gastric reflux and, occasionally, shock. Acute onset of moderate to severe pain, significant volumes of orange-brown and fetid gastric reflux, dilated small intestine on rectal examination, fever, depression, elevated heart and respiratory rates, extended CRT, and darkened mucous membranes are all symptoms. Pain typically decreases after stomach decompression in cases of DPJ. It is crucial to differentiate DPJ from small intestinal obstruction because the latter may require surgical intervention (Feary and Hassel, 2006; Uzal and Diab, 2015).

Distinguishing between these conditions can be challenging and often relies on a combination of clinical signs, physical examination findings, laboratory tests, and ultrasound to support one diagnosis over the other. However, a definitive diagnosis can only be confirmed through exploratory surgery or post-mortem examination (necropsy). DPJ is often treated medically with nasogastric intubation every 1-2 hours to relieve gastric pressure caused by reflux and vigorous fluid support to maintain hydration and correct electrolyte imbalances. Horses are frequently denied nourishment for several days. Anti-inflammatory, anti-endotoxin, anti-microbial, and prokinetic medicines are commonly used to treat this disease (Feary and Hassel, 2006; Uzal and Diab, 2015).

C. Colitis

Colon inflammation is known as colitis. The horse rapidly loses fluid, protein, and electrolytes through the intestines, which causes hypovolemic shock, severe dehydration, and death. For this reason, it is regarded as a medical emergency. Horses usually have colic symptoms before developing a lot of watery, foul-smelling diarrhea. Colitis can have both infectious and non-infectious origins. Horse colitis is frequently caused by *Salmonella*, *Clostridium difficile*, and *Neorickettsia risticii* in adult horses (Thirumalapura et al., 2023; Uchida-Fujii et al., 2023).

Antibiotics can adversely alter the microbiota microenvironment, whereas sand, grain, and poisons like arsenic and cantharidin can also cause colitis. The treatment of colitis typically involves the administration of large volumes of intravenous fluids to address severe dehydration and fluid loss. Antibiotics are often prescribed to manage the underlying infection or inflammation. Additionally, plasma or synthetic colloid solutions may be administered to prevent the development of endotoxemia and improve blood protein levels, contributing to the overall treatment strategy for colitis. NSAIDs can cause colitis to develop more slowly. Laminitis is a potential consequence for horses suffering from colitis, and it can become the primary reason for euthanasia due to the risk of endotoxemia. Horses with colitis are also more susceptible to thrombophlebitis, which is inflammation of the veins often associated with the formation of blood clots. These conditions can further complicate the management and prognosis of colitis cases (Feary and Hassel, 2006; Uzal and Diab, 2015).

Diagnosis of equine colic

The diagnosis of colic of intestinal etiology was achieved based on the patient's medical history, physical examination results (hematology, plasma biochemistry, rectal examination, ultrasonography, gastric reflux, abdominocentesis, exploratory laparotomy, color of mucous membranes, capillary refill time, and borborygmi), and response to treatment (Constable et al., 2017).

Case history

Upon arrival, gathering an accurate and comprehensive history of the affected animals is essential. This should include information such as the age and gender of the horse, the onset and duration of colic pain, details about the feed and water intake, and the management and housing practices. Additionally, any observations or signs noticed by the owner should be meticulously recorded, as they can provide valuable insights into the horse's condition and help guide the diagnostic and treatment process (Hunt et al., 1986; Bonfig, 1988; Dukti, 2012).

Clinical signs

Horse pain often manifests through behavioral changes, such as pawing, stamping, or kicking at the belly. Restlessness may be evident as the horse paces in small circles or repeatedly stands up and lies down, often with exaggerated care. Other pain symptoms can include nibbling, staring at the flank, rolling, and even lying on their back. These behaviors serve as important indicators of discomfort or distress in horses (Rhodes and Madrigal, 2021).

The penis is frequently protruded without urinating or with frequent small-volume urine. It is usual to play with water without actually drinking (sham drinking). Discomfort can be continuous or intermittent, with bouts of discomfort lasting up to 10 minutes and followed by equivalent periods of relief. In general, the severity of the pain remains consistent throughout the illness; sudden exacerbations may indicate a change in the disease status or the development of another abnormality, such as a horse with large colon impaction developing a displacement of the colon or a horse with diarrhea developing necrotizing enteritis. Horses

nearing the end of their lives may experience a significant reduction in pain due to pressure relief from a ruptured bloated bowel and depression produced by toxemia and shock. Pain responses in colic can be so acute, and uncontrolled movements so violent that the horse can injure himself severely. Other causes of pain, such as pleuritis or rhabdomyositis, can be confused with colic, but a horse that collapses and rolls almost certainly has alimentary tract colic (Dukti, 2012; van Loon and Van Dierendonck, 2015; Constable et al., 2017; Mair and Sherlock, 2023; Talbot et al., 2023).

The horse's posture is frequently aberrant, with the forefeet more cranial, the hindfeet more caudal than usual, or the so-called "sawhorse" stance. Some horses lie on their backs with their legs in the air, indicating a need to relieve mesenteric stress. Abdominal distension is a rare but significant diagnostic symptom. The most common cause of symmetric, severe distension is distension of the colon, occasionally involving the cecum, as a result of colon torsion or impaction of the large or small colon, with subsequent fluid and gas collection. The abdomen can exhibit an asymmetrical enlargement in the right sub-lumbar fossa if just the cecum is dilated. Maximum distension of the stomach or small intestine does not result in noticeable distension of the abdomen (Constable et al., 2017; Mair and Sherlock, 2023).

Physical examination

The heart rate in horses can serve as a valuable predictor of illness severity and progression, although it may have limited diagnostic utility. Typically, horses with heart rates below 40 beats per minute often have mild disease, whereas those with heart rates exceeding 120 beats per minute frequently have severe or more advanced disease. Monitoring heart rate is an important component of assessing a horse's overall health and can aid in determining the seriousness of their condition. Heart rates in horses with obstructive, non-strangulating illness are frequently between 40 and 60 beats per minute. Horses with strangulating illness or necrotic gut typically have heart rates of more than 80 beats per minute. However, heart rate is not a perfect predictor of illness severity, as horses with colon torsion can have heart rates of 40 to 50 beats per minute. The respiratory rate varies and might reach 80 breaths per minute during periods of intense pain (Stashak, 1979; Dukti, 2012).

In normal horses and horses with adequately functioning cardiovascular systems, the color of their visible mucous membranes typically appears pink and moist and returns to its normal position within approximately 2 seconds after being relieved of firm digital pressure. This observation of mucous membrane color and capillary refill time is essential to a clinical examination assessing a horse's health and circulatory status. Dehydrated horses have dry mucous membranes despite appropriate capillary refill time and color. Horses with poor cardiovascular function exhibit pale, dry mucous membranes and delayed capillary refill (over 2 seconds) (Constable et al., 2017; Rhodes and Madrigal, 2021).

In endotoxemic horses, mucous membranes often present with varying characteristics as the condition progresses. Initially, the mucous membranes may appear bright red, and capillary refill may be either normal or slightly delayed. As the disease advances, the mucous membranes can turn blue or cyanotic, and the capillary refill time exceeds 3 seconds. In the terminal stages of the disease, mucous membranes may become cold, purple, and dry, and the capillary refill time remains prolonged at more than 3 seconds. In severe cases, the gingival edges of the gums may show signs of necrosis, commonly referred to as the "toxic line." These changes in mucous membrane appearance and capillary refill time indicate the severity of endotoxemia in horses. Cool extremities can indicate reduced cardiovascular function, but they should be interpreted cautiously and only in the context of the rest of the clinical examination (Constable et al., 2017; Rhodes and Madrigal, 2021; Mair and Sherlock, 2023).

Sweating is a common symptom in horses experiencing severe abdominal pain, and when it is observed in combination with cold extremities and signs of circulatory failure, it can be indicative of a poor prognosis (Constable et al., 2017). Abdominal auscultation, which involves listening to the sounds produced within the abdomen, can provide valuable diagnostic and prognostic information. It should be conducted thoroughly and without haste to accurately assess the horse's condition and guide appropriate treatment and management decisions. The abdomen's four quadrants (dorsal and ventral, left and right sides) should be checked for at least 1 minute at each spot. The strength, frequency, and nature of spontaneous gut sounds (borborygmi) should be noted. Repeated observations are frequently required to discover intermittent or rapid changes in the borborygmi's nature. Continuous, loud borborygmi in all or most quadrants is a sign of intestinal hypermotility and is associated with spasmodic colic, imminent diarrhea, or the very early stages of a small intestinal obstructive/strangulating lesion. Ileus is characterized by the lack or presence of intermittent high-pitched, short sounds, sometimes with a splashing nature. These noises are not confused with typical peristalsis's rolling, lengthy sounds. A pinging sound like that formed by flicking an inflated balloon is produced by combining percussion and auscultation. Such sounds suggest the presence of a firmly gas-distended bowel close to the body wall. This intestine is nearly typically of the large colon or cecum type and is associated with gas distension related to ileus, small or large-colon impaction, gas colic, or colon displacement, including torsion (Constable et al., 2017; Rhodes and Madrigal, 2021; Mair and Sherlock, 2023).

A thorough rectal examination is perhaps the most crucial aspect of colic clinical evaluation and should not be overlooked. To make reasonable and correct judgments concerning the position of various organs, the examiner must be familiar with the anatomy of the posterior abdomen. Gas and fluid distension of the cecum and colon, fluid distension of the small intestine, impaction of the large and small colon, and displacement of the large colon should all be recognized. Small-intestinal distension manifests as loops of tubular structures 10 to 15 cm in diameter extending as far caudally as the pelvic canal. Rectal palpation can reveal colonic distension, impaction, and displacement. The large colon is distended with gas and liquids. Large (>20 cm) stretched structures reaching the pelvic canal indicate gas and fluid distension of the large colon. The dilated colon may extend into the pelvic canal, preventing the caudal abdomen from being examined. Impaction is visible in the large or small colon as columns of hard ingesta. The pelvic flexure in the caudoventral abdomen and the entry to the pelvic canal are the most prevalent sites. When squeezed with the fingertips, the affected material remains imprinted. Loops of tubular structures in the caudal abdomen indicate small colon distension. The gut loops have a pronounced anti-mesenteric band, which is not seen in the small intestine. Large colon displacement is seen rectally as tight bands running from the ventral abdomen cranially, dorsally, and to the left or cranially, dorsally, and the right in left and right colon displacements, respectively. Displacement of the colon, if it obstructs the normal movement of ingesta and gas, may result in asymmetrical abdominal distension of the horse, necessitating specialized assessment and care (Constable et al., 2017; Mair and Sherlock, 2023).

The passage of a nasogastric tube is a crucial step in evaluating a colic horse, as it serves multiple purposes. First, it provides important diagnostic information, including assessing the presence of gastric distention, reflux of stomach contents, or other abnormalities. Second, relieving gastric distension through nasogastric intubation can be life-saving in cases of colic by alleviating pressure on the stomach and preventing further complications. When successfully passed, the nasogastric tube should extend through the esophagus and into the stomach, allowing for the evaluation and treatment of gastric issues. As the stomach is penetrated, this is usually indicated by the emission of a small amount of sweet-smelling gas.

Indeed, the procedure for nasogastric intubation and assessing for reflux in colic cases is a critical diagnostic and therapeutic measure. Here are the key steps reiterated:

1. Advance the nasogastric tube into the stomach.
2. Establish a siphon by adding approximately 500 mL of water to the tube.
3. Swiftly lower the end of the tube below the horse's stomach to induce reflux.
4. If reflux is not obtained, repeat the process three or four times and carefully record the amount and characteristics of the reflux.

Table 1: Selected biomarkers for colicky horses with different types of gastrointestinal lesions.

Biomarker	General function	Finding during colic	Diagnostic or prognostic value	Reference
Procalcitonin (PCT)	PCT is a precursor to the calcitonin hormone, which is a regulator to calcium levels.	PCT is increased in colicking horses as a result of systemic inflammatory response syndrome (SIRS)	Proinflammatory cytokines stimulate the secretion of PCT into the circulation during SIRS.cannot be used as a colic biomarker.	Nocera et al. (2021)
Interleukin-6 (IL-6)	Pro-inflammatory cytokine	- The levels of IL-6 in peritoneal fluid and blood were higher in strangulating intestinal lesions compared to non-strangulating lesions in affected horses - Peritoneal IL-6 levels were higher than the serum levels.	The prognostic utility of measuring IL-6 levels was higher than diagnostic utility because of non-specific release during colic cases.	Barton and Collatos (1999)
Interleukin-1β (IL-1β)	Pro-inflammatory cytokine	- Serum IL-1β in horses with intestinal strangulations was significantly higher than the healthy horses - There was no correlation between serum IL-1 β and patient survival	The prognostic utility of measuring IL-1β levels was higher than diagnostic utility because of non-specific release during colic cases.	Teschner et al. (2015)
Tumor necrosis factor-α (TNF-α)	Pro-inflammatory cytokine and signaling pathway mediators	TNF-α levels were increased in case of strangulating diseases than healthy or mild inflammatory cases.	The prognostic utility of measuring TNF-α level was higher than diagnostic utility because of non-specific release during colic cases.	Ludwig et al. (2023)
Activin A	Activin A is a common marker for inflammation.	Strangulating or inflammatory lesions markedly induced an increment in serum activin A.	Activin A may have limited use as a diagnostic colic biomarker because of low specific reactivity.	Forbes et al. (2011)
Serum amyloid A (SAA)	SAA, a major acute phase protein (APP) in horses.	Increased levels of SAA were reported in serum or peritoneal fluid of horses with different causes of colic (inflammatory vs strangulating vs non-strangulating) against healthy horses.	Its short half-life time renders it a promising biomarker for the prognosis of inflammatory and treatment response	Ludwig et al. (2023)
Haptoglobin	Acute phase protein.	Haptoglobin levels are significantly increased in the peritoneal fluid of colicking horses, particularly in strangulating cases compared to healthy horses or non-strangulating ones.	The prognostic utility was higher than the diagnostic utility because of non-specific release during colic cases.	Pihl et al. (2015)
Fibrinogen	It is an APP involved in tissue repair and many immune responses	GIT inflammation induces a marked increase in fibrinogen levels with the earlier appearance in peritoneal fluids followed by plasma.	The prognostic utility was higher than the diagnostic utility because of non-specific release during colic cases.	Collatos et al. (1995); Pihl et al. (2015)
C-reactive proteins (CRP)	It is an APP that is produced as a feedback of cytokines production.	In horses, CRP is a moderate APP, it starts to elevate at 3–5 days post the inflammatory stimulus, and high levels have been reported in many other illnesses.	The prognostic utility was higher than the diagnostic utility because of non-specific and delayed release during colic cases.	Takiguchi et al. (1990); Yamashita et al. (1991)
L-Lactate	An ideal biomarker for equine colic.	It increases in the blood and peritoneal fluid as a response to anaerobic glycolysis due to poor tissue perfusion, which can occur in the ischemic intestine and collaterally impacted sections of the bowel.	- High levels of L-lactate were reported in peritoneal fluid and plasma of horses affected with strangulating or non-strangulating intestinal lesions compared to normal horses. - L-lactate concentrations were higher in peritoneal fluid than plasma in horses with intestinal strangulation and ischemia. Peritoneal fluid levels of L-lactate have a higher significance than the blood use and it can be used to differentiate between strangulating and non-strangulating intestinal lesions in horses with colic.	Latson et al. (2005); Peloso and Cohen (2012)
Creatine Kinase (CK)	CK is involved in the cellular energy homeostasis in many tissues of the intestine.	In colicking horses, an increased peritoneal CK was recorded which was a highly sensitive marker of a strangulating lesion, even more sensitive, though less specific, than peritoneal lactate.	Combined measuring of CK and lactate may provide a promising situation for the prognosis of colic.	Kilcoyne et al. (2019)
Intestinal fatty acid binding protein (I-FABP)	I-FABP is expressed by intestinal cells.	The I-FABP serum and peritoneal fluid levels in horses with colic demonstrated high concentrations of I-FABP in peritoneal fluid correlated with non-survival, while plasma I-FABP levels correlated with the requirement of colic surgery.	Its increase during confirmed colic cases has prognostic utility for small intestine involvement.	Nieto et al. (2005)
HMGB-1 and Nucleosome	Increased plasma HMGB-1 and nucleosomes are associated with the severity of GIT diseases in horses	Levels of HMGB-1 and nucleosomes were markedly increased in inflammatory and strangulating groups compared to healthy horses.	It cannot be used as a colic marker because it is secreted broadly in SIRS.	Bauquier et al. (2016)
Glucose	In colicky horses, usually hyperglycemia is highly recorded.	High glucose levels were recorded in 50.2% horses suffering from acute abdominal disease	Hyperglycemia in the first 48 hours of health care is correlated to a bad prognosis for survival to hospital discharge.	Hollis et al. (2007)
Acid-base and electrolyte imbalances	Acid-base and electrolyte imbalances are common sequelae to several systematic disorders in horses.	- All colic horses revealed a significant decrease in calcium and potassium levels. - Also, the diarrheic group revealed a significant decrease in Na1, tCa, tMg, total protein, and albumin. pH was not severely altered in any colic group.	The prognostic utility was higher than the diagnostic utility because of non-specific and delayed release during colic cases.	Navarro et al. (2005)

5. Measure the volume of reflux and anything above 2 liters of net reflux is considered significant.
6. If reflux occurs, keep the nasogastric tube in place or replace it at regular intervals (e.g., 1-hour intervals) until the colic resolves.
7. If there is no reflux, but the horse remains colicky, continue with repeated attempts to induce reflux.

Importantly, oral medications should not be administered to horses with nasogastric reflux. This procedure serves diagnostic and therapeutic purposes, providing valuable information, and can be life-saving by relieving stomach distension in colic cases (Constable et al., 2017; Mair and Sherlock, 2023).

Abdominal ultrasonography has been used to identify the exact reason for colic. The technique can be applied against the side of the horse or transrectally. Ultrasonography can help in diagnosing the presence of sand, distention, entrapment, strangulation, intussusception, and wall thickening of intestinal loops, as well as diagnose nephrogenic entrapment, peritonitis, abdominal tumors, and inguinal or scrotal hernias (Busoni et al., 2011; le Jeune and Whitcomb, 2014; Constable et al., 2017; Rhodes and Madrigal, 2021; Mair and Sherlock, 2023). Abdominal ultrasonography has proven to be a reliable tool for identifying small intestine outflow obstructions. Many horse clinics use ultrasonography in the diagnosis of acute abdomen routine work. The pace of abdominal ultrasonography in equine patients has enhanced the field ultrasound procedures. Nonmotile and enlarged small intestinal loops are linked to strangulated blockage. Renosplenic entrapment is linked to the inability to observe the left kidney, and strangulating volvulus is linked to a thickened large intestine (Beccati et al., 2011). The abdomen should be examined systematically with a 2.0 to 3.5-mHz transducer, and a procedure allowing rapid examination of the abdomen of horses has been proposed. This protocol's importance is ensuring a methodical and comprehensive evaluation of the chest and belly for indications of the colic's underlying cause (Epstein et al., 2008).

Laboratory findings

Although colic symptoms vary depending on the type, stage, and severity, equines with colic may have an increased hematocrit value, leucopenia a shift to the left in the case of endotoxemia, and increased total plasma protein. In horses with severe acidity and significant parts of the devitalized gut, hyperkalemia is prevalent. Hypokalemia is common in horses with chronic colic. In horses with severe colic, hypocalcemia and hypomagnesemia are prevalent. Serum urea nitrogen and creatinine levels are good hydration and renal function predictors. Hyperglycemia is frequent in horses suffering from colic. Most horses suffering from severe colic have metabolic acidosis (Constable et al., 2017; Ludwig et al., 2023).

Biomarkers are often proteins, enzymes, or other molecular changes that are elevated or lowered in body fluids during inflammation or disease. Biomarkers are an incredibly appealing tool for establishing the diagnosis and prognosis of equine gastrointestinal colic, one of the most common causes of morbidity and mortality in horses. Serum enzyme activities are rarely beneficial in assisting in the diagnosis or treatment of horses with colic. However, serum γ-glutamyl transferase (GGT) can be increased due to compression of the common bile duct by colon displacement. Horses with ischemia or inflammatory bowel illness had greater serum and peritoneal alkaline phosphatase activity. Horses that die from colic have greater adrenaline, cortisol, and lactate levels in their blood (Constable et al., 2017; Mair and Sherlock, 2023)(Constable et al., 2017; Ludwig et al., 2023; Mair and Sherlock, 2023).

In more detail, when testing a group of pro-inflammatory cytokines and mediators, systemic inflammatory response syndrome (SIRS) causes an increase in procalcitonin (PCT) in colicking horses (Nocera et al., 2021). Additionally, horses with strangulating intestinal lesions had considerably greater levels of IL-6 in their blood and peritoneal fluid than horses without such lesions, and IL-6 levels were more commonly elevated in the latter than in the former (Barton and Collatos, 1999). Comparing colicking horses with intestinal strangulations to a control group of healthy horses, serum IL-1β was considerably greater in the strangulated horses. However, Serum IL-1β levels and animal survival were not correlated(Teschner et al., 2015). Compared to healthy horses or horses with non-strangulating and non-inflammatory forms of colic, horses with ischemic/inflammatory lesions, enteritis, colitis, and strangulating intestinal lesions had considerably raised TNF-α concentration. Furthermore, high fatality rates in colicky horses have been linked to elevated serum TNF-α concentration (Ludwig et al., 2023). Additionally, the authors note that strangulating and non-strangulating intestinal lesions likely cause varying degrees of inflammation, so activin A should not be relied upon to differentiate between these causes of colic. Serum activin A was significantly higher than controls in horses with inflammatory or strangulating lesions (Forbes et al., 2011).

In comparison to healthy horses, horses suffering from distinct types of colic (inflammatory, strangulating, or nonstrangulating) were found to have elevated levels of serum amyloid A (SAA) in their serum or peritoneal fluid (Ludwig et al., 2023). Colicking animals had significantly higher haptoglobin levels in their peritoneal fluid than healthy horses. Additionally, horses with strangulating intestinal lesions revealed peritoneal fluid haptoglobin elevation more quickly (by 12–24 h) than horses with simple obstructions or inflammatory diseases and those suffering from chronic colic (Pihl et al., 2015). Similarly, significant increases in plasma and peritoneal fluid fibrinogen concentrations are seen in horses with inflammatory gastrointestinal diseases like colitis, enteritis, peritonitis, and equine grass sickness compared to healthy control horses (Collatos et al., 1995; Pihl et al., 2015). Peritoneal fluid changes occur earlier than blood changes. Elevated amounts of C-reactive protein (CRP), a mild APP in horses, have been observed in those with sepsis, colic, enteritis, and those who underwent experimental jejunojejunostomies. It rises about 3–5 days after the inflammatory stimulus (Takiguchi et al., 1990; Yamashita et al., 1991).

Additionally, several items have been examined to find appropriate indicators for equine colic. In this regard, peritoneal fluid and plasma L-lactate levels in horses with strangulating or non-strangulating intestinal lesions were substantially higher than in healthy animals. In horses with intestinal strangulation and ischemia, peritoneal fluid L-lactate levels were substantially higher than plasma levels. In horses with colic, L-lactate levels in peritoneal fluid but not in the blood can be utilized to distinguish between strangulating and non-strangulating intestinal lesions (Latson et al., 2005; Peloso and Cohen, 2012). Even more sensitive than peritoneal lactate, increased peritoneal creatine kinase in horses with colic has been documented as a highly sensitive indication of a strangulating lesion (Kilcoyne et al., 2019). High peritoneal fluid concentrations of the intestinal fatty acid binding protein (I-FABP) were associated with non-survival, while plasma I-FABP concentrations were associated with the need for colic surgery in horses that presented with colic with strangulating lesions (Nieto et al., 2005).

Compared to healthy horses, concentrations of HMGB-1 and nucleosomes were significantly greater in the inflammatory and strangulating groups but not in the horses with nonstrangulating disease (Bauquier et al., 2016). When horses with acute abdominal illness were admitted, blood glucose levels were 50.2% higher than the reference range, 0.4% lower than the reference range, and 49.4% within the reference range (Hollis et al., 2007). All horses suffering from colic disorders showed a slight but statistically significant drop in ionized Calcium (tCa21) concentration. Except for those in the inflammatory group, horses with colic had moderately but significantly lower potassium levels. Additionally, the diarrheic group showed a slight but substantial decrease in sodium ion (Na1), tCa, total magnesium ions (tMg), total protein, and albumin, even though none of the colic groups' pH levels were significantly affected (Navarro et al., 2005) (Table 1).

Differential diagnosis of equine colic

Based on previous clinical and laboratory investigations, different types of colic in equine can be summarized in specific points, as shown in Table 2. Pain and its severity, repetition, and signs are very important to distinguish between different types of colic. Sudden, intense, and recurrent colic in the form of fits or bouts usually is characteristic of spasmodic colic. A severe form of

Table 2: A brief scheme for differential diagnosis of equine colic.

Parameter	Spasmodic colic	Tympanic colic	Impaction colic	Obstructive colic
Pain	Intermittent	Continuous	Continuous	Continuous
Sweating	Patchy	Distributed	Distributed	Generalized
Muscular tremor	Absent	May occur	May occur	May occur
Temperature	Normal	Slight increase	Slight increase	Slight increase
Pulse rate	Increased during attack	Increased	Increased	Increased
Respiratory rate	Increased during attack	Increased	Increased	Increased
Visible mucous membranes	Normal	Congested	Congested	Congested
Gastric reflux	Absent	Absent	May occur	May occur
Intestinal sound	Present	Present	Absent	Usually absent
Sonography	Negative	Useful	Useful	Useful
Rectal palpation	Negative	Useful	Useful	Useful
Feces	Present	May occur	Absent	Absent
Passage of sands	May occur	Absent	Absent	Absent
Passage of flatus	Absent	May occur	Absent	Absent
Passage of blood	Absent	Absent	Absent	May occur
Abdominal distention	Absent	Marked	Slight	Marked
Palpation on flank	Hard	Elastic	Doughy	Hard
Percussion flank	Dull	Drum like	Dull	Dull
Lactate	Normal	Normal	Normal or low	High
C-reactive protein (CRP)	Low	Low	Moderate or high	High
Serum amyloid A	Low	Low	Moderate or high	High
Procalcitonin	Low	Low	Moderate or high	High
Treatment	Spontaneous or Medical	Medical	Medical or surgical	Surgical

Figure 2: A diagram showing brief steps for reducing the risk of colic in horses.

colic is manifested by intense pain, usually associated with remarkable changes in systemic status indicated by a high rise in body temperature, heart rate, and respiratory rate. Investigation of visible mucous membranes such as conjunctiva, gums, or vagina has a considerable concern during colic diagnosis or prognosis. Changes in capillary refilling time, color, and wetness of mucous membranes are usually observed during severe or complicated cases of colic, such as obstruction, non-strangulating, or strangulating colic.

Abdominal palpation, rectal examination, and coprological testing are valuable in recognizing colicky horses with abnormal GIT contents and detecting the type of such content (gas, ingesta, fluid, foreign bodies). This is a highly helpful approach for accurate diagnosis, prognosis, and rapid treatment of the cause of horse illness (Constable et al., 2017). Advancements in developing and using ultrasonographic and radiographic technology medical diagnostics have also been exploited in veterinary medicine. Diseases such as enterolith, foreign bodies, and strangulating or impaction obstructions can be detected efficiently using ultrasonographic and radiographic technology (Busoni et al., 2011; le Jeune and Whitcomb, 2014). In addition, certain biomarker levels have been greatly altered during severe or complicated cases of colic, such as lactate, SAA, and CRP. Therapeutic diagnosis is a critical approach for differential diagnosis of colic, relying on the degree of response and recovery if it exists (Constable et al., 2017; Rhodes and Madrigal, 2021; Mair and Sherlock, 2023).

General approaches for treatment and prophylaxis of equine colic

Briefly, equine colic is treated through four pathways: 1) analgesia, 2) restoration of body fluid, electrolyte, acid-base, and hemostatic imbalances, 3) gastrointestinal lubrication or administration of fecal softeners, and 4) treatment of underlying disease. In addition, it is possible to prevent or reduce the incidence

of equine colic if good management practices of equine animals have been conducted. These practices include offering animals regular exercise and supplying appropriate and healthy feeds. Also, avoiding stressful conditions, extreme cold or hot weather, and sudden diet changes is important. Monitoring of animal health, regular vaccination, and deworming procedures should be thoroughly performed to reduce the risk of colic (Dukti, 2012; Constable et al., 2017; Rhodes and Madrigal, 2021; Mair and Sherlock, 2023) Figure 2.

Concluding remarks

Review work has the potential to inspire researchers and scientists working in the same domain. We attempted to share the research aptitude, a rational approach, and a profound understanding of equine colic research. We have thoroughly examined the etiological and clinical facets of equine colic in the current study. There is a severe shortage of knowledge in this area, and some papers have only covered a few aspects. Furthermore, the biomarkers analysis test was primarily used to investigate contemporary methods for diagnosis and prognosis. Equine colic is among equines' most important, common, and emergent health issues, particularly horses. Although colic syndrome is primarily diagnosed and even recognized by the owners, accurate diagnosis of the real cause is difficult, especially for complicated cases. Such a step of correct diagnosis is vital for successful case handling, management, and treatment. In this context, insights from clinicians and researchers might help develop an appropriate tool not only for the diagnosis of the real cause of colic but also for the prognosis and evaluation of the degree of severity or fate of the disease. Exploiting the great advances in the sonographic and radiographic industry and the revolutionary progress of biomarker discovery are the prospects to diagnose and treat equine colic efficiently.

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