Open surgical correction combined with an u-shaped external splint for pectus excavatum in a Scottish fold cat

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ABSTRACT

A 4 month-old, 1.9 kg, female, Scottish fold cat was brought to Kırıkkale University Veterinary Faculty Research and Practice Hospital with complaints of progressive dyspnea and exercise intolerance. Dorsal deformation in the caudal part of the sternum and displacement of the heart into the left hemithorax were determined in the clinical and radiographic examinations. In the measurements made on the radiographic images taken before the operation, the frontosagittal index (FSI) and vertebral index (VI) values were measured as 3.5 and 5.1, respectively. An external splint made of PVC material is fixed to the thorax with suture material passed around the sternebrae, in order to correct the sternal malposition in intraoperative treatment. The patient was followed for 8 weeks after the operation. The external splint was removed five weeks after the operation, and the FSI and VI values were measured as 1.4 and 11.3 on the radiographs, respectively. In the postoperative period, it was observed that the patient's problems such as dyspnea and exercise intolerance disappeared. In animals with bone development yet to be completed, it has been determined that external splint application gives successful results.

Pectus excavatum (PE) is the most common congenital deformity of the anterior chest wall. Dorsal deviation occurs in the caudal part of the sternum and associated costal cartilage or it can be seen abnormal growth on several ribs and sternum. As a result, the chest narrows and a collapsed appearance is formed. PE is sometimes referred to as Cobbler's chest, Sunken chest, Funnel chest, Shoemaker chest or a Dent in the chest (1, 15). Costo-sternal deformity causes the rib cage to dorsoventrally narrow. Due to the restriction in ventilation and cardiac compression, narrowing occurs especially in the caudal direction (6, 13). Cardiac and lung functions deteriorate due to decreased intrathoracic volume and restriction of diastolic filling in PE cases (10).

Although most of the cases are congenital, abnormalities are also observed during puberty. Large negative intrapleural pressures can cause the collapse of the sternum and intercostal cartilage in humans. There is information in the literature that conditions that cause upper airway obstruction at a young age lead to abnormal respiratory gradients and that PE may develop as a result. An example of this is the "swimmer syndrome", which causes collapse of the sternum as a result of newborn dogs unable to walk in a proper manner and constantly lying in the sternal position (16). Another information about PE formation is the formation of a concave abnormality in the caudal sternebrae as a result of the short and hypoplastic diaphragm inhibiting the development of the sternum and caudal ribs (18). In postmortem examinations in a cat with PE, it was determined that the primary abnormality included the ventral part of the diaphragm (17).

In the case presentation, the treatment of PE in a 4-month-old cat with external splint application is described.

A 4-month-old, 1.9 kg, female intact, Scottish Fold cat with the complaint of respiratory distress was brought to Kırıkkale University Veterinary Faculty Research and Practice Hospital. The first findings observed in the clinical examination were tachypnea, exercise intolerance, and sternum deformity that was noticeable on inspection. It was determined that a dorsal deviation of the last 4

sternebrae and sternum on the laterolateral radiography, and heart shifted to the left of the median line on ventrodorsal radiography. (Figures 2a and 2b). For determining the severity of the deformity, measurements were made according to the frontosagittal index (FSI) and vertebral index (VI), which were defined in previous studies (2). The FSI value was determined to be 3.53 (reference range 0.7-1.3) and the VI value was determined to be 5.1 (reference range 16.2-18.8) in these measurements (Table 1). According to the measurements made, it was decided that the clinical score of the cat was 'severe' and that an operation should be performed.

Upon premedication with butorphanol (0.01 ml/kg, IV) (Butomidor; Richterpharma, Austria), propofol (3 mg/kg, IV) (Propofol 2% Fresenius; Fresenius Kabi, Austria) was administered for anesthesia induction. After the intubation of the patient, anesthesia was maintained with isoflurane (Isoflurane USP, Adeka, Türkiye). Fluid therapy (Lactate Ringer 10ml/kg/hour) (Ringesol, Vilsan, Türkiye) was administered during the intraoperative period. Cefazolin sodium (25 mg/kg) (Cefazol, Mustafa Nevzat, Türkiye) was administered intravenously 20 minutes before the operation and during the intraoperative period.

Table 1. Grading of the clinical severity of PE using Frontosagittal and Vertebral indices.

Clinical Score	FSI	VI
Normal	0.7-1.3	12.6-18.8
Mild	2	>9
Moderate	2-3	6-9
Severe	>3	<6

FSI: Frontosagittal index. VI: Vertebral index.

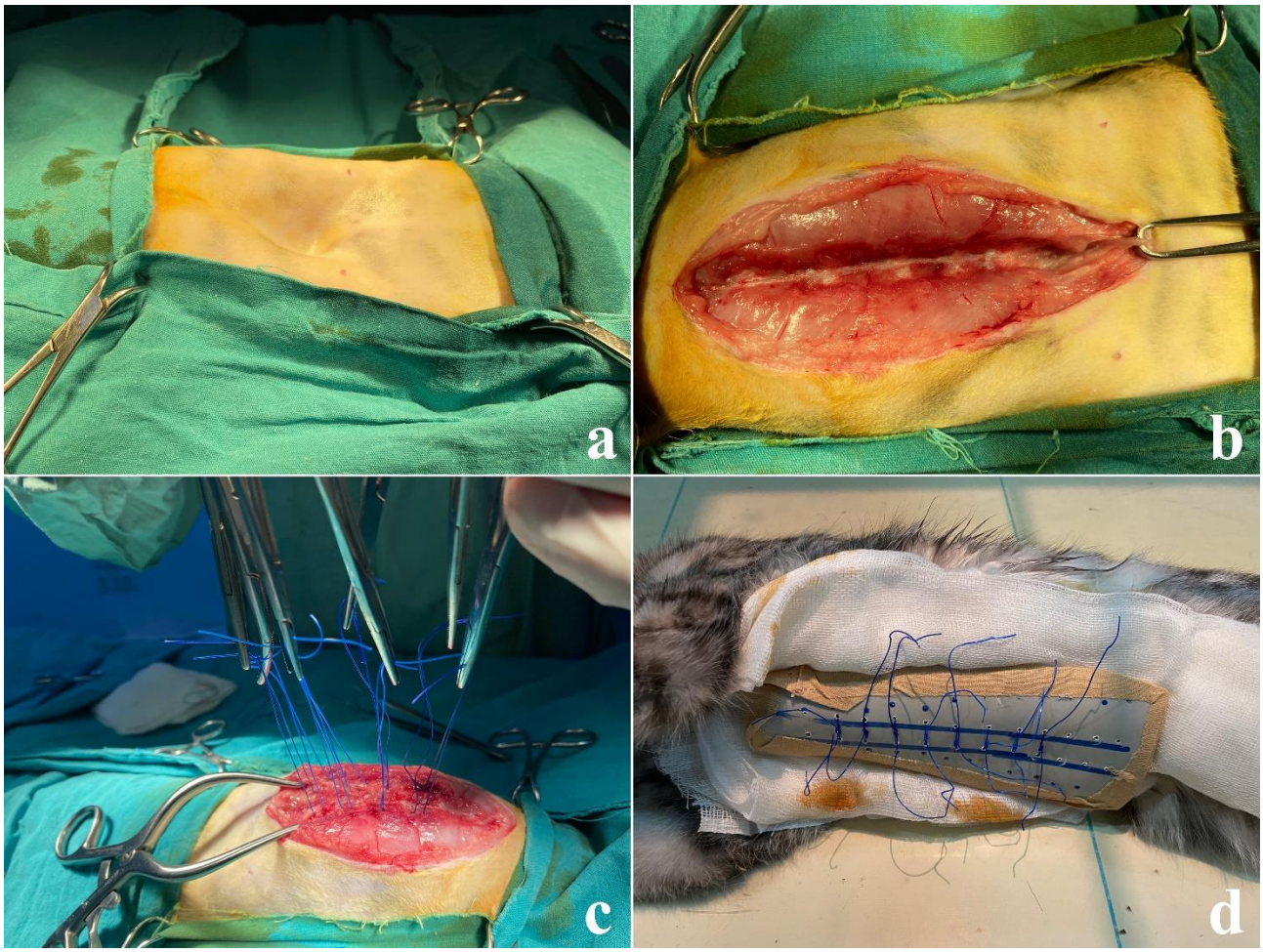

Figure 1. Preoperative appearance of a cat with PE showing dorsal deviation of the caudal sternum (a). Separation of deep pectoral muscles from the sternum (b). Circumsternal sutures are retracted ventrally to straighten the sternal deviation (c). Stabilization of external U-shaped splint. (d).

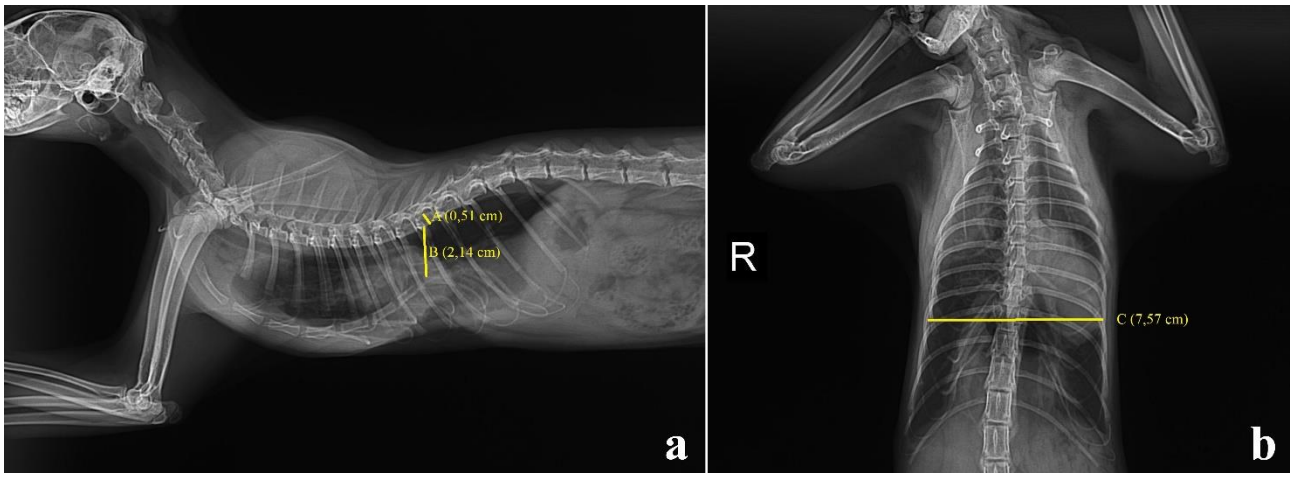

Figure 2. a: Measurement of the vertebral body for calculation of vertebral indices in laterolateral radiograph. The diameter of the vertebral body overlying the deformity and the distance of the same vertebra to the sternum added (A+B). The ratio of the result to the diameter of the vertebra determines the vertebral indices. ((A+B)/A). b: Measurement of thoracic width at the 10th thoracic vertebra on a ventrodorsal radiograph for calculation of frontosagittal index (C).

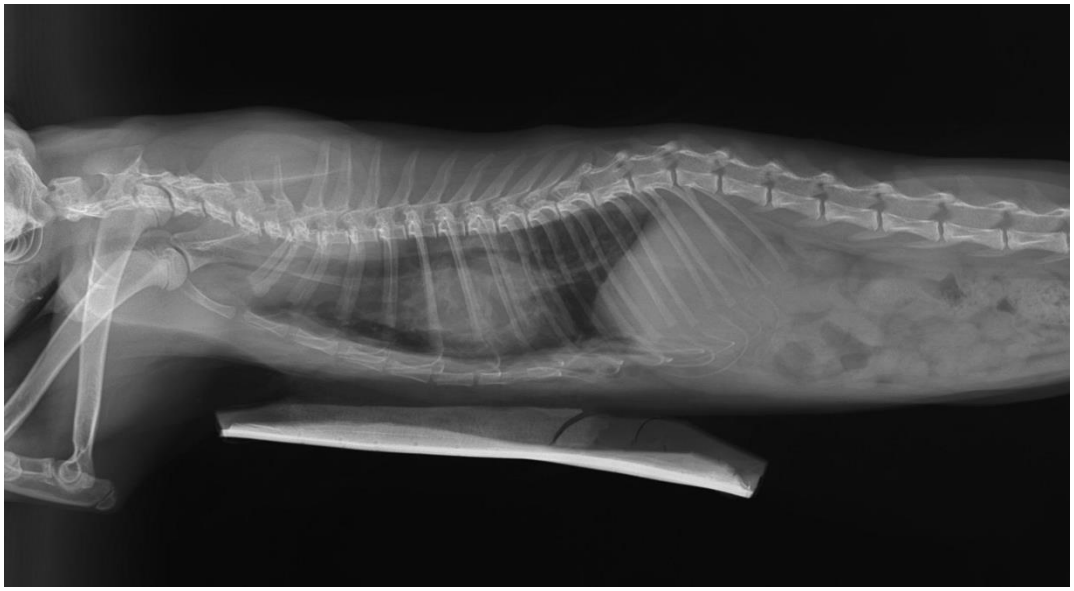

Figure 3. Laterolateral radiographic image of the thorax on first postoperative day.

The operation area was shaved and the patient positioned in the dorsal recumbency. The operation area was disinfected and prepared for the operation (Figure 1a). A skin incision was made in the midline of the thorax, extending from the second sternebra to the processus xiphoideus. The deep pectoral muscles were separated from the place where they were attached to the sternum with the help of a periosteal elevator (Figure 1b). With this method, the sutures were placed more easily and carefully, as the sternal deviation was made more prominent. As the suture material, monofilament polypropylene (USP 1) was preferred. As the deviation in the sternum was very deep, the first of the circumsternal sutures were placed on the processus xiphoideus. The placed sutures were fixed with hemostatics and pulled upwards (Figure 1c). Thereby, safe suture areas were created for other suture materials to be placed. After placing all the sutures, the skin was closed and the free ends of the suture materials were passed through the prepared U-shaped PVC support material. Surgical pads were put under the PVC support to as not to create an abrasion wound on the skin. Subsequently, the free ends of the suture materials were tie on the PVC and the external splint was fixed to the thorax (Figure 1d and 3).

Amoxicillin-clavulanic acid (Synulox; Zoetis, Finland) was used for 7 days postoperatively and meloxicam (Maxicam; Sanovel, Türkiye) was used for 4 days, and the patient was called for controls every week.

In accordance with the information obtained from the owner of the patient, it was learned that the cat's breathing improved and its activity increased 5 days after the operation. A bandage was changed during the controls, the pads between the skin and the external splint were removed, the area was cleaned as much as possible, and control radiographs were taken. On the radiographs taken in the fourth postoperative week, pulmonary edema was detected and furosemide (2 mg/kg) (Lasix, Sanofi, France) and dexamethasone (0.5 mg/kg) (Vetakort, Vetaş, Türkiye) were used for this purpose for 4 days. This complication is thought to result from reexpansion. The external splint was removed at the end of the fifth week. When the external splint was removed, no abrasion wound was observed on the skin and pulmonary edema had resolved. One week after removing the splint, clinical examinations of the patient were performed again and control radiographs were taken. FSI and VI scoring was performed on the radiographic images taken (Figure 4). In accordance with the results, it was determined that the patient's thorax index turned from severe to near normal (FSI: 1.4 and VI: 11.35).

A pectus anomaly is a chest wall deformity in which several ribs and the sternum are abnormally enlarged and consequently produce a convex (carinatum) or concave (excavatum) appearance on the ventral aspect of the chest wall. This anomaly is frequently seen in animals, particularly in cats and dogs (5, 8). Even though the incidence of PE in cats is not known clearly, it has been reported that it is more common in Bengal cats than domestic shorthair cats (4). It is reported that the presence of PE in Burmese cats is associated with flat-chested kitten syndrome (19). It is reported that the most common clinical symptoms in PE cases are exercise intolerance, tachypnea, growth retardation, or growth arrest (3). It is reported that the PE case can be easily felt on palpation of the thorax (2). The main clinical findings in this case were exercise intolerance and dyspnea. It was also noted by a previous studies (14, 21). In the weeks following the diagnosis of PE, progressive respiratory distress was detected.

Although the diagnosis of PE can be easily determined by palpation of the defect in the sternum, the clinical severity of the disease can be visualized by deformation of the sternum determined by orthogonal radiographs and decreased thoracic volume. FSI and VI assessments are designed for scoring purposes. Together with these, the displacement of the heart's position to the left or right according to radiographic findings is also shown to be among the remarkable findings in PE cases (2, 21). In this study, the PE was diagnosed at first by palpation and then by radiographs. Consistent with previous studies (2), dorsal deviation of the last 4 sternebrae in lateral radiographic findings and the displacement of the heart to the left hemithorax in the ventrodorsal radiograph was noted. The severity of PE in this case was graded according to the FSI and VI values (3.53 and 5.1, respectively) defined in previous studies. In our study, the assessment of FSI and VI was, as stated by Risselada et al. (14) and Charlesworth (2), made by considering the vertebra where the distance between the highest point of sternal deviation and the vertebra (min_{TH}) was minimum, and in accordance with that, the min_{TH} was determined at the 9th vertebra level. Because the T10 vertebral level was far from the point where the sternum deviation is maximum and therefore it was thought that such a measurement method is not suitable for the correct determination of the thorax index.

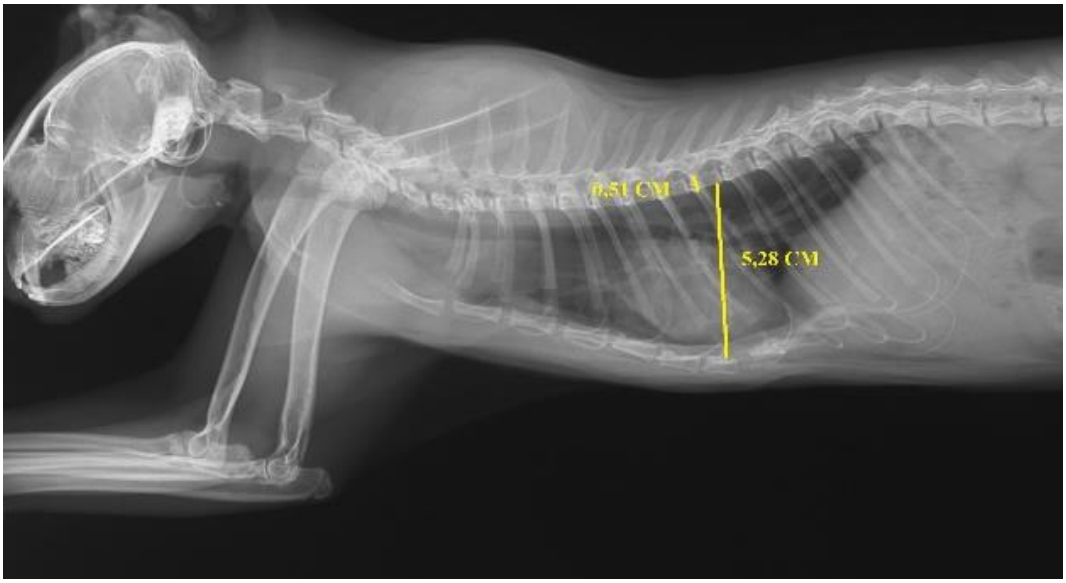

Figure 4. Lateral radiographic view of the thorax and thorax index values at 6th weeks postoperatively.

It was stated that the operation can be performed in cats and dogs with PE by evaluating according to clinical symptoms. It was reported that the diagnosis of patients with mild PE is often overlooked when they do not show clinical symptoms, and the operation will be contraindicated for these patients (10, 15). It was reported that this situation should be corrected by performing an operation in animals with severe PE, and for this purpose, external splint, internal splint (plate and rod application), or longitudinal sternebral pining combined with external splinting provides successful outcomes. It was reported that especially external splint application is indicated in young animals whose sternebra is still flexible (14, 15, 21). It was stated that the effectiveness of external splint application in adult and old animals is weak (11, 15). It was reported that the most common complications are internal thoracic vascular damage, heart or lung perforation, iatrogenic pneumothorax, and infection or dermatitis in the splinted area (2, 16). Because of the reason that the cat was 4 months old and the PE degree was severe according to the thorax index, it was thought that external splint application would be appropriate by performing the operation in the study conducted. In the external splint application, the suture placement was done very carefully because the sternum deviation was close to the heart. Even though no intraoperative complication was observed, the presence of reexpansion pulmonary edema was noted in the postoperative period. Postoperative FSI and VI values (1.4 and 11.35) were found to be rather close to the reference range.

In various studies (2, 5, 12, 16), the use of external splint for the treatment of PE in young animals has given successful results. In this study, PE was successfully corrected using an external splint in a 4-month-old cat. Our study also supports these results.

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Conflict of Interest

The authors declared that there is no conflict of interest.

Author Contributions

Diagnose, surgical plans and procedure, writing-reviewing, editing and postoperative controls and evaluations are made by BK and MB.

Data Availability Statement

The data supporting this study's findings are available from the corresponding author upon reasonable request.

Ethical Statement

This study does not present any ethical concerns.

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