Enteral fluid therapy through nasogastric tube in rumen cannulated goats[1]

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ABSTRACT.- Atoji-Henrique K., Ribeiro Filho J.D. & Malafaia P. 2012. **Enteral fluid therapy through nasogastric tube in rumen cannulated goats.** *Pesquisa Veterinária Brasileira 32(12):1281-1284.* Coordenação de Zootecnia, Universidade Tecnológica Federal do Paraná, Dois Vizinhos, PR 85660-000, Brazil. E-mail: katiatoji@gmail.com

This paper reports the effects of fluid therapy in goats through nasogastric route with an electrolyte solution composed by concentrations of sodium, potassium and chloride similar to goat plasma (140mmol/L of Na^+, 4.5mmol/L of K^+, 110mmol/L of Cl^-). Four Alpine Chamoisee goats, two of them with evident leakage of the rumen cannulas, were used in a crossover experimental design of two periods and two groups. In one group the two goats were submitted to a treatment protocol to induce dehydration before the fluid therapy, whereas the other group was not. Fluid therapy consisted supplying 10mL/kg/h of the electrolyte solution during 8 hours. No signs of discomfort or stress were observed. The dehydration model employed caused a mild dehydration indicated by decrease in feces humidity, body weight and abdominal circumference, and increase in plasma total solids concentration. During fluid therapy globular volume and plasma total solids decreased, whereas % body weight and abdominal circumference increased. No signs of hyperhydration were observed and serum electrolytes (Na^+, Cl^-, K^+) presented no significant alterations in both groups. Fluid therapy proposed in this study was efficient to treat dehydration, even for rumen cannulated animals with evident leakage, and can be administrated safely with no electrolyte imbalance.

INDEX TERMS: Electrolyte imbalance, enteral fluid therapy, nasogastric tube, dehydration, goats.

RESUMO.- [**Fluidoterapia enteral por via nasogástrica em cabras fistuladas no rúmen.**] Este estudo relata os efeitos da fluidoterapia em cabras que receberam, por via nasogástrica, uma solução eletrolítica com concentrações de sódio, potássio e cloreto similares às verificadas no plasma de caprinos (140mmol/L of Na^+, 4.5mmol/L of K^+, 110mmol/L of Cl^-). Foram utilizadas quatro cabras da raça Parda Alpina, sendo duas com cânulas ruminais apresentando vazamento evidente, em um delineamento experimental *crossover* com dois períodos e dois grupos. Em um grupo, as cabras eram submetidas a um protocolo terapêutico para induzir a desidratação antes da fluidoterapia enquanto o outro grupo não passava por este protocolo. A fluidoterapia consistia em fornecer 10mL/kg/h da solução eletrolítica durante 8 horas. Não foi observado nenhum sinal de desconforto ou estresse. O protocolo para induzir a desidratação ocasionou desidratação moderada indicada pela diminuição da umidade das fezes, peso corporal e circunferência abdominal e aumento da concentração de sólidos totais no plasma. Durante a fluidoterapia o volume globular e a concentração de sólidos totais no plasma diminuiram, enquanto o peso vivo e a circunferência abdominal aumentaram. Não foram observados sinais de hiper-hidratação e dos eletrólitos (Na^+, K^+, Cl^-) em ambos os grupos. A fluidoterapia proposta neste trabalho foi eficiente em tratar a desidratação, inclusive dos animais fistulados apresentando evidente extravasamento de líquido ruminal, e pode ser administrada com segurança, sem a ocorrência de desequilíbrios eletrolíticos.

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TERMOS DE INDEXAÇÃO: Caprinos, fluidoterapia enteral, tubo nasogástrico, desequilíbrio eletrolítico, desidratação.

INTRODUCTION

Rumen cannulated animals are indispensible for feeding evaluation trials, quantitative aspects of digestion and microbial studies. Cannulas are implanted through surgical fistulas and kept permanently with a good post operative prognosis, and the animals can survive for long periods (Gomes et al. 2009). However those animals demand some special care, such as, weekly cleaning and disinfection of the surgical fistula and cannula, as well as, the replacement of the cannula when needed. The appropriated size of the cannula is a very important feature because if it does not fit in the fistula, the rumen content begins to leak and may result in microbial alteration and dehydration that are very deleterious for the animals (Gomes et al. 2009).

Dehydration is the most important indication for fluid therapy (Roussel 2004) and is commonly observed in fistulated goats. Fluid administration aims to restore plasma volume and tissue perfusion, and to correct plasma electrolyte concentrations and acid-base imbalances (Spier et al. 1993). Diseases affecting goats as coccidiosis, worms, mycoplamosis, caseous lymphadenitis, contagious ectyma, caprine arthritis-encephalitis and ketosis may cause dehydration by many ways (Smith & Sherman 1994, Ribeiro 1997). Those illnesses are dynamic events, thus selection of fluid type and volume may change according to the response of the patient and constant monitoring is needed to avoid deterioration of the underlying problem. Monitoring the physiologic responses of the patient is not precise and sometimes monitoring devices are not available or are not frequently used, especially at field situations (Mathews 2011).

The route of administration to be chosen will depend on the need of systemic effects, the integrity of the gastrointestinal tract and the financial resources available (Lopes 2003). Fluid therapy in ruminants is often administered by intravenous and orogastric route (Dirksen 1993). Intravenous administration of fluid therapy has the advantage of immediate systemic effects without concerning integrity of the gastrointestinal tract; however, this form of fluid therapy presents the limitations of high cost and the use of sterile material and fluids with finely adjusted compositions (Lopes 2002). The orogastric route can be recommended for administration of fluids in ruminants to increase plasma volume, alter plasma electrolyte concentration, blood pH and promote diuresis (Hossaini-Hilali et al. 1994, Silanikove 2000) because rumen epithelia has a great absorptive ability to electrolytes and water (Dobson et al. 1976, Leonhard-Marek 2002). Also, the gastrointestinal tract is the most physiological form of fluid therapy because the mucosa acts as a natural selective barrier for absorption and the fluids must not be necessarily sterile nor with finely adjusted composition, resulting in an easier and lower cost route of administration (Lopes 2002). However the need of introducing and removing the tube at each administration is laborious, stressing to the animal with high risk of causing injuries to esophagus and pharynx mucosa. Another limitation of this route is the impossibility of slow and continuous infusion of fluids (Dirksen 1993).

The use of a small bore tube with external diameter of 6mm for fluid administration through nasogastric route can be an alternative because the tube can be placed and kept in the animal as long as the treatment lasts, fluids can be administrated continuously and the infusion rate controlled with a drip chamber and a screw clamp placed on the tube (similar to the intravenous infusion set). This tube causes less discomfort to the animal and, when connected to a coiled line, the patient can eat and move freely, a very important feature to welfare when prolonged treatments are needed (Lopes 2002, Ribeiro Filho et al. 2011). Therefore, this route has the same advantages of the orogastric route without the limitations cited above.

The fluids used in the routine through intravenous route are known to cause interference in ionic interactions and increase acidosis, hypovolemia, brochoconstriction, hemodilution, renal dysfunction, lung edema and immune mediated reactions, according to the type of fluid or volume of administration (Matthews 2011).

Thus, the present study was conducted to evaluate the tolerance of the nasogastric route and the effects of fluid therapy using a solution with calculated concentrations of sodium, potassium and chloride similar to goat plasma**,** in rumen cannulated goats with evident leakage and in normal goats submitted to a protocol for dehydration.

MATERIALS AND METHODS

The number of animals were calculated according to the equation for experimental sample size by Eng (2003), thus, four 4-year-old Alpine Chamoisee female goats, from 45 to 54 kg (mean 49.5kg) of weight, two of them with rumen cannulas presenting evident leakage, were kept in individual stalls (3.5m^2) of sawdust bed. Tifton hay was offered twice a day and water was available *ad libitum* in water troughs. During the trial periods the goats had no access to water.

A crossover experimental design was used with one treatment, two groups and two periods. At the first period, two goats were randomly assigned to receive fluid therapy only (Group 1) while the other two passed through a dehydration model and then received fluid therapy (Group 2). Two weeks later, the same procedures were repeated, but the goats from Group 1 became Group 2 and *vice versa*.

The fluid used had the following composition: 6.17g NaCl, 0.34g of KCl and 2.89g of $NaHCO_3$ in one liter of tap water. Animals received 10mL/kg/h during 8 hours (mean of 0.495L per hour). Calculated concentration of electrolytes were 140mmol/L of Na^+, 4.5mmol/L of K^+ and 110mmol/L of Cl^- similar to goat plasma according to Yamagishi et al. (1999). This fluid was kept in 1.5L bottles and administered at room temperature through a coiled line equipped with a drip chamber and a screw clamp that was connected to the nasogastric tube with 0.6cm of external diameter and 130cm of length. This tube was inserted into the goats through the nose taking care to make sure that it would reach the rumen.

The dehydration model which Group 2 were submitted consisted on the administration of one dose of furosemide (4mg/kg, IV) 46 hours before fluid therapy and water restriction during the same period.

All animals were physically examined and had samples of blood and feces taken 46 hours before fluid therapy (-46h), immediately before fluid therapy (0h), immediately after fluid therapy (8h) and

24 hours after fluid therapy (24h). Variables evaluated in the physical exam were: behaviour, appetite, occurrence of enophtalmia, colour of mucosa, capillary refill time, skin turgor, rectal temperature, abdominal circumference, rumen contractions, heart and respiratory rates and body weight. Blood samples were used to determine hematocrit (microhematocrit), plasma total solids (refractometry) and serum for electrolyte concentration analysis. Na^+ and K^+ concentrations were determined by flame photometry and Cl^- concentration by colorimetry. Feces samples were collected directly from rectum and 15 to 20 fecal balls were placed in a oven at 60°C/72h. Comparisons between groups in each time (-46h, 0h, 8h, 24h) and effects of treatment through time were investigated analyzing the means of the following variables: hematocrit, plasma total solids, serum concentration of sodium, potassium and chloride, feces humidity, abdominal circumference, heart and respiratory rates, rectal temperature, ruminal contractions and body weight.

Data was analysed using t-test for paired measures, considering each animal as its own control at 0.05 level of significance.

RESULTS AND DISCUSSION

The tube was easily placed with the usual restraint and goats did not show any sign of intolerance to the nasogastric tube or stress during fluid administration. The volume per hour (0.495L) was easily administered in 45 minutes. All animals ruminated, laid, fed or were alert during fluid administration, without any abnormal behavior. Other observations performed in physical exam (color of mucosa, capillary refill time, appetite, occurrence of enophtalmia and skin turgor) did not present alterations throughout the experimental periods.

The dehydration model applied reduced feces moisture, abdominal circumference (Table 1) and increased plasma total solids (Table 2). Body weight of the dehydrated goats decreased 15% after 46 hours of dehydration and was recovered 24 hours after the fluid therapy (Table 1). Olsson et al. (1982) and Dahlborn et al. (1988) reported that lactating goats deprived of water during 48 hours lost 20% of their initial body weights. Silanikove (2000) described the progress of dehydration in ruminants in two phases: in phase one the feed intake and salivation are still sufficient to maintain barely normal the rumen fermentation; in phase two (last stage of dehydration) the feed intake, salivation and ruminal content decrease severely. The role of the rumen in this lost of body weight is about 50% in sheep and goats (Silanikove, 2000). Therefore, the dehydration model used in this study was enough to cause a mild dehydration in the goats.

The increase in rectal temperature (Table 1) observed immediately after fluid therapy should not be related with this treatment once the fluids were administered at room temperature. Jessen et al. (1998) offered water in different temperatures for Bedouin goats and reported that body temperature changed according to the temperature of the water, but this effect was observed only for a few seconds. The most likely explanation for the variation of rectal temperature is the nychthemeral variation (Kleiber 1975). Values found in this study (38.2°C at 8 a.m. and 39.4°C at 4 p.m.) are very alike the values found by Jessen et al. (1998) that measured goats arterial blood temperature during 24 hours and found 38.2°C at 8 a.m. and 39,5°C at 4 p.m.

During the experimental periods the goats were manipulated several times, maybe this was the main cause of the increase of heart rate (Table 1). Despite significantly high, heart rates were between the reference values cited by Pugh et al. (2002).

The nasogastric fluid therapy was efficient, because hematocrit and plasma total solids decreased in both treatments (Table 2) and the animals recovered weight and abdominal circumference after fluid therapy (Table 1). These

Table1. Physical exam (means) of goats before (-46h), during (0h, 8h) and after (24h) fluid therapy

Parameters	Control				Dehydrated			
	- 46h	0h	8h	24h	-46h	0h	8h	24h
Weight	50,0a	46,7b	50,5a	51,3a	50,3a	43,0b	47,3ª	49,7ª
Heart rate	63,0a	66,7a	77,5b	76,0b	60,0a	75,0b	76,0b	73,7b
Respiratory rate	15,0a	14,0a	14,0a	15,5a	15,0a	18,0b	16,0b	14,5b
Rectal temperature	38,0a	38,4a	39,4b	38,6a	38,2a	38,3a	38,9b	38,8b
Abd.* circumference	100,3ab	100,5a	101,5ab	103,5ab	100,0a	95,3b	101,3c	104,0d
Ruminal movements	7,50ª	7,00a	7,00a	6,50a	7,50a	7,50a	7,50ª	7,50ª
Faecal umidity	60,5ª	53,8a	53,2a	54,9a	65,3a	55,3b	52,3b	61.4ab

Lines followed by same letters are not significantly different according to t-test (paired measures) at 0.05 level of probability. *Abd. = abdominal.

Table 2. Means of the blood parameters of goats before (-46h), during (0h, 8h) and after (24h) fluid therapy

Parameters	Control				Dehydrated			
	- 46h	0h	8h	24h	-46h	0h	8h	24h
Globular volume	32,0a	31,3a	27,0b	29,5ab	29,0ab	31,5a	29,0ab	30,8ac
Plasma protein	79,0a	86,5b	77,5a	79,0a	76,5a	82,0b	75,0a	78,5ª
Plasma Na^+	126,0a	136,7a	122,0a	113,2a	136,7a	120,5a	120,0a	116,7ª
Plasma Cl^-	108,5a	106,5a	110,5a	111,7a	104,2a	105,7a	102,2ª	103,2ª
Plasma K^+	2,83a	3,33a	3,10a	2,45a	3,28a	2,55a	3,00a	2,65ª

Lines followed by same letters are not significantly different according to t-test (paired measures) at 0.05 level of probability.

observations confirms that the gastrointestinal tract of goats has a great ability to absorb fluids administrated in a short period of time, as previously observed by Dahlborn & Karlberg (1986) and Silanikove (2000), even with evident leakage of rumen content.

The goats did not show polyuria and urinated only at the end of fluid therapy. Black Morroccan goats presented diuresis one hour after receiving 10% of their body weight of water (Hossaini-Hilali et al. 1994), the same was observed in Swiss goats (Olsson et al. 1982). Probably, the liquid leakage through the fistula may have reduced these effects.

Mean values of serum concentration of sodium and potassium (Table 2) were below to the reference values for goats (Na^+=142-155mEq/L and K^+=3.5-6.7mEq/L, Kaneko et al. 2008), since the beginning of the experiment. Barioni et al. (2001) reported an influence of age on the concentration of these electrolytes in Alpine goats, wherein mature goats had lower concentrations of serum sodium and potassium than the young ones.

A decreasing tendency for serum concentration of potassium is shown in the Table 2 at time 0h. Although not significant, this effect was expected due to furosemide pharmacodynamics where sodium and chloride resorption are inhibited and potassium excretion is increased because of a blockage of sodium-potassium-chloride pump at the thick segment of ascendent Henle's loop (Reece 1996).

The utilization of a solution with calculated concentrations of sodium, potassium and chloride similar to goat plasma did not alter significantly the serum levels of these electrolytes. In contrast, Dahlborn & Karlberg (1986) observed hypernatremia and hyperchloremia when saline (NaCl 0.9%) was administered in goats.

Although not significant, a decrease in serum concentration of sodium could be observed 16 hours after fluid therapy (Table 2, time 24h) probably due to the intake of large volumes of water after fluid therapy, when the access was *ad libitum*. Silanikove (1994) reported that goats water deprived for some time are able to drink large volumes of water in one intake, as also related by Jessen et al. (1998) when Bedouin goats drank an amount of seven liters of water in five minutes, after seven days of water deprivation. Hossaini-Hilali et al. (1994) observed a decrease in plasma concentration of sodium one hour after loading 3 L of water in black Moroccan goats, these values kept lower until the next day.

CONCLUSION

Goats did not show any sign of discomfort or stress during enteral fluid therapy through nasogastric tube and the fluid with sodium, potassium and chloride concentrations similar to goat plasma was efficient to treat dehydration without altering the levels of that electrolytes in serum even of the goats that were not dehydrated. Therefore enteral fluid therapy through a nasogastric tube using a formulated electrolyte solution is efficient, secure and inexpensive for rehydration of goats.

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