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THE EVOLUTION OF DIAGNOSIS OF VASCULAR RINGS IN THE DEPARTMENT OF VETERINARY SURGERY CLINIC IN WROCLAW

Abstract

Vascular ring is formed as a result of disturbances in the angiogenesis of large vessels, leading to the incarceration of the esophagus and trachea. In dogs and cats distinguished 7 types of vascular ring. Symptoms from the gastrointestinal tract usually appear when a puppy is separated from the mother and sustainable food is introduced. Diagnosis is mainly based on clinical study review, contrast X-ray examination and esophagoscopy. Treatment requires surgery, which consists of ligation and intersection of the structures involved in creating the ring.

Key words: *vascular ring, angioCT, ligamentum arteriosum, esophagoscopy*

Introduction

Vascular ring formed as a result of congenital malformations in the formation of the vascular system of the embryo, which may lead to the incarceration of the esophagus and / or trachea between the large vascular trunks. Anomaly may be isolated or is associated with other cardiac malformations. The first descriptions of the vascular ring in humans come from the first half of the eighteenth century and involved the incorrect positioning of the subclavian artery and double aortic arch (1). Intravital diagnosis of this defect was made possible after the introduction of the contrast x-ray of esophagus using a barite slurry by Kommeralla in 1936 (2). The first surgery of releasing of the vascular ring was performed by Gross in 1945, who also introduced to science the term vascular ring (3).

In dogs and cats, so far, it identified seven types of anatomical anomalies in the formation of these structures, which may lead to a complete or partial vascular ring (4).

Type 1: Persistent Right Aortic Arch with persistent left ligamentum arteriosum – PRAA;

Type 2: Right fourth aortic arch with aberrant left subclavian artery;

Type 3: Right fourth aortic arch with aberrant left subclavian artery and Left sixth ligamentum arteriosum;

Type 4: Double Aortic Arch – DAA;

Type 5: Normal left fourth aortic arch with right sixth ligamentum arteriosum;

Type 6: Normal left fourth aortic arch with aberrant right subclavian artery;

Type 7: Left fourth aortic arch with right sixth ligamentum arteriosum and right aberrant subclavian artery

Material and methods

We analyzed all the correction surgeries of the vascular ring performed in small animals in the years 2004-2009 in the Department of Veterinary Surgery Clinic in Wroclaw. The collected data were compiled based on the book of clinical small animal surgery. The study included analysis of information obtained from history, clinical parameters, the results of additional studies, intraoperative image of defects, and additional postoperative annotations. In the interview, were taken into account the animal's age, his race, sex, time of occurrence and symptoms from gastrointestinal tract, additional clinical symptoms. Clinical examination included a general assessment of animal health with particular emphasis on the degree of cachexia, changes in the circulatory system and complications of respiratory. All animals were performed preoperative blood analysis including hematology and biochemical. In radiological procedures (X-ray my f-Siemens with digital image processing - Agfa) a review images of the chest and contrast x-ray using a barite slurry were performed. In most animals before surgery and during surgery performed endoscopy of the esophagus. In one case the diagnosis was based on performance of vascular CT - CT angiography. In all cases surgery was covering the left-sided thoracotomy in 4 or 5 intercostal space and the preparation, ligation, and the intersection of structures forming ring.

Results

In the analyzed period of 5 years was performed 17 procedures of the correction of vascular ring including 15 dogs and two cats. The quantitative part of treatments in each year was as follows: 2005 - 2, 2006 - 3, 2007 - 3, 2008 - 4, 2009 - 5. Among the 15 operated dogs in 6 cases, the defect related to German Shepherds, 2 golden retrievers, 1 labrador, 1 giant schnauzer, 1 miniature schnauzer, 2 dobermans, 1 Czech Woolfdog, 1 mongrel. In cats: 1 case in Maine coon, 1 in Devon rex. In the 10 cases were females in 7 males.

Defect is usually diagnosed between 6 weeks and 4 months of age of the animal and in 12 cases during this period performed surgery. In 4 cases the animals have been diagnosed and undergone surgery between 5 - 8 months of age, in one case at the age of 16 months (German shepherd with incomplete vascular ring).

In all animals suspicion of presence of vascular ring was made on the basis of clinical symptoms and radiological examinations. In all 17 cases, the predominant symptom was regurgitation of food occurring since the first days of life of the animal. In the initial stage of development (liquid food), regurgitation was observed immediately after eating but not every time. At the time of transition to solid foods, in all test animals sudden exacerbation of clinical symptoms was observed. Regurgitation was occurring after almost every meal and the intervals between feeding and regurgitation underwent progressively longer. All patients were characterized by considerable emaciation despite preserved appetite, clearly weaker

growth compared to their peers, no signs of dehydration. In 10 cases, the early symptoms from the respiratory system in the form of aspiration inflammation were noticed. In the blood tests were found in all cases decrease of the quantity of total protein, albumin, and neutropenia. In 5 cases, the characteristics of anemia in the form of reduction in the number of erythrocytes and reduced hemoglobin were noticed. There were no in any case very clear indicators of changes in blood chemistry. In the radiological procedures of review of chest, intracranially from the heart was demonstrated pronounced, air-filled esophagus. After administration of contrast medium in the form of barium sulphate, in each case, a strong narrowing of the esophagus above the heart was demonstrated, with subsequent pre-cardiac baggy extension. In 15 patients (since 2006) additionally before each surgery the esophagoscopy was performed using Pentax videoendoscopy. Studies have demonstrated a very strong expansion in the pre-cardiac esophagus, then the total amount of the narrowing of the heart. In the enlarged part in each case revealed residual reflux. In 9 cases revealed through the wall of the organ on the right side throbbing of large blood vessels. In one dog (Labrador) a detailed diagnosis of defects was made based on computed tomography. The study showed the presence of right-aortic arch with left ligamentum arteriosum.

In 13 dogs, thoracotomy was performed in 4 intercostal space, and 2 dogs (a miniature schnauzer and mongrel) and in two cats in the 5th intercostal space. In 9 cases revealed through the wall of the organ on the right side throbbing of large blood vessels. In one dog (Labrador) a detailed diagnosis of defects was made based on computed tomography. The study showed the presence of right-aortic arch with

In 13 dogs, thoracotomy was performed in 4th intercostal space, and in 2 dogs (a miniature schnauzer and a hybrid) and in two cats in the 5th intercostal space. The definitive diagnosis of the type of vascular ring was made on the basis of intraoperative image of the defect. In 14 cases showed right hand aortic arch with left ligamentum arteriosum. In 2006 the left aortic arch with right ligamentum arteriosum had been detected in German Shepherd, in 2008 in meine coon cat the right aortic arch with left ligamentum arteriosum and aberrant left subclavian artery was revealed, and in 2009 in the Czech Woolfdog symmetrical double aortic arch. All procedures were completed without complications. In 14 cases, the complete withdrawal of regurgitation symptoms within 2 weeks after surgery was reported. During this time the animals were fed in standing position and received food in which every day increased the involvement of solids components. After 6-8 weeks after surgery the animals were considered cured. In two cases the degree of esophageal dilatation was sufficiently advanced that the treatment did not bring a satisfactory improvement and operated dogs require feeding in standing position. The symptoms of regurgitation incidence significantly decreased but not totally disappeared. In one case, no improvement was achieved. Probably the ring defect was accompanied by symptoms of esophagus achalasia.

Discussion

The reasons of vascular ring anomalies occurrence in animals are not definitively known and explained. In humans, was confirmed by genetic factor (10). In animals, beyond the genetic factors are taken into account the teratogenic factors, infectious diseases in the mother's first pregnancy, nutritional deficiencies, mainly vitamin A deficit (8).

Pathologies associated with aortic arch anomaly, occur rarely in animals. The most common form of vascular ring, which has clinical significance, is persistent right aortic arch with left ligamentum arteriosum which is about 95% of all cases. PRAA most often occurs in large breeds such as German shepherd, Irish setter, Great Dane (8, 9, 10). Much less likely this defect is present in cats (7). It has been found predilections to occurrence of PRAA in Siamese and Persian cats (6, 7). There were no gender predilection (16). In the material collected by us the dominant type of vascular ring was PRAA. Out of 17 patients which undergone surgery this defect appeared in 14 animals what representing over 82% of cases. Among the dogs in our material the defect most often revealed in German Shepherds - 6 cases, whereas the 2 cases noted in the group of dobermans and golden retrievers. Two cases involved cats, which also indicates a smaller share of the vascular ring in this species. Two cases involved cats, which also indicates a smaller share of the vascular ring in this species. In both cases, the pathology related to a cat with pedigree what may indicate greater predisposition to malformations or genetic defects in animals selected for breeding, but also may result from a limited diagnostics in cats with lower market value. It is also difficult to consider gender predilections for such limited material. Slight predominance of females results more from to the statistical error than any tendency. Anomaly occurs much less frequently in animals is a double aortic arch. In humans, this defect is considered the most common type of vascular ring anomaly (1). You can venture to say that a double aortic arch is the most dangerous in consequences from the vascular ring anomaly. Above all, in this defect, more often than in other types the strong dyspnoea is diagnosed. Originally it is a consequence of vascular trunks compression on the trachea, a secondary aspiration pneumonia. In addition, most animals have so far made of surgical correction of double aortic arch are unsuccessful. The reason for this is that normally the two aortic arches are of comparable diameter, and thus the ligation of one of them, resulting in a sudden and large increase in pressure in the remaining vessel, causing rupture of its wall (12). In 2009, a double aortic arch was diagnosed intraoperatively in our clinic in a dog breed Czech Woolfdog. Disclosure during the treatment of 2 symmetric aortic arches require a decision to close one of them. After careful evaluation of each of the arches it was decided to close the left arch. Before the final ligation and intersection of such a large and important vessel we used maneuver which is not described in any of the cases of double aortic arch in dogs, namely, we closed on the left aortic arch for 15 minutes vascular clamp, thereby closing completely the blood flow in this area. Throughout the period of clamping on, continuous and very precise measurements of cardiovascular parameters were performed and palpably examination of the degree of vascular filling of the right arch. Within 15 minutes of observation no significant changes in cardiovascular parameters

has been stated. There has not been any changes in the heart rhythm. There was only about 10% decrease in heart rate and approximately 15% decrease in blood pressure (oscillometric measurement of the calf). There were no significant changes in the increase in the diameter of the active arch. On the exposed section of the left arch were set up 2 ligatures using cardiovascular material 2 / 0 Eticon and then the vessel was cut between them. Additionally the stumps was secured with seam. Further dissection of tissue around the cut left arch completely freed the esophagus, which was monitored constantly by videoesophagoscopy. Other types of "vascular rings" in dogs and cats are very rare. Please note that the statistics on this subject, are based almost exclusively on published cases, which means that they can be flawed. In the literature there are descriptions of the single "classical" types of vascular rings as well as more complex defects of the aortic arch (14, 15, 16, 17). In our practice over the 5 years we found intraoperatively 2 other defects namely left aortic arch with right ligamentum arteriosum in a German Shepherd and in Maine Coon cat right aortic arch with left ligamentum arteriosum and aberrant left subclavia. Successful correction of these defects has shown that despite the lack of accurate preoperative diagnosis of the type of occurring anomalies, the theoretical knowledge of all possible variants guarantee the correctness of the implementation of the procedure. Also in the case of occurrences of the "mirror" type defects such as the left aortic arch with right ligamentum arteriosum, thoracotomy from the left side allows for correction of such defects even though the complexity of the surgery is significantly increased.

Regardless of which vessels form a vascular ring, the clinical picture as well as a diagnostic procedure leading to the disclosure of irregularities, are the same. Symptoms from the gastrointestinal tract may present only slightly different degree of severity, depending on whether we are dealing with a complete, or incomplete vascular ring. The most characteristic symptom are constantly repeated regurgitations of undigested food which may occur during food intake or immediately after eating - usually after leaving the head down. A very important element of the diagnostic abnormalities suggestive of the presence of vascular ring is the age of the animals. Similarly, as indeed in many other congenital heart defects, also there the first symptoms appear in very young animals. This time is closely correlated with the stage of transition of animals from milk liquid diet to solid food, which in dogs and cats is usually at the age of 3-4 weeks. The consequences of the difficult passage of gastric contents are the characteristics of malnutrition, sometimes severe emaciation and dehydration. Animals clearly differ from their peers from litter, although they have maintained or even increased appetite. During auscultation of the heart and lungs, in most cases, do not state any changes, unless there was aspiration pneumonia, which is one of the complications of that pathology. Symptoms of the respiratory system in the form of cough or shortness of breath, can be a consequence of vascular compression on the trachea as observed in a double aortic arch (13), but more often due to aspiration pneumonia. Instead, they occur far less frequently than gastrointestinal symptoms, what is associated with increased resistance to the oppression of the trachea, due to its anatomical structure. For animals which undergone surgery in our clinic characteristic symptoms from gastrointestinal track

were the basic of a detailed diagnosis. In 12 cases, the animals were very young, less than 4 months of age, and in this group were all cases of complete vascular rings. Usually the first contact with veterinarian the animals had at the time of their withdrawal from the mother. Change to solid food rapidly exacerbate the clinical symptoms. Additionally, in the majority of these animals the symptoms of cough and respiratory tract irritation appeared. In case of double aortic arch symptoms from the respiratory tract in the form of whistling, and shortness of breath increasing after eating have been observed since the beginning of a patient's life. No significant improvement after implementation of treatment was the basis in all cases to refer the patient for further diagnosis. Each of the patients underwent blood tests. Observed hypoproteinemia, hypoalbuminemia, neutropenia, decreased values of PCV, MCV shows the consequences of malnutrition rather than direct effects of anomalies. Regurgitation of food especially in young animals is an indication for X-ray examination of the neck and chest. In the review examination the esophagus manifests as a creation extended intracranially from the heart, filled with air and nourishment. The dorso-ventral projection is sometimes possible to identify the descending aorta on the right side of the esophagus in animals with persistent right-sided aortic arch. Contrast examination of the esophagus with barium sulfate, lets say extension in the thoracic part of esophagus, which may occur in some cases up to the cervical part and its characteristic narrowing at the base of the heart, where the contrast agent accumulates.

By 2005, the basis for diagnosis of vascular rings in our clinic were clinical symptoms, blood tests and contrast radiography. The introduction of a detailed endoscopic examination of the esophagus before surgery significantly improved the recognition of anomalies. An endoscopy is performed to rule out other causes of obstruction of the esophagus and to assess the prevalence of erosions and ulcerations. Observed during the study throbbing on the right side of the esophagus shows that we are probably dealing with a persistent right aortic arch. In addition, in this examination we can pre-assess whether we are dealing with full time or part-vascular ring. In human medicine, in order to differentiate the type of disorders of the vascular ring the ultrasound of the heart and major blood vessels, CT angiography mode is usually performed. In absence of such opportunities the classical angiography is done. In animals, such advanced diagnostic techniques are used, even in well-equipped veterinary clinics, very rarely. Because intraoperatively cut and ligated vascular structures have different diameters, what is more in endoscopy examination sometimes had the impression that all the elements constituting the ring pulsate, the next step was the introduction in preoperative diagnosis in our patients an ultrasound of the heart and major blood vessels. It is assumed on the basis of the literature that approximately 10% of dogs with persistent right-sided aortic arch, patency of ductus arteriosus is maintained (11). Moreover, in human medicine, vascular ring anomalies are sometimes accompanied by other malformations of the heart. All these elements contributed to the fact that since 2009, every patient with suspected vascular ring is directed to a detailed examination of cardiology.

The direct method showing the structure of the cardiovascular system is angiography. However, it is invasive test, requiring assumption of catheter into the aorta and administration adequate amount in adequate unit of time contrast using a special pump. Due to the volume of patients, this technique is difficult in its execution. In addition, it is fraught with the possibility of complications associated with inserting and intrarterial administration of large amounts of contrast. Requires a good quality of the video track. Angiography does not reveal the ligamentum arteriosum, because blood does not flow through it. However it may show other abnormal vessels although sometimes assessment of angiographic images is difficult (17). All these problems led to the abandonment of our implementation of the classic angiography in cases of vascular rings.

In 2008 reported about the application of CT angiography using a computer tomography to diagnose persistent aortic arch with right-left arterial ligament in the dog (18). Intraoperatively found a case of double aortic arch in the Czech Woolfdog prompted us to extend the arsenal of preoperative diagnostic tests. In 2008 reported about the application of CT angiography using a computer tomography to diagnose persistent aortic arch with right-left arterial ligament in the dog (18). Intraoperatively found a case of double aortic arch in the Czech Woolfdog prompted us to extend the arsenal of preoperative diagnostic tests. Nowadays, this study should be made mandatory in the diagnosis of defects of the cardiovascular system. However, as yet, the costs reduce the possibility of such examination.

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