

Pectus Excavatum in Puppies and Kittens

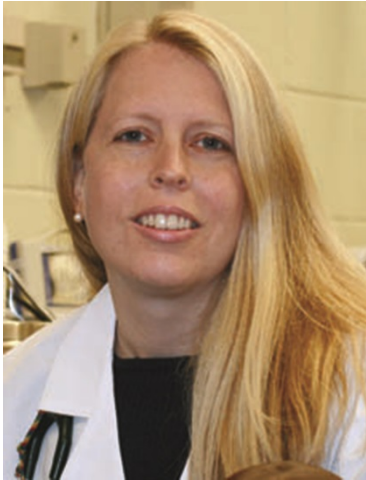
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Pectus excavatum, which is from Latin meaning “hollow breast,” is a chest wall deformity seen frequently in humans and less often in veterinary patients.¹ It has been described in dogs, cats, lambs, calves, rabbits and sea otters.^{2,3} It is a congenital defect where the caudal ribs and sternum do not grow properly resulting in a concavity starting around the 3rd to 5th rib and continuing to the xiphoid process.^{1,2} This deformity causes compression of the right side of the heart with deviation of the heart, to the left side of the thorax.⁴ Pectus excavatum is the most common chest wall deformity seen in both people and animals, accounting for 90% of human cases.¹ In people, it occurs in approximately one in 400 live births and is more common in males with as high as a 9:1 ratio reported.^{1,4} It is not thought to be as common in animals and no sex predilection has been described. Pectus excavatum was first described in people the early 1600s and several case reports from the late 1800s were published.¹ The first surgery for pectus excavatum was reported in 1911 and involved removal of rib cartilage.¹ The first reported case of pectus excavatum in an animal was in 1968 in a Siamese cat.⁵ The first report in dogs was in 1973 in three Setter-cross littermates.⁶ Since that time, there have been numerous case reports of the condition, but because it is fairly rare, the literature is still limited.



Pectus excavatum, seen here, is a congenital defect resulting in a chest wall deformity.

The etiology of pectus excavatum is unknown. Early theories ranged from hypertension of the diaphragm, and nutritional disturbances causing a weakness of the sternum, to an increased intrauterine pressure, causing the fetus' chin to compress the thorax.¹ Current thought is that there is a defect in metabolism in the sternocostal cartilage that leads to biomechanical weakness and overgrowth.¹ The condition has been shown to be genetic in people, with 43% of patients having a family history.⁴ There is an association with scoliosis and connective tissue disorders like

Marfan, Noonan and Ehlers-Danlos syndromes.⁴ Predisposition for pectus excavatum is seen in Bengal and Burmese cats as well as brachycephalic dogs, most commonly in the Maltese and English Bulldog.⁷⁻¹⁰ Acquired pectus excavatum has been reported in people secondary to respiratory obstruction and there is a single case report describing acquired pectus excavatum in a dog secondary to laryngeal paralysis.^{11, 12} Recently, a rat model for pectus excavatum has been reported where removal of the last four costal cartilages results in collapse of the sternum.¹³

Pectus excavatum is present at birth and is detectable within days in puppies and kittens.^{2,12} The defect worsens with growth and in people it is sometimes is not obvious until adolescence.^{1,4} Once growth ceases, the condition does not progress. The clinical signs can be variable with most cases in humans presenting with mild signs or concern about cosmesis.⁴ In severe cases, disabling cardio and respiratory compression is present and clinical signs worsen with age. Dyspnea, chest pain, fatigue, palpitations, tachycardia, and exercise intolerance have all been reported in people.⁴ Dyspnea is the most common clinical sign in animals.¹² Exercise intolerance, inappetence, recurrent respiratory infections, weight loss, cough, cyanosis, and heart murmurs are also reported.^{12,14}

Pectus excavatum is diagnosed on physical examination however imaging helps to determine the severity of the condition. The anthropometric or clinical index, measures the depth of the defect and compares it to the depth of the thorax.^{15,16,17} This is a simple test that requires no additional equipment. Radiographs show the degree of deformity and can be used to calculate several different indices which assess the amount of compression. The frontosagittal index (FSI) compares the width of the thorax at its widest point with the depth of the thorax at its most narrow point and a ratio is determined.¹⁶ The vertebral index (VI) compares the distance between the dorsal border of the spine and the sternum at the narrowest point, with the depth of a vertebral body.¹⁶ In animals, two view thoracic radiographs can be used to calculate both the FSI and the VI and when combined with clinical signs, help to determine if surgery is recommended. The Haller index (HI), also called the pectus index, was first described in 1987 and is calculated by dividing the transverse diameter of the chest by the narrowest anterior-posterior distance on a computed tomography (CT) scan axial slice.^{16,18} The Haller index is the most commonly used pectus excavatum index used in people. It can also be calculated using plain film and has been shown to correlate well with the CT calculations.¹⁶ Indices may not correlate with clinical signs in some cases. CT scan has been shown to result in a lower vertebral index and a higher frontosagittal index in kittens when compared to radiographic measurements.¹⁹ CT was useful in determining if the xiphoid was midline or lateralized with the thought that midline defects cause more clinical signs.¹⁹ CT scan also helped determine safe corridors for surgical suture placement.¹⁹



Treatment for pectus excavatum depends on the severity of the clinical signs. Pain is a common complaint in human patients and non-steroidal anti-inflammatory medication and acupuncture have been reported to help.⁴ Physical therapy has been recommended to help strengthen the chest muscles and help develop the ribcage. Daily medial lateral compression of the chest or compression bandages have been described for neonatal puppies and kittens however, this is unlikely to improve severe deformities.² In people, the use of a vacuum bell has been reported with success in milder cases and in young patients who still have a compliant thorax.²⁰ Several hours of daily use is required and patients wear the device for up to two years after the deformity is corrected. In the case of severe pectus excavatum or in older patients, surgery is required. The two most commonly performed surgeries are the Ravitch procedure and the less invasive Nuss procedure. The Ravitch procedure involves an open surgical approach with removal of the deformed cartilage and metal bars are implanted to support the sternum. This is a long

procedure with potentially significant morbidity. The Nuss procedure is performed under thoracoscopic guidance and a curved metal bar is placed and then flipped into position to raise the sternum.^{21,22,23} In veterinary patients, the choice of surgery is dependent on age. In older animals, an open approach is required to correct the deformity. Osteotomy of a portion of the costal cartilage is required to allow the sternum to be realigned and an internal splint, such as a bone plate, is used to keep the sternum in this position.²⁴ An open approach to release the sternum, combined with an external splint has also been described.^{25,26} Animals less than 4 months of age will typically have a compliant thorax and external splints with circumsternal sutures can be used.²⁷ The sutures are tied to the splint to keep the thorax in a normal position and the splint is left in place for 3 to 4 weeks.^{27,28,29} Complications associated with surgery include inadvertent puncture of the lungs or heart, pneumothorax, hemorrhage and re-expansion pulmonary edema which can be fatal.^{28,30} Minor complications include bandage sores and abrasions from the splint or reaction to the sutures.



An external splint to address pectus excavatum.

Anesthesia in patients with pectus excavatum can be challenging.³¹ Ninety-five percent of patients present with some degree of ventricular compression.³¹ Heart murmurs and arrhythmias are common.^{14,31} Underlying respiratory disease including infections should be treated prior to surgery and assisted ventilation is needed during anesthesia. Because surgery is often performed in very young puppies and kittens, their body temperature should be carefully monitored as their thermoregulation is not fully developed and they have little fat. Their metabolism rate is higher than adult patients and as a result, they require shorter fasting times and higher fluid rates.¹⁴ Enzymes systems should be fully developed by 4 weeks allowing the use of injectable medications.¹⁴

Pectus excavatum is a treatable condition that has a favorable prognosis in puppies and kittens. Severe cases can do well with surgery. A procedure with circumsternal sutures and an external splint is the most commonly performed in young animals. Surgery is best accomplished between 8 and 12 weeks when the thorax is still compliant but the patient is old enough to tolerate anesthesia.

References

- 1) Brochhausen C, Turial S, Muller FKP, et al. Pectus excavatum: history, hypotheses and treatment options. *Interac CV Thorac Surg* 2012; 14: 801-806
- 2) Singh M, Parrah JUD, Moulvi, BA et al. A review on pectus excavatum in canines: a congenital anomaly. *Iran J Vet Surg* 2013; 8(1): no 18 59-64
- 3) Mann N, MacLean J, et al. Pectus excavatum and swimmer puppy syndrome with concurrent congenital cardiac anomalies in two domestic rabbits. *J Ex Pet Med* 2019; 29: 212-216
- 4) Abid I, Ewais MM, Marranca J, et al. Pectus excavatum: a review of diagnosis and current treatment options. *J Am Osteopath Assoc* 2017; 117(2):106-113
- 5) Grenn HH, Lindo DE, Pectus excavatum (funnel chest) in a feline. *Can Vet Jour* 1968; 9(12):279-282
- 6) Pearson JL, Pectus excavatum in the dog (a case report). *Vet Med* 1973; 125-128
- 7) Charlesworth TM, Sturgess CP, Increased incidence of thoracic wall deformities in related Bengal kittens. *J Fel Med Surg* 2012; 14(6): 365-368
- 8) Sturgess CP, Waters L, et al. Investigation of the association between whole blood and tissue taurine levels and the development of thoracic deformities in neonatal Burmese kittens. *Vet Record* 1997; 141: 566-570
- 9) Komsta R, Osinski Z, Debiak P, et al. Prevalence of pectus excavatum (PE), pectus carinatum (PC), tracheal hypoplasia, thoracic spine deformities and lateral heart displacement in thoracic radiographs of screw-tail brachycephalic dogs. *PLOS ONE* 2019

- 10) Hassan EA, Hassan MH, Torad FA, Correlation between clinical severity and type and degree of pectus excavatum in twelve brachycephalic dogs. *J Vet Med Sci* 2018; 80(5):766-771
- 11) Kurosawa TA, Ruth JD, et al. Imaging diagnosis- acquired pectus excavatum secondary to laryngeal paralysis in a dog. *Vet Rad Ultra* 2012; 53(3):329-332
- 12) Fossum TW, Boudrieau RJ, Hobson HP, Pectus excavatum in eight dogs and six cats. *JAAHA* 1989; 25:595-605
- 13) David VL, Ciornei B, Horhat FG, et al. Rat model of pectus excavatum. *Life* 2020; 10:96
- 14) Boudrieau RJ, Fossum TW, et al. Pectus excavatum in dogs and cats. *Compend Cont Ed* 1990; 12(3): 341-355
- 15) Rebeis EB, Milanez de Campos JR, et al. Anthropometric index for pectus excavatum. *Clinics* 2007; 62(5):599-606
- 16) Martinez-Ferro M, Indexes for pectus deformities. In *Chest Wall Deformities and Corrective Procedures* Springer Inter Pub, Switzerland, 2016
- 17) Sujka JA, St. Peter SD, Quantification of pectus excavatum: anatomic indices. *Sem Ped Surg* 2018; 27(3):122-126
- 18) Poston PM, Patel SS, Rajput M, et al. The correction index: setting the standard for recommending operative repair of pectus excavatum. *Ann Thorac Surg* 2014; 97:1176-1180.
- 19) Charlesworth TM, Schwarz T, Sturgess CP, Pectus excavatum: computed tomography and medium-term surgical outcome in a prospective cohort of 10 kittens. *J Fel Med Surg* 2016; 18(8):613-619
- 20) Haecker FM, Sesia S, Non-surgical treatment of pectus excavatum. *J Vis Surg* 2016;2:63
- 21) Hebra A, Calder BW, Leshner A, Minimally invasive repair of pectus excavatum. *J Vis Surg* 2016;2:73
- 22) Sakamoto Y, Yokoyama Y, et al. Outcomes of the Nuss procedure for pectus excavatum in adults. *J Plast Recon Aesth Surg* 2020
- 23) Xie Y, Ning J, Application of polydioxanone sutures in the Nuss procedure. *Thorac Cardiovasc Surg* 2021
- 24) Risselada M, de Rooster H, Liuti T, et al. Use of internal splinting to realign a noncompliant sternum in a cat with pectus excavatum. *JAVMA* 2006; 228(7): 1047-1052
- 25) Mestrinho LA, Ferreira CA, et al. Open surgical correction combined with an external splint for correction of a non-compliant pectus excavatum in a cat. *J Fel Med Surg* 2011; 14(2):151-154
- 26) Crigel MH, Moissonnier P, Pectus excavatum surgically repaired using sternum realignment and splint techniques in a young cat. *J Small Ani Pract* 2005; 46:352-356
- 27) McAnulty JF, Harvey CE, Repair of pectus excavatum by percutaneous suturing and temporary external coaptation in a kitten. *JAVMA* 1989; 194(8): 1065-1067
- 28) Fossum TW, Boudrieau RJ, et al. Surgical correction of pectus excavatum, using external splintage in two dogs and a cat. *JAVMA* 1989; 195(1):91-97
- 29) DeGroot W, Tobias KM, External splinting for pectus excavatum in kittens. *Clinician's Brief*, May 2018
- 30) Soderstrom MJ, Gilson SD, Gulbas N, Fatal reexpansion pulmonary edema in a kitten following surgical correction of pectus excavatum. *JAAHA* 1995; 31:133-136
- 31) Patvardhan C, Martinez G, Anaesthetic considerations for pectus repair surgery. *J Vis Surg* 2016;2:76