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TRACHEAL COLLAPSE IN DOGS: SURVEY OF THE PROFILE OF ANIMALS TREATED IN THE RADIOLOGY DEPARTMENT OF HCV/ UFRGS FROM 2017 TO 2022

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Abstract: The trachea is a circular organ of the respiratory system formed by rigid C-shaped cartilage rings. Tracheal collapse is a progressive multifactorial disease that mainly affects middle-aged toy and miniature dogs. It is characterized by the degeneration of the cartilaginous rings of the trachea due to a decrease in glycosaminoglycan and chondroitin sulphate, causing the trachea to collapse in a dorsoventral direction. The clinical signs of the disease depend on the severity of the tracheal collapse and can range from a dry cough similar to "goose squawking" to respiratory stress and dyspnea. Radiography is widely used for diagnosis, identifying the location and severity of the lesion, which can occur in both the cervical and thoracic regions. Dogs with tracheal collapse can improve clinically with changes in management, drug treatment or surgery. We selected dogs with tracheal collapse treated at the Hospital de Clínicas Veterinárias of the Federal University of Rio Grande do Sul between 2017 and 2022 to analyze the frequency of diagnoses before, during and after the COVID-19 pandemic. The radiographic reports showed the breed, age, sex and region of tracheal collapse of the affected dogs, and 54 animals were diagnosed during this period. All regions of the trachea were affected, with a higher incidence in the cervicothoracic transition. The most prevalent breeds were non-defined breeds (SRD), Yorkshire terriers and poodles. No gender predilection was identified and the ages found ranged from one to 17 years, with a higher prevalence between eight and 14 years. It was also possible to observe that between the years 2018 and 2020 there was a drop in diagnoses, possibly caused by the pandemic.
Keywords: dog; radiography; trachea

INTRODUCTION

The trachea is a circular organ of the respiratory system, primarily responsible for conducting air to the caudal airways through a system of low resistance (Jericó; Neto; Kogika, 2023), as well as "[...] *preparing it* for the removal of particles, warming it to body temperature and moistening it to saturation with water vapor" (Klein, 2021, p. 530). This organ is made up of rigid C-shaped cartilage rings, which are connected by fibroelastic annular ligaments (Jericó; Neto; Kogika, 2023). The main function of the cartilaginous rings is to maintain the rigidity of the trachea and prevent it from collapsing (Reece; Rowe, 2020). The annular ligaments project longitudinally from the trachea and allow it to be flexible (Jericó; Neto; Kogika, 2023). The dorsal portion of the cartilaginous rings of the trachea is incomplete and is filled by the tracheal muscle, which is arranged transversely to the trachea, and by connective tissue (Jericó; Neto; Kogika, 2023). These make it possible to vary the diameter of the trachea, mainly by increasing its size when there is a greater need for ventilation, and the tracheal muscle is responsible for controlling this increase in diameter (Reece; Rowe, 2020).

Tracheal collapse is a progressive disease that mainly affects middle-aged Toy and miniature dogs (Tappin, 2016), such as Yorkshire terriers and poodles (Eleutério, 2018). In this disease, the cartilaginous rings of the trachea degenerate, causing it to collapse in a dorsoventral direction (Tappin, 2016).

The clinical signs of the disease depend on the severity of the tracheal collapse, and can range from a dry cough similar to "goose squawking" (Maggiore, 2020) to respiratory stress and dyspnea (Tappin, 2016). These symptoms usually appear after episodes of excitement, pulling on the lead or after eating and drinking (Maggiore, 2020). Tachypnea, exercise intolerance and respiratory stress can also occur during physical exercise, caloric stress or very humid weather conditions (Maggiore, 2020). Coughing in response to palpation of the trachea is common in these dogs (Maggiore, 2020).

Thoracic radiography is commonly used to identify the location and severity of tracheal collapse, as well as to control the progression of the disease (Maggiore, 2020). Another radiographic finding that can be found in tracheal collapse is a redundant tracheal membrane, characterized by compliance of the tracheal muscle over part of the tracheal lumen (Bylicki; Johnson; Pollard, 2015), but this is also found in dogs without tracheal collapse (Bylicki; Johnson; Pollard, 2015; PPrestes *et al.*, 2019). The severity of tracheal collapse can be classified by tracheobronchoscopy according to the percentage of lumen reduction in grades I, II, III and IV, with tracheal lumen reduction of 25%, 50%, 75% and more than 90%, consecutively. (Tangner; Hobson, 1982).

Many dogs achieve clinical improvement with changes in management, but in some cases drug treatment is necessary. The use of antitussives, steroidal anti-inflammatories and bronchodilators is common in animals with milder symptoms (Tappin, 2016) Chondroitin sulphate can also be used (Almeida *et al.,* [20--?]). In dogs refractory to drug treatment, surgical treatment is indicated (SUN *et al.*, 2008) considering options such as chondrotomy (Slatter; Pettit, 1974) the use of intraluminal stents (Maggiore, 2020) and extraluminal prostheses (Tangner; Hobson, 1982).

The aim of this study was to carry out a retrospective study of dogs diagnosed with tracheal collapse at the Hospital de Clínicas Veterinárias of the Federal University of Rio Grande do Sul, based on radiographic reports, between 2017 and 2022, characterizing them according to breed, age, sex and region of tracheal collapse. We also checked the frequency of diagnosed cases of tracheal collapse in dogs

before, during and after the COVID-19 pandemic, in order to see if there was a drop in the number of diagnoses of tracheal collapse during this period.

MATERIAL AND METHODS

A six-year period was selected, from 2017 to 2022, to check the reports of radiographs taken at the UFRGS Veterinary Clinics Hospital (HCV/UFRGS), considering the years before, during and after the COVID-19 pandemic. We analyzed the records of the dogs treated at the veterinary radiology service at HCV/UFRGS, and from these we selected the chest or tracheal radiographic examinations during this period. These examinations were carried out in the ventrodorsal, right laterolateral and left laterolateral decubitus positions, and images were not taken at both inhalation and exhalation. There was also no tangential projection or use of a "rubber pear" for tracheal compression. The radiographic reports of these animals were then located and 102 cases were selected which showed a reduction in the tracheal lumen in the report. These were analyzed according to the animal's breed, age, sex and region of collapse in the trachea. This information was selected because it was the most common information found in the radiographic reports selected, and the degree of tracheal collapse was not selected because the HCV/UFRGS does not classify it. Of the cases obtained, one was excluded because it didn't identify the specific age of the animal, considering it only as an adult, one because it didn't show the region of tracheal collapse, 34 because they didn't have the images available for evaluation, and 12 because they didn't show tracheal collapse on the images, making a total of 54 dogs. A graph was also drawn up showing the number of diagnoses of tracheal collapse issued during the years of the study, and whether or not there was a drop during the years of the pandemic.

RESULTS

In the selected period, 54 animals presented tracheal collapse between 2017 and 2022. Among the dog breeds, the following were identified: 18 animals with no defined breed (SRD); 12 poodles; 11 Yorkshire terriers; three labradors and pinschers; and one cocker spaniel, lhasa apso, Maltese, pug, rottweiler, schnauzer and shih tzu (Figure 1). In terms of sex, there were the same number of females and males (Figure 2).

As for age, there was a wide variation in the diagnosis of the disease. There were animals between one and 17 years old, with the most prevalent being dogs between 8 and 14 years old, as shown in Figure 3.

Regarding the region where the trachea collapsed, 17 animals showed alterations in the cervical region, 35 in the cervicothoracic transition region and two in the thoracic region (Figures 4 and 5).

Regarding the number of diagnoses of tracheal collapse in dogs issued according to year, nine cases were observed in 2017, none in 2018, seven in 2019, none in 2020, eleven in 2021 and 27 in 2022 (Figure 6).

DISCUSSION

In relation to the breeds of dog observed in this study, the animals without a defined breed (SRD) had the highest incidence of tracheal collapse, which corroborates with MMacready, JJohnson and PPollard (2007)tracheal collapse was confirmed fluoroscopically and lateral cervical and thoracic radiographic views were reviewed. A board-certified radiologist (who was unaware of the dogs' clinical history and differs from MMarolf, BBlaik and SSpecht (2007). This result may have occurred due to the large number of dogs without a defined breed in Brazil (Flores *et al*., 2018), in addition to the possible genetic variation in dogs compared to other countries. We cannot rule out the possibility of environmental fac-

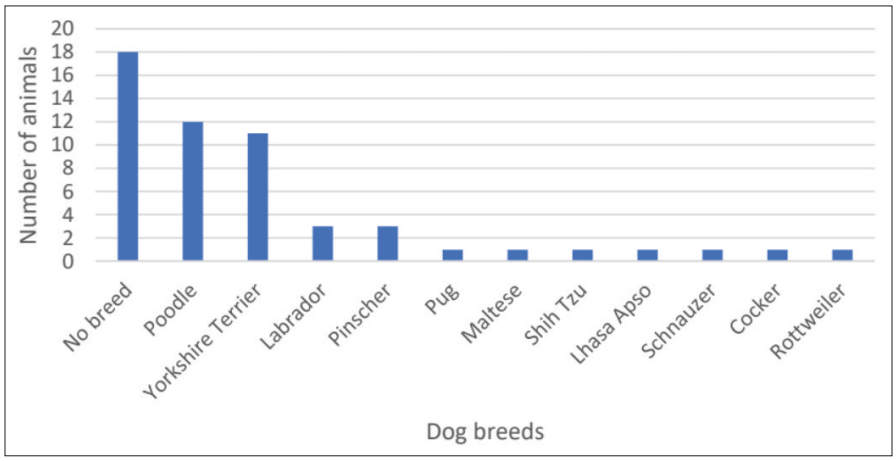

Figure 1 - Graph of the breeds of dogs diagnosed with tracheal collapse between 2017 and 2022 at HCV/UFRGS
Source: the authors, 2024.

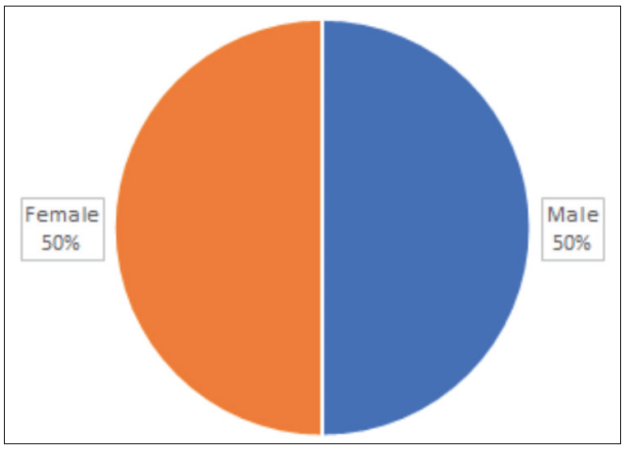

Figure 2 - Graph of the percentage of dogs diagnosed with tracheal collapse according to sex, between 2017 and 2022, at HCV/UFRGS
Source: the authors, 2024.

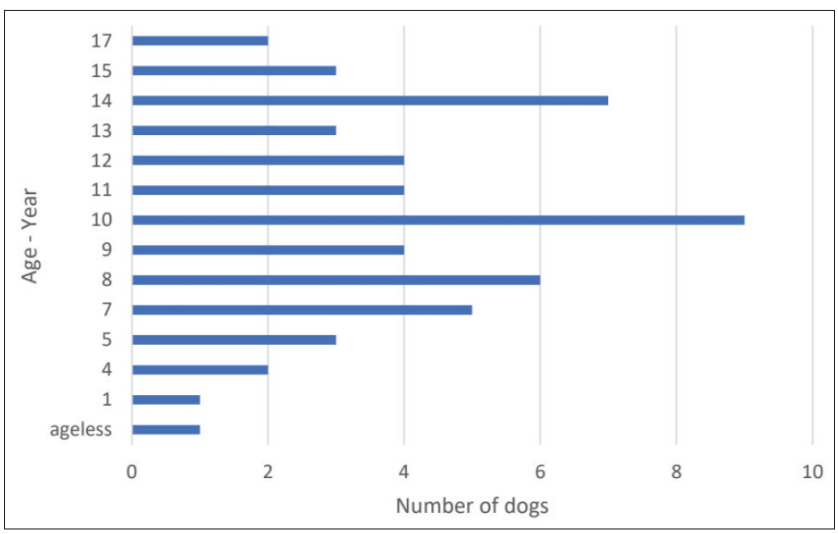

Figure 3 - Graph of dogs diagnosed with tracheal collapse according to age, between 2017 and 2022, at HCV/UFRGS
Source: the authors, 2024.

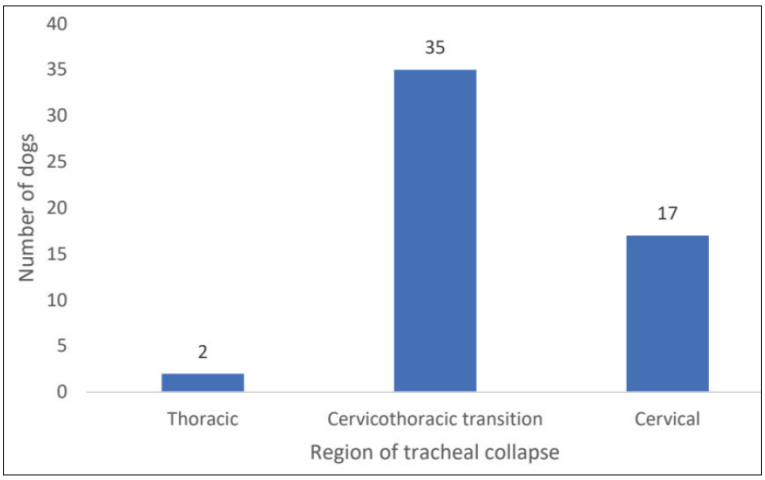

Figure 4 - Graph of dogs diagnosed with tracheal collapse according to the region of collapse, between 2017 and 2022, at HCV/UFRGS

Source: the authors, 2024.

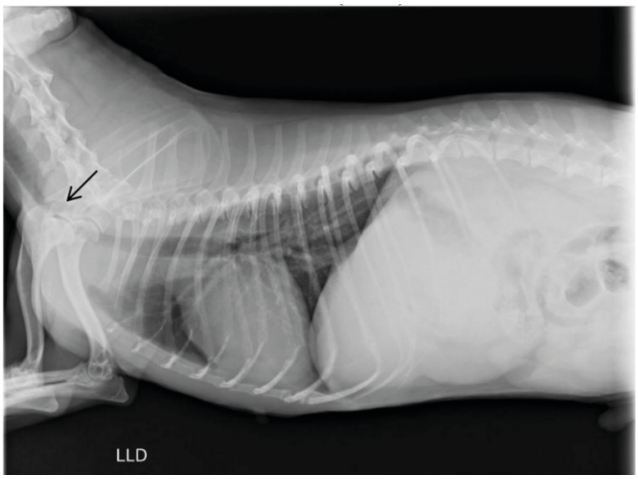

Figure 5 - Radiographic image of part of the cervical region, thoracic region and part of the abdominal region of a one-year-old Yorkshire terrier seen at HCV/UFRGS in 2022, showing tracheal collapse at the cervicothoracic transition (arrow).

Source: HCV/UFRGS, 2022.

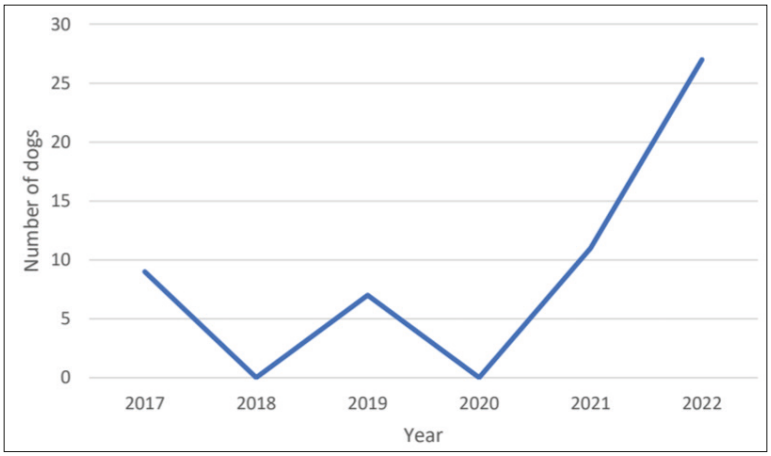

Figure 6 - Graph of the number of dogs diagnosed with tracheal collapse between 2017 and 2022 at HCV/UFRGS

Source: the authors, 2024.

tors affecting this data, since tracheal collapse has an origin that is not very well elucidated and is probably multifactorial (Tappin, 2016). The high incidence of tracheal collapse in poodles differs from some authors (Eleutério, 2018; Macready; Johnson; Pollard, 2007tracheal collapse was confirmed fluoroscopically and lateral cervical and thoracic radiographic views were reviewed. A board-certified radiologist (who was unaware of the dogs' clinical history; Marolf; Blaik; Specht, 2007; White; Williams, 1994) and at the same time is similar to the data reported by Ferian (2009) e TTangner and HHobson (1982). The third highest incidence was presented by the Yorkshire terrier breed, corroborating the studies by Eleutério (2018), Ferian (2009), Macready, Johnson and Pollard (2007)tracheal collapse was confirmed fluoroscopically and lateral cervical and thoracic radiographic views were reviewed. A board-certified radiologist (who was unaware of the dogs' clinical history, Marolf, Blaik and Specht (2007) e White and Williams (1994). According to Ferian (2009), this high number of the disease in the breeds mentioned may indicate an anatomical abnormality in these dogs.

With regard to the distribution between the sexes, the current study found that there was no prevalence in the diagnosis of tracheal collapse in any sex, which is similar to the data found by CChisnell and PPardo (2014) Eleutério (2018), Flores *et al.* (2018este estudo objetivou realizar uma análise das características relacionadas à raça, ao gênero e à idade dos cães necropsiados neste serviço de diagnóstico ao longo de 50 anos (1964-2013), GLG *et al.* ([*s. d.*])Horowitz (2011), Macready, Johnson and Pollard (2007)tracheal collapse was confirmed fluoroscopically and lateral cervical and thoracic radiographic views were reviewed. A board-certified radiologist (who was unaware of the dogs' clinical history, MMarolf, BBlaik and SSpecht (2007) e WWhite and WWilliams (1994). As for the age of the dogs, the disease was diagnosed in young people, young adults, adults, seniors and geriatrics, according to the age range described by HHarvey (2021)However, most of the images evaluated belonged to animals between seven and 14 years old. These results partly agree with Eleutério (2018), MMacready, JJohnson and PPollard (2007)tracheal collapse was confirmed fluoroscopically and lateral cervical and thoracic radiographic views were reviewed. A board-certified radiologist (who was unaware of the dogs' clinical history e WWhite and WWilliams (1994)as these authors reported a higher number of diagnoses of tracheal collapse in young dogs, young adults and adults. The presence of tracheal collapse in young animals implies the possibility of a congenital form of the disease (Cook, 1964)reinforcing the probable multifactorial cause of tracheal collapse. On the other hand, the higher prevalence in senior and geriatric dogs raises the possibility of an acquired cause of the disease (Fingland *et al.*, 1987 *apud* White; Williams, 1994), as well as the possibility that secondary stressors may be capable of triggering symptoms of tracheal collapse in dogs that previously had the congenital form (White; Williams, 1994).

Radiographic images of the affected dogs showed tracheal collapse from the cervical to the thoracic region. Most of the dogs collapsed in the cervicothoracic transition region, and the same result was obtained by CChisnell and PPardo (2014)Eleutério (2018), Ferian (2009), MMacready, JJohnson and PPollard (2007)tracheal collapse was confirmed fluoroscopically and lateral cervical and thoracic radiographic views were reviewed. A board-certified radiologist (who was unaware of the dogs' clinical history e TTangner and HHobson (1982). It is known that there is a higher incidence of widening of the tracheal rings and consequent stretching of the dorsal tracheal membrane in

this region (Ferian, 2009)However, the low density of nerve cells in the trachea at the thoracic inlet causes a deficiency in neuronal control, which may be one of the reasons for cervicothoracic tracheal collapse. (Yamamoto *et al.*, 1998)little is known about the morphology of the intrinsic nervous plexuses in the dog trachea and quantitative data about the ganglia and nerve cell bodies are lacking. The structure of the nervous plexuses and detailed morphometric data about the intrinsic neurons of the dog have not previously been reported. Methods The structure of the intrinsic nerves in the dog trachea was examined by a combination method of digestion with KOH and immunohistochemical ataining of protein gene product 9.5. In addition, areas of nerve cell profiles, numbers of nerve cell bodies per ganglion and densities of nerve cell bodies per ganglion were estimated in preparations from five dogs. Results In the dog trachea, the peritracheal plexus, outer submucosal plexus, inner submucosal plexus, and mucosal plexus were identified from adventitia to epithelium in that order. The peritracheal plexus, situated in the lamina adventitia of the trachea, consisted of thick nerve bundles that were densely distributed in the membranous wall. The peritracheal plexus contained ganglia with round or oval nerve cell bodies. In the trachealis muscle, the intramuscular plexus, which was a well-developed, three-dimensional nervous network, was observed. It did not include ganglia and consisted of inter- and intrafascicular networks. The outer submucosal plexus was observed as small clusters in the inside of the trachealis muscle. A few round nerve cells were observed in the outer submucosal plexus as small clusters. The ganglionated inner submucosal plexus was identified in the superficial layer of the submucosal layer. A finer meshwork, namely, the mucosal plexus, was observed in the lamina propria. Among the entire length of the trachea, we counted 2,134–2,873 ganglia (average, 2,389. Despite this result, it should be borne in mind that the HCV/UFRGS does not take X-rays during inspiration and expiration for the diagnosis of tracheal collapse, nor does it identify in which respiratory movement the images were taken, which can mask various diagnoses and possibly generate a false result. The degree of tracheal collapse could be defined using X-rays because, although it is a static exam to assess a dynamic disease and this makes the degree of collapse by this method more uncertain, identifying the possible severity of the lesion could indicate the degree of urgency and the most appropriate treatment for each case.

It has been commented that the redundant tracheal membrane is closely related to tracheal collapse, since its excess is a consequence of its widening, which is caused by the flattening of the tracheal rings (Ferian, 2009; Fuentes; Johnson; Dennis, 2010). Despite this, clinically normal dogs can show radiographic evidence of a redundant tracheal membrane over the trachea (Macready; Johnson; Pollard, 2007)tracheal collapse was confirmed fluoroscopically and lateral cervical and thoracic radiographic views were reviewed. A board-certified radiologist (who was unaware of the dogs' clinical historyand it is possible to identify the dorsal limit of the trachea in dogs with a redundant dorsal membrane (Bylicki; Johnson; Pollard, 2015). For this reason, it was decided to remove the examination reports of animals that did not have a diagnosis of tracheal collapse concomitant with the study.

The six-year interval was chosen because 2017 was the year that one of the authors of this study entered the veterinary medicine course at UFRGS, and 2022 was the last year before this author finished his course. As seen in the current study, the years 2018 and 2019 showed a decrease in the diagnosis of dogs with tracheal collapse at HCV/UFRGS, possibly due to the fact that HCV/UFRGS

faced an economic crisis during this period. The year 2020 was atypical, with no cases of tracheal collapse diagnosed. This change probably occurred because of the COVID-19 pandemic, which caused care at HCV/UFRGS to drop dramatically (Marra, 2022) and be interrupted between April and December 2022, which differs from Angelon (2021). In the years 2021 and 2022, the number of visits increased, and the radiographic routine returned to normal, along with the decrease in COVID-19 cases (Nebehay, S. *et al*, 2021).

CONCLUSION

Tracheal collapse is a common disease characterized by the progressive degeneration of the cartilage of the tracheal rings. It is seen frequently in clinical practice and mainly affects senior and geriatric dogs, toy and miniature breeds (American Kennel Club, [2024?]). Its diagnosis can be made using radiography, which can identify the location and severity of the disease. Analyzing the data obtained from radiographs in the radiology department at HCV/UFRGS between 2017 and 2022, the main dogs with tracheal collapse are Yorkshire terriers, poodles and dogs of no defined breed, of both sexes, aged between seven and 14 years old. The main region of tracheal collapse is the cervicothoracic transition, with a high incidence of cases in the cervical region as well, but this result has low reliability, as radiographic examinations are not carried out during inspiration and expiration. It is important to note that the pandemic had an impact on the study, significantly reducing diagnoses of tracheal collapse at its start in 2020. In this way, we can suggest that tracheal collapse is an important pathology, considered a common cause of cranial airway obstruction, which affects the quality of life of affected dogs. Despite this, it is still an understudied disease with an uncertain cause, which is why it should continue to be researched.

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