Revista de Medicina Veterinaria

Volume 1 | Number 31 Article 9

January 2016

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Citación recomendada

Mira Hernández J, Posada Arias S, Castillo Franz CA y Vélez Mejía M. Dilatación de estenosis esofágica proximal con balón guiado por endoscopia y radiografía en potro falabella. Rev Med Vet. 2016;(31): 85-95. doi: https://doi.org/10.19052/mv.3712

Dilation of a Proximal Esophageal Stricture by Endoscopically and Radiologically Guided Balloon in a Falabella Foal

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Abstract

Esophageal strictures or stenosis are generally triggered by necrosis, as a result of the pressure caused by esophageal impactions that generate ulceration and erosion of the esophageal mucosa, as well as due to lesions caused by the oral administration of corrosive agents, cervical trauma and congenital strictures. Esophageal dilation procedures have been used for the treatment of strictures in humans and small animals but are rarely used in horses, given the number of sessions required for successful treatment and the limited information published on the subject. The objective of this work was to determine the effectiveness of esophageal dilation with an endoscopically and radiologically guided balloon in a *Falabella* foal with an esophageal stricture caused by an obstruction. The result was successful after five sessions of dilation when the patient tolerated solid food, and no complications were found after six months of observation.

Keywords: esophagus, endoscope, radiographic images, Foley balloon.

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How to cite this article: Mira Hernández J, Posada Arias S, Castillo Franz CA, Vélez Mejía M. Dilation of a proximal esophageal stricture by endoscopically and radiologically guided balloon in a *Falabella* foal. Rev Med Vet. 2015;(31):85-95.

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Resumen

Las estenosis esofágicas son causadas, generalmente, por necrosis, consecuencia de la presión ejercida por impacciones esofágicas que erosionan y ulceran la mucosa esofágica, además de las lesiones causadas por la ingestión oral de agentes corrosivos, el trauma cervical y las estenosis congénitas. Los procedimientos de dilataciones esofágicas se han utilizado en pequeños animales y en humanos para el tratamiento de estenosis; pero son escasamente utilizados en caballos, debido a la cantidad de sesiones que se requieren para obtener el éxito y a la escasa información publicada al respecto. El objetivo de este trabajo fue determinar la efectividad de la dilatación esofágica con balón guiado por endoscopia y radiografía en un potro falabella con estenosis esofágica mural, producto de una obstrucción. El resultado fue exitoso, pues el animal, después de cinco sesiones seguidas de dilataciones, toleró la vía oral para alimentos sólidos y así fue sometido a observación durante seis meses, sin complicaciones evidentes.

Palabras clave: esófago, endoscopio, imágenes radiográficas, balón Foley.

Reception date: March 29th, 2015 . Acceptance date: May 12th, 2015

Dilatação de estenose esofágica proximal com balão guiado por endoscopia e radiografia em potro falabella

Resumo

As estenoses esofágicas são causadas, geralmente, por necrose, consequência da pressão exercida por impactações esofágicas que corroem e ulceram a mucosa esofágica, além das lesões causadas pela ingestão oral de agentes corrosivos, o trauma cervical e as estenoses congênitas. Os procedimentos de dilatações esofágicas Têm sido utilizados em pequenos animais e em humanos para o tratamento de estenose; mas são escassamente utilizados em cavalos, devido à quantidade de sessões requeridas para obter o êxito e à escassa informação publicada com respeito a isso. O objetivo deste trabalho foi determinar a efetividade da dilatação esofágica com balão guiado por endoscopia e radiografia em um potro falabella com estenose esofágica mural, produto de uma obstrução. O resultado foi exitoso, pois o animal, depois de cinco sessões seguidas de dilatações, tolerou a via oral para alimentos sólidos e assim foi submetido à observação durante seis meses, sem complicações evidentes.

Palavras chave: esôfago, endoscópio, imagens radiográficas, balão Foley.

Introduction

Esophageal strictures are frequently caused by necrosis produced after the pressure of esophageal impactions had induced erosion or circumferential ulceration of the mucosa. Lesions made by the oral ingestion of corrosive agents and cervical trauma can also result in strictures, in addition to the reported cases of congenital strictures. Strictures formed by mucosal and submucosal traumas are known as *esophageal rings*. When muscle layers and the adventitia are compromised, they are known as *esophageal wall strictures*, and when all esophageal wall layers are compromised, they are known as *annular strictures* (1-3).

The normal diameter of the esophageal wall can be affected after posttraumatic strictures, which will eventually lead to a thickening of the wall and a narrowing of the esophageal lumen. This will bring recurrent episodes of obstruction and prestenotic diverticulosis (3). Horses with such lesion have a clinical situation similar to those with simple obstructions, because strictures cause partial obstructions and impaction of the alimentary material in the esophageal lumen. Among the most common signs triggered by obstructions, nasal discharge with food (73, 5%), cough (50%) and increase of saliva production (41%) can be remarked. Other signs or clinical findings that can be linked to those previously mentioned are head and neck extension, sweating, anxiety, apathy and even palpation of masses in the esophagus (4,5). As for the diagnosis, it is possible to detect esophageal rings using endoscopy, while the identification of wall or annular strictures can require a double contrast esophagography (1,3).

Esophageal mucosal strictures can or cannot be surgically intervened. In most of the cases they can be managed with diet and care, avoiding very dry or hard food for at least 60 days. Some surgical treatments include resection, esophageal anastomosis and esophagostomy (2).

To treat this condition in small animals and humans, bougienage has been successfully used (3). This is a procedure that involves a bougie, which is defined as a thin, flexible surgical instrument of rubber, plastic, metal or another material for exploring or dilating a passage of the body such as the esophagus (6,7). This procedure is not commonly used in horses given the fact that most of them are surgically treated due to the high number of sessions required to achieve a successful result with this technique. On the other side, Reichelt et al. (3) report a treatment

with dilation balloon in two horses with a remarkable outcome, while surgery includes many postoperative complications. The most important one is the recidivism of the strictures caused by tissue scarring (1,8).

At the Veterinary Clinic of the Corporación Universitaria Lasallista (Medellín, Colombia), a 10 days old Falabella foal was admitted due to an esophageal obstruction caused by food and wood chip impaction; a medical intervention was performed without success because the foal continued presenting recurrent obstructions due to an esophageal stricture. Therefore, the objective of this work was to evaluate the effectiveness of esophageal wall stricture dilation by the use of an endoscopically and radiologically guided balloon, varying the techniques previously reported by other authors.

Patient examination

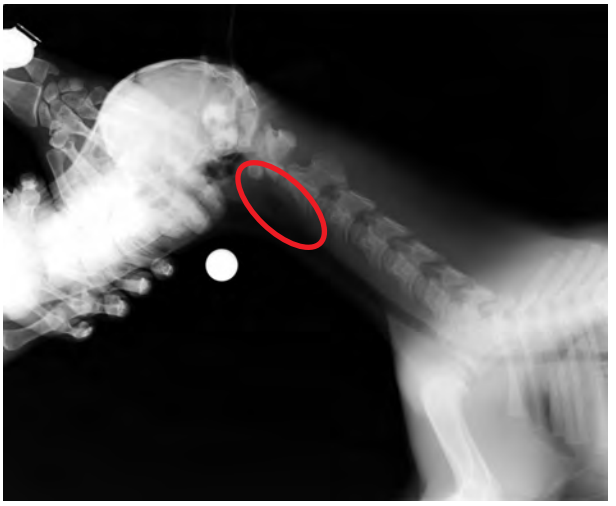
Anamnesis, clinical findings and diagnostic aids

A 10 kg Falabella foal was referred to the Veterinary Clinic of the Corporación Universitaria Lasallista, with a complaint of milk regurgitation (mouth and nostrils), a slight difficulty for breathing and weakness. General clinical evaluation is shown in detail in Table 1. Clinical pathology only evidenced hypochromic mild anemia (4.90 million erythrocytes/microliter). In the palpation evaluation of the proximal esophagus, a hard mass with a length of approximately 2 cm and a diameter of one centimeter was detected. Left lateral cervical radiograph was taken, with 65 kV (kilovoltage) and 2.06 mA (miliamperage), and using a 14x17 cm chassis. A radiopaque foreign body could be seen in the proximal esophagus with the measures previously mentioned (2 cm long and 1 cm diameter), thus confirming the diagnosis of esophageal obstruction (Figure 1). Endoscopic examination of the trachea showed no presence of milk. In the endoscopic examination of the esophagus lumen, the radiopaque foreign body previously observed was identified as compacted material (impaction) composed by wood chips and milk, completely occupying the diameter of the animal's proximal esophagus. There are no available images of the endoscopy, since it was performed with a common endoscope without any video recorder.

Table 1. Clinical findings at foal's arrival to the Veterinary Clinic of the Corporación Universitaria Lasallista

Parameter	Patient	Reference values (9)
Attitude	Depressed	Not assessed
Temper	Not evaluable	Not assessed
Heart rate	140 beats per minute (bpm)	From 28 to 36 bpm
Respiratory rate	56 respirations per minute (rpm)	From 8 to 16 rpm
Mucous membranes	Cyanotic	Pink, moist and bright
Capillary refill time	2 seconds	From 1 to 2 seconds
Temperature	38,5 °C	37,5 a 38,8 °C (foals under one moth of age)
Digestive motility	Normal motility of the four digestive quadrants	Normal motility of the four digestive quadrants
Body condition	6/9	6/9

Figure 1. Left lateral cervical radiograph on the day of admission. The impaction in the proximal esophagus is indicated by a red circle



The impacted material was extracted using total intravenous anesthesia, in triple dripping with 500 mg of xylazine, 500 mg of ketamine, and 500 ml of guaifenosin, 1.5 drops/10 s, intravenously (9, 10), with a flexible endoscope and biopsy forceps, always trying to avoid surgery (figures 2 and 3). After 2 h, 50% of the impaction was extracted and an oxytocin infusion (0.11 international units [IU]/kg IV) diluted in saline solution was administered and the rest of the impaction passed easily from the esophagus to the stomach. Oxytocin infusion is indicated for esophageal relaxation and passage of the impacted material through the esophagus (1). The possibility of using esophageal washes was discarded due to the proximal location of the compacted material and the risk of bronchial aspiration.

Figure 2. Impaction material extracted by endoscopy and biopsy forceps

After the initial treatment, the patient continued presenting recurrent obstructions, so esophageal wall stricture was suspected, maybe due to an inflammation of the zone caused by the manipulation during the extraction of the material. This diagnose was not confirmed with histopathology, given the difficulty to approach the area and the risk to worsen the clinical condition. The inflammation could be seen by radiographic imaging and could be perceived by nasogastric intubation and esophageal palpation.

Figure 3. Endoscopy procedure with flexible endoscope under total intravenous anesthesia

Treatment approach

Due to recurrent obstructions after 15 days of medical treatment, an esophageal stenosis dilation with a non-common dilation balloon (14 caliber Foley urinary catheter of 40 cm) guided by endoscopy and radiographic image was decided to be used, with variations in the methodology applied in horses by other authors. The treatment was approved by the Ethics Committee of the Corporación Universitaria Lasallista and an informed consent was signed by the owner.

Patient housing

The pony was housed in a stall at the Veterinary Clinic of the Corporación Universitaria Lasallista with the following characteristics: 16 m^2 of area, a construction of vacuumed bricks up to 2 m of height and empty bricks above. The floor is made of cement with a slight inclina-

tion from the four edges to the center and it is always kept with a 10 cm high bed made of chip.

Food

During the first 2 months, food was based on milk substitute (Sprayfo®). This substitute is made of milk protein enriched with vitamins and minerals adapted to the animal's taste. The substitute was administrated through a bottle, with a calculated dose of normal foal consumption (27% of its weight per day) and was administered on an hourly basis (11).

Intake was controlled in order to avoid new obstructions. When personnel from the clinic did not accompanied the foal, a muzzle was used to prevent consumption of foreign material.

Esophageal dilation with balloon

This procedure was performed with the following protocol:

1. Physical examination to discard any systemic disease or pneumonia by aspiration as a consequence of recurrent obstructions.
2. Previous weighing of patient, in order to determine the dose of anesthetics to be used, as the procedure had to be performed under total intravenous anesthesia. Sedation with xylazine (0.8 mg/kg IV), anesthetic induction with ketamine (2.5 mg/kg IV) and diazepam (0.05 mg/kg IV) sustained with triple dripping (concentrations equal to those previously described) (10).
3. Contrasted radiographic imaging with 30 ml of barium sulfate, administrated orally (12), in order to find the location of the stricture.
4. Wash of the oral cavity, in order to avoid the presence of food or residual contrast medium that could be aspirated by the animal.
5. Examination of the esophagus with endoscope one hour after the contrasted radiography, locating the distance to the stenosis. Once the stenosis was found, a 14 caliber Foley urinary catheter of 40 cm with a metal guide (biopsy forceps of the endoscope) was orogastrically introduced.
6. The location of the catheter, concerning the stenosis, was reconfirmed with a simple radiography.
7. The catheter's balloon was dilated with water. The quantity of water was determined after establishing the diameter of the esophagus with Levin nasogastric tubes of different calibers before endoscopic examination. The quantity of water established was 5 ml. The balloon was dilated for 60 s.

Frequency of the esophageal dilation

This procedure (points 5 to 7 of the protocol) was performed for 5 days in a row, constantly evaluating the esophagus both endoscopically and by radiographic imaging with a previous orogastric monitoring with a Levin nasogastric tube, to determine the effectiveness of the procedure and the necessity and possibility of new sessions, because it had already been reported that the number of dilations depends on the patient's evolution (13,14). Only one series of dilations was required, as obstructions no longer appeared.

Evaluation of tolerance to solid food

Food intake was strictly controlled, administrating exact quantities of milk substitute (according to a foal's usual daily consumption in liters of milk) and solids (in order to evaluate tolerance: No signs of esophageal obstruction). A constant evaluation of tolerance to new solid food was performed, having as indicators the absence of clinical signs of esophageal obstruction and the pass of the nasogastric tube with different calibers (2,3,13,14). Solid food was dosed as follows:

- 50 g of a mixture of bran, molasses and mineralized salt, administrated every 6 h.
- 10 g of green pasture, every 6 h.
- 50 g of concentrated food, every 12 h.
- 50 g of pure alfalfa powder every 12 h.
- Water ad libitum.

Successful treatment criteria

According to reports available in the literature (3), it is recommended to re-evaluate the animal 12 months after dilation. However, the owner asked for the foal to be discharged after six months. Therefore, a 90-days moni-

toring with nasogastric tube and radiographies was performed and, later, a permanent observation with food ad libitum was performed for another 90 days.

The treatment could be considered successful by clinicians if the following criteria are met 90 days after dilation:

- Pass of the 22-caliber Levin nasogastric tube with no difficulty and confirmation of this fact by radiographic image (13,15).
- Pass of the endoscope with no difficulty and no erosion of the esophageal mucosa (2,3,13,15).
- No clinical signs of esophageal obstruction (1,2,3,8, 13,14,15).

Treatment results

Data concerning tolerance to food were registered in the following table, which includes the presence or absence of clinical signs and the pass of the nasogastric tube, according to the caliber, evaluating the evolution per days after five consecutive dilation sessions (Table 2).

Table 2 shows the absence of clinical signs of esophageal obstruction from day one to day 90 of evolution, after dilations were finished. After this strict observation and the due registration, the animal was left to feed at its free will during another 90 days in which no further signs of recurrent obstructions were observed.

The pass of the nasogastric tube was evaluated with several calibers, starting with a 14-caliber, which was the minimum tolerated by the animal after the obstruction was solved. At day 10 after dilation, a 16-caliber tube passed with no difficulties. At days 15, 25 and 60, it was possible to pass tubes 18, 20 and 22, respectively.

Table 2. Evaluation of tolerance to solid food and to the nasogastric tube's passage after dilations

Signs	Day 1	Day 5	Day 10	Day 15	Day 20	Day 25	Day 30	Day 60	Day 90
Nose discharge with food	No	No	No	No	No	No	No	No	No
Cough	No	No	No	No	No	No	No	No	No
Hypersalivation	No	No	No	No	No	No	No	No	No
Tracheal rales	No	No	No	No	No	No	No	No	No
Depression	No	No	No	No	No	No	No	No	No
Dyspnea	No	No	No	No	No	No	No	No	No
Pass of the nasogastric tube	**Day 1**	**Day 5**	**Day 10**	**Day 15**	**Day 20**	**Day 25**	**Day 30**	**Day 60**	**Day 90**
Levin catheter 14	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Levin catheter 16	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Levin catheter 18	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Levin catheter 20	No	No	No	No	No	Yes	Yes	Yes	Yes
Levin catheter 22	No	No	No	No	No	No	No	Yes	Yes

Figure 4. Left lateral cervical radiograph on day 10 after dilation, with a 16-caliber tube guided with the endoscope's biopsy forceps

Figure 5. Left lateral cervical radiograph on day 25 after dilation with an 18-caliber tube

Figure 6. Left lateral cervical radiograph on day 150 after dilation with a 22-caliber nasogastric tube

Discussion

Milk regurgitation associated to dysphagia in foals is not uncommon. Most of the causes are linked to both pharyngeal and laryngeal abnormalities, like soft palate displacement and cleft palate (16). On the other side, there are some reports describing congenital esophageal abnormalities ending in esophageal obstruction in foals (17-23).

It has been reported that esophageal strictures are the result of collagen deposit and formation of fibrous tissue stimulated by an esophageal lesion. In humans, the most common lesion is peptic stenosis due to exposition to gastric acid, and it represents 70-75% of benign esophageal strictures. Other common etiologies of stenosis include the intake of caustic products, exposition to radiotherapy, reactions produced by foreign bodies, infectious esophagitis or surgical alterations of the normal anatomy of the esophagus (13,14). It is hard to establish, for this case, if the esophageal obstruction was caused only by wood chips and milk accumulation in a specific place of the esophagus or if it was a congenital esophageal stenosis that could have favored the obstruction, as the animal was only ten days old. If the obstruction was the result of the impaction of rough and dry material, it can be inferred that the stenosis that appeared after the medical intervention was iatrogenic and benign, and it took place due to the manipulation made to extract the impacted material. Acquired esophageal strictures in neonatal foals are also associated with gastric ulceration and reflux esophagitis (24), but in this case there was no sign of reflux esophagitis in the endoscopic examination.

Benign esophageal stenosis or strictures can be classified into two groups: simple and complex. Stenosis with a diameter big enough to allow the pass of the endoscope, short, specifically located and defined, are considered as simple (13,14). This foal's stenosis could be considered as such given its morphological characteristics—despite the fact that the endoscope could not pass due to the size of the animal—, so dilation was a good choice for treatment.

The treatment of esophageal stenosis aims to heal the signs of dysphagia, to avoid complications brought by

esophageal obstruction and to prevent the recurrence of stenosis (13,15). Due to the fact that surgical treatment options for esophageal stenosis in horses have a high risk of complications, dilation with a balloon and with bougies can be a useful alternative for conservative treatment of moderate strictures or for those surgically inaccessible ones (thoracic or abdominal). Successful use of balloons or bougies has been reported in small animals and in humans (3) and also in a foal with a single stricture at the thoracic level with good outcomes (25), contrary to an 11 days old foal with a non-treated triple esophageal stricture that was subjected to euthanasia (26).

The dilation devices used for esophageal stenosis can be divided into balloons and bougie types. They can be passed using a metallic guide or can be guided with fluoroscopy. The efficiency and safety of the dilation system depend on the experience of the person performing the endoscopy and on the type of stricture. Balloons can be passed with endoscope or with a metallic guide, which is useful for stenosis with very narrow lumens that impede the pass of the endoscope (13) or, just like in this case, where there were not enough resources to acquire the commercial balloon or the bougie. Due to this fact, a metallic guide (biopsy forceps) was necessary to give the Foley catheter the required stability. According to Reichelt et al. (3), the balloon must be filled with water, like it was done with this foal, because the hydrostatic dilation results in a complete transfer of radial force of the stricture.

Previous anecdotic reports about the use of bougie dilators in esophageal strictures in horses and cattle have been published, but the problem has been the lack of adequate instruments to develop the process. The most common method for horses has been bougienage, by inserting endotracheal tubes in the esophagus and then inflating the balloon. As expected, the results with this method have been inconsistent due to the fact that these tubes are not designed for this type of procedures (2). Reports about the use of Foley catheters in esophageal dilations in pony foals have not been found, so this would be the first one. It cannot, nevertheless, be used as a base method because it was performed in only one animal for which the results were successful, but this is not accurate enough to assure the same results in other patients with different types of strictures. This was an experimental model encouraged by the owner's interest in the patient's life, despite his lack of resources. However, there are reports on the use of Foley catheters for extraction of foreign bodies in children (27).

Another difficulty may consist of choosing the right size of balloon, because it has to be consistent with the estimated size of the stricture. There is not a lot of data about the selection of dilation balloons in the literature about horses. In small animals, the indicated diameter of the balloon is 4 mm more than the diameter of the stricture when the latter is collapsed. In humans, sizes between 6 and 40 mm are recommended. If a good esophagogram is not available and there is no estimated measure provided endoscopically, it is possible to approximately calculate the diameter of the stenosis with nasogastric probes of different calibers (3). This is exactly how the dilation diameter and the quantity of water to be applied into the balloon were calculated for the five sessions performed on this patient, as the calculation using an endoscope and an esophagogram was not clear enough.

There are reports about the use of dilatant balloons with controlled radial expansion (CRE wire-guided balloon dilators). According to Hawkins (2), these devices are relatively cheap (about US$300) and are available in diameters between 6 and 18 ml. The unavailability of such equipment, as well as the difficulty to get it on time and at a reasonable price, led to the experimental use of a Foley catheter to perform dilations to this *Falabella* foal.

Esophageal dilations are considered safe and with a good prognosis. However, esophageal perforation is the most important complication they might have. The perforation rate reported for humans is between 0.1% and 0.4%. Despite the favorable forecast after dilation, 30% to 40% of human patients with benign strictures have signs of recurrence one year after dilation (13). In the two cases reported by Reichelt et al. (3), no recurrent obstructions were observed one year after dilation.

Besides the high risk of surgical complications, a great commitment of the animal's owner is necessary to achieve a good result of the surgical procedure (2). In the two cases reported by Reichelt et al. (3), they mentioned that the use of balloons for dilations instead of surgery is related only to the location of the stenosis and to the risks of sedating old animals, so it is important to consider other conditions such as the size and the age of the animal, not only because of sedation risks, but also because of the surgical approach and the high risk of stenosis caused by scarring. Treating posttraumatic stenosis with dilations could have a lot of benefits, such as an increase in survival possibilities for the animal, a lower cost for the owner and an easier recovery.

According to other authors' reports, dilation with balloons should always be considered as an option before any surgical intervention to horses with esophageal mucosal strictures (2). However, Craig, Shivy, Pankowski and Erb (16) reported that the long term survival rate in medically treated horses was significantly better for acute stenosis than for chronic stenosis cases. It is then necessary to carefully consider each particular case and to use every resource at hand to make the best decision between medical and surgical treatment, and to always keep in mind the age and size of the animal and the economic resources available for treatment.

It is sometimes difficult to obtain a contrast esophagogram that provides reliable information. In these cases, the diagnosis can only be based on clinical, radiological (simple radiograph) and endoscopic findings. Despite this fact, Reichelt et al. (3) suggest that contrasted radiographies of the esophagus are a requisite to decide between surgical and conservative treatments, after diagnosing the location and the severity of the stenosis.

In humans, it has been demonstrated that an intralesional injection of corticoids can reduce the recurrence of strictures after dilation. Nonetheless, the action mechanism is not well defined yet, although there is a belief that corticoids can prevent collagen depositions and strengthen its local destruction, thus reducing the formation of scars. Most of the authors that have written about humans use a diluted 40 mg/ml 1:1 saline solution. 0.5 ml of the dilution is administered in the four quadrants of the stenosis (13,14). Due to the scarce information and experience in the use of intralesional corticoids, this treatment was not taken into account at the moment of performing the esophageal dilations, but it could have been an important support therapy for this case. More studies on the subject, with adequate measurements, are necessary to consider it reliable.

It is important to remark diet recommendations to be followed depending on the resolution of the lesion and the endoscopic and radiological evolution of the animal. For this case, a slow reintroduction to solid food was carried out, starting with humid semi-solid food and, later, dry solid food at will. No recurrent obstructions were observed. Other authors, such as Reichelt et al. (3), recommend the administration of humid food during the whole lifetime of the animal.

Conclusion

In conclusion, we consider the dilation of proximal esophageal stricture with Foley catheter successful. Although the treatment of esophageal stricture must always be based on the age of the patient, the location of the stricture and its characteristics, which have to be previously determined by radiographic and endoscopic diagnosis. In addition to this, the conservative treatment of benign stenosis must be prioritized due to the characteristics of the esophageal wall scarring and the risk of relapse.

Acknowledgements

We express our gratitude to the Research Vice-Presidency, the Administrative Vice-Presidency and to the Veterinary Clinic of the Corporación Universitaria Lasallista for their financial support to this work. We also thank the owner of the foal for his support to develop the treatment.

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