



Traumatic Diaphragmatic Hernia in Cats and Factors Affecting Survival (A Clinical Study with 24 Cats)

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Abstract: Diaphragm hernia is still a severe problem in cats exposed to trauma. This study aimed to contribute to clinical practice and colleagues by notifying clinical observations on traumatic diaphragm rupture in cats and factors effective on survival. In this study, 24 cats with traumatic diaphragm hernia were presented. Contrast radiography has provided great convenience in diagnosing suspicious cases. 20 out of 24 cats (83%) remained alive, but four died. The localization of the diaphragm of these cats in 3 cats was in the left half, which was relatively high (50%) in the left tears. In the defects on the right, the herniated organs were the liver, small intestine, and omentum, while the stomach, small intestine, and spleen in the defects on the left. As a result, survival in 83% is important, and this is a good prognosis for aperture hernia. Despite many negative stress factors, good operation management and postoperative maintenance can increase survival.

Keywords: Cat, Diaphragmatic hernia, Survival rate, Trauma.

Kedilerde Travmatik Diyafram Fıtığı ve Sağkalımı Etkileyen Faktörler (24 Kediyle Klinik Bir Çalışma)

Özet: Travmaya maruz kalan kedilerde diyafram fıtığı hala ciddi bir sorundur. Bu nedenle kedilerde travmatik diyafram yırtılması ve hayatta kalma üzerine etkili faktörler ile ilgili klinik gözlemler aktarılarak klinik pratiğe ve meslektaşlara katkı sağlanması önemlidir. Bu çalışmada travmatik diyafram fıtığı tanısı alan 24 kedi sunuldu. Kontrastlı radyografi şüpheli durumlarda tanı açısından büyük kolaylık sağladı. Çalışmada bulunan 24 kediden 20'si (%83) hayatta kaldı ancak 4'ü öldü. Bu kedilerin diyafram lokalizasyonu 3 kedide sol yarıda olup, sol yırtıkta bu oran oldukça yüksekti (%50). Sağdaki defektlerde fıtıklaşan organ karaciğer, ince bağırsak ve omentum, soldaki defektlerde ise mide, ince bağırsak ve dalaktı. Sonuç olarak %83 oranında hayatta kalma önemlidir ve bu da diyafram fıtığı için iyi bir prognostur. Birçok olumsuz stres faktörüne rağmen iyi bir ameliyat yönetimi ve ameliyat sonrası bakım, hayatta kalma oranıyla birlikte artırılabilir.

Anahtar Kelimeler: Diyafram fıtığı, Kedi, Sağkalım oranı, Travma.

Introduction

The diaphragm is a membranous muscle section separating the abdomen and chest. Rupture or disruption of the integrity of this thin muscle structure is called diaphragmatic hernia. This condition may be congenital or acquired. In acquired cases, the etiology is often trauma. The source of trauma may be a fall from a height, a traffic accident or another animal attack (Ozer et al., 2007; Temiz, 2017).

In congenital diaphragmatic hernias, peritoneal-pericardial diaphragmatic hernia (PPDH) is more common, and PPDH is caused by defective development of the fetus. The overall prevalence of PPDH in domestic cat populations has been reported to be 0.062–0.59%. This condition should be considered separately from traumatic type diaphragmatic hernia or rupture. When a traumatic diaphragmatic tear/hernia occurs, organs such as the omentum, stomach, liver, and intestines can enter the chest cavity from the abdomen and cause compression of the lungs, preventing them from fully inflating and causing respiratory distress known as dyspnea. Additionally, irritation of the heart muscle often causes abnormal heart rhythms. Fluid can leak into the chest cavity, further complicating and worsening cardiopulmonary function (Margolis et al. 2018; Temiz, 2017).

The diaphragm consists of a central tendinous part and an outer muscular part. The muscle part is divided into three parts (pars lumbalis, pars costalis and pars sternalis), and the pars costalis is often ruptured. The diaphragm has three openings: the caval foramen, the esophageal cavity, and the aortic cavity. Three different types of diaphragmatic tears are commonly seen: circumferential (40%), radial (40%) and combination (20%) (Pereira et al., 2023). Clinical symptoms

may vary depending on the location of the rupture and the herniated organs. The most common symptom is shortness of breath. In addition, cardiac arrhythmias and shock, enteric symptoms and vomiting may occur (Yayingül et al., 2019).

In patients with respiratory distress, management such as oxygen therapy, fluid therapy, and the use of inhaler treatments along with monitoring have a major role in the prognosis (Aulia et al., 2022; Deveci et al., 2022; Fucks de Souza et al., 2021).

This study aimed to inform clinical practice and our colleagues about the factors affecting clinical observations and survival rates in cats with traumatic diaphragmatic hernia.

Material and Methods

This study is not subject to HADYEK permission by Article 8 (k) of the "Regulation on Working Procedures and Principles of Animal Experiments Ethics Committees".

In this study, 24 cat cases diagnosed with traumatic diaphragmatic hernia among cats brought to Dicle University Veterinary Faculty Animal Hospital surgical clinics on different dates were investigated. Diaphragmatic hernias that were not accepted for surgery by their owners during the period of this study and were congenital were not included in the study. In addition to information such as age, gender, source or type of trauma, clinical findings, intraoperative findings, postoperative period findings, and complications were noted. A detailed clinical examination was performed for each cat (Table 1).

Table 1. General information about the cats operated on in the study.

	Gender	Cause of trauma	Age/month	Body weight/kg	breed
1	Male	Fall from height syndrome	12	4.8	Mix breed
2	Male	Fall from height syndrome	18	4.6	Persians
3	Male	Traffic accident	8	1.5	Mix breed
4	Female	Fall from height syndrome	15	4.7	Mix breed
5	Male	Fall from height syndrome	17	3.9	scottish fold
6	Female	Traffic accident	15	4.1	Mix breed
7	Male	Fall from height syndrome	19	4.3	scottish fold
8	Male	Fall from height syndrome	14	4.5	Mix breed
9	Male	Fall from height syndrome	17	3.8	Persians
10	Female	Traffic accident	23	4.8	Mix breed
11	Male	Fall from height syndrome	24	4.7	scottish fold
12	Female	Fall from height syndrome	29	4.8	Mix breed
13	Male	Traffic accident	72	3.9	Persians
14	Male	Fall from height syndrome	70	4.2	Mix breed
15	Male	Fall from height syndrome	68	4.6	Scottish fold
16	Female	Fall from height syndrome	60	3.6	Mix breed
17	Male	Fall from height syndrome	54	3.8	Siamese breed
18	Male	Fall from height syndrome	58	4.8	Siamese breed
19	Male	Traffic accident	62	3.6	Mix breed
20	Male	Traffic accident	36	3.9	scottish fold
21	Female	Fall from height syndrome	18	4.6	scottish fold
22	Male	Fall from height syndrome	68	6.7	Mix breed
23	Female	Fall from height syndrome	43	7.0	Mix breed
24	Female	Unknown	18	4.5	Mix breed

Since these patients were trauma patients, trauma management was taken into consideration. In the first evaluation, he was evaluated with plans A (air way), B (breathing), C (circulation), D (neurological disability). Thoracic trauma was evaluated until proven otherwise. After their general condition was stable, direct radiographs

including the thorax and abdomen were examined (Ecotron EPX-F5000 (110 kv-100mA) Fujifilm) for definitive diagnosis in cats. In cases where the diagnosis was doubtful with plain radiography, it was evaluated with contrast radiography (with iohexol 40/50 mg/kg oral, Omnipaque™ Opakim-Istanbul) (Fig 1-3).

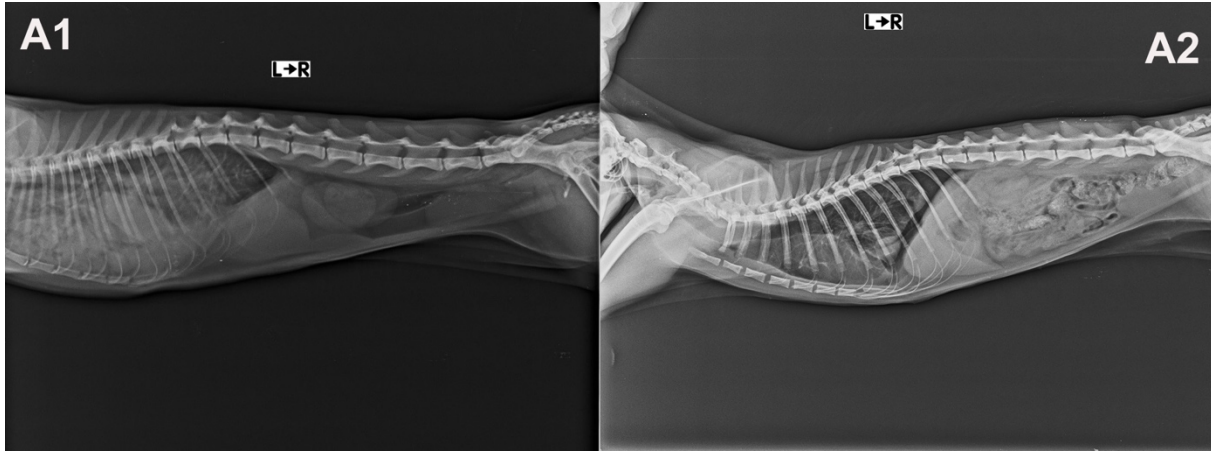


Figure 1. A1 Direct radiological appearance of intestinal loops in the thorax. A2 Post-operative image of the case.

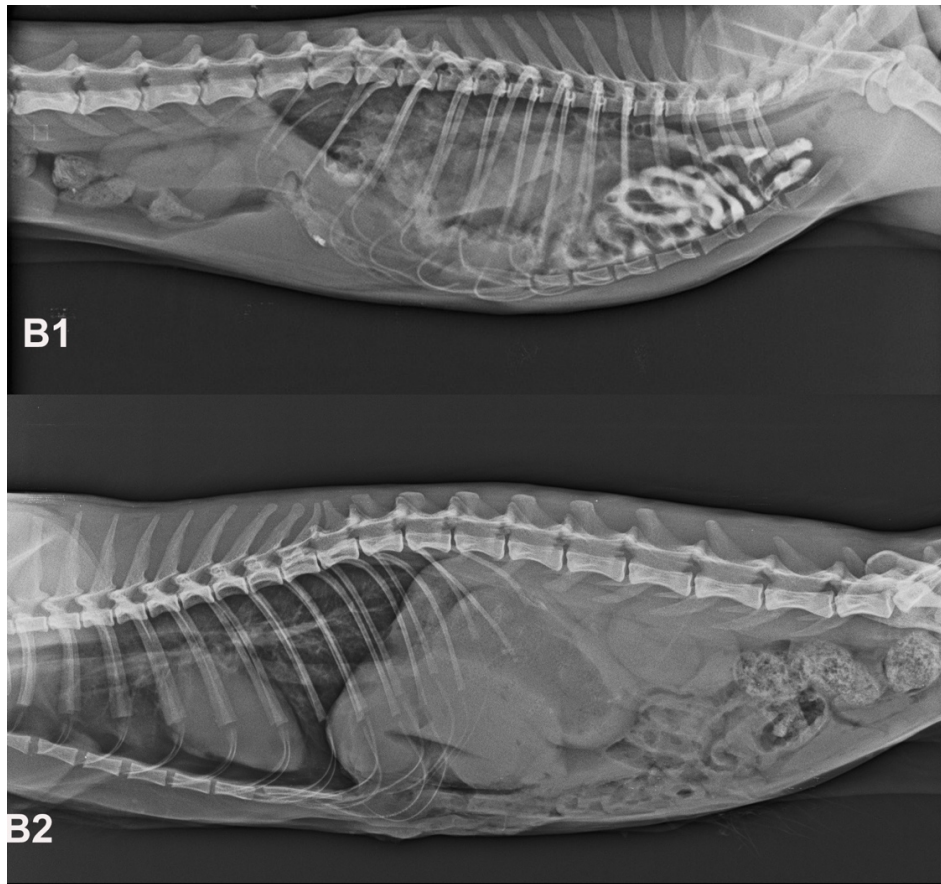


Figure 2. B1 View of the intestinal segment within the thorax using contrast radiography. B2 Post-operative image of the case.

Venous catheterization was provided to the ramus dorsal of vena sephana parva, and then, during the clinical examination, venous blood was taken before anesthesia and at the 24th postoperative hour for hematological and biochemical analyses.

Even if the general condition of the patients was stable, their surgery was planned after 48 hours. For perioperative effect, cefazolin sodium (Cezol 250 mg, Deva, Türkiye, 20 mg/kg IM) was administered as an antibiotic before surgery, and meloxicam (Maxicam, Sanovel, Türkiye, 0.3 mg/kg SC)

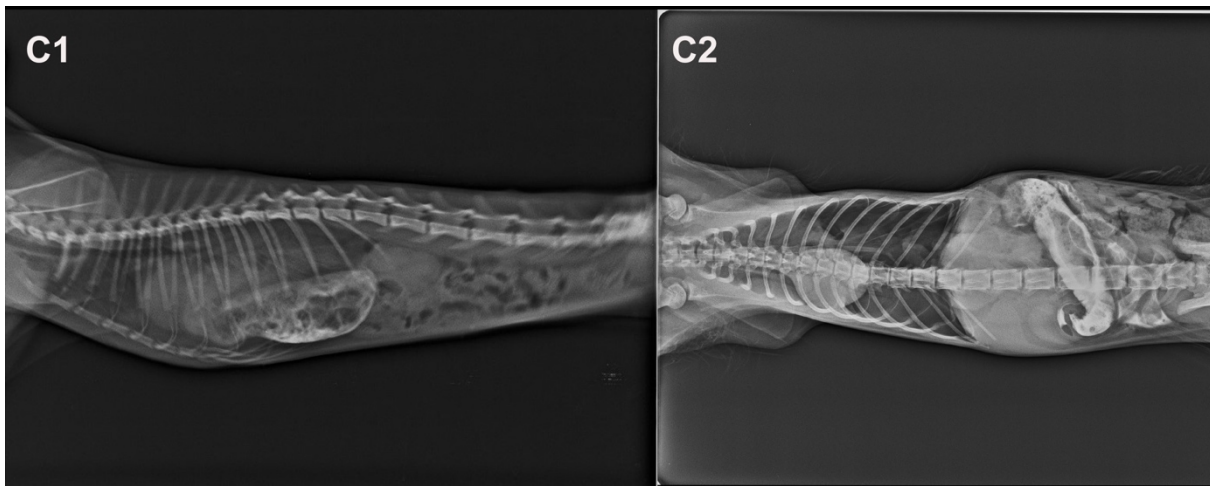


Figure 3. C1 View of the stomach within the thorax in a cat with a diaphragmatic hernia. C2 View of thorax postoperatively.

was administered as an analgesic. In addition, preoperative oxygen was administered using a mask or in the intensive care cabin for 10 minutes. After injection xylazine HCL (Xylazin Bio, Interhas, Türkiye, 1 mg/kg/IV) and ketamine HCL (Ketasol, Interhas, Türkiye, 10 mg/kg/IV) was given for induction, endotracheal intubation was achieved (with No. 3-3.5 tube) and then anesthesia was maintained with sevoflurane in 100% O₂. Mannitol and Lactated Ringer's solution (10 ml/kg/hour, IV) were given for perioperative and intraoperative fluid management.

In cats that were placed on their backs, the aseptically prepared operating area was covered with sterile drapes. The diaphragm was approached through a ventral median line laparotomy extending from the xiphoid cartilage to the umbilicus. The organs that passed into the chest cavity were transferred back to the abdominal region. This study categorized the localization of diaphragmatic hernia in two different ways. The first is defined by Deveci (Deveci et al., 2022), and the second is circumferential, radial, and combination, as defined by Bjorling (Bjorling and Sicard, 2004). The diaphragmatic defect was repaired with simple continuous or X suture techniques with non-absorbable thread (Prolene, Ethicon, USP 2/0-3/0). Negative pressure of the chest cavity was created before the final stitching. The operating area was then routinely closed. Anesthesia was terminated and extubated. Oxygenation continued in the intensive care cabin for half an hour. Additionally, the administration of cefazolin sodium (Cezol 250 mg, Deva, Türkiye, 20 mg/kg IM, once a day) was continued for 7 days postoperatively.

Results

The etiology of diaphragmatic hernia in all cases was traumatic. Among these, there were falls from height in 18 cases (75%), motor vehicle accidents in 5 cases (20%), and blunt trauma of unknown cause (a cat running away from home) in 1 case (4%). The clinical presentation times of the cases were between 1-7 days after the trauma. The age of the cats varied, and the average age ranged from 8 months to 72 months. 16 (66%) of the cats were male and 8 (33%)

were female. Their average body weight was between 1.5-7 kg.

In the clinical examination of the study, all patients (100%) had tachypnea, respiratory distress, open mouth breathing, abdominal breathing and exercise intolerance. There were also cases of anorexia (15 cats, 62.5%) and vomiting (3 cats, 12.5%). While direct radiography was sufficient for diagnosis in 16 cases (66%), contrast radiography was performed in the other 8 (33%) suspicious cases. It was found remarkable that the diaphragmatic borders were not clear, and the heart silhouette disappeared in the radiographic examination. Additionally, abdominal organs were observed to be displaced. Intestinal segments within the thorax were more easily identified. In addition to diaphragmatic hernia in the cats in this study, radius-ulna fracture was detected in 1 cat, humeral fracture in 1 cat, cleft palate in 2 cats, and soft tissue trauma in 3 cats.

According to the scale of Deveci et al. (2022), the location of the diaphragmatic tear in this study was at 10 o'clock in 12 cases (50%), at 11 o'clock in 5 cases (20%), at 14 o'clock in 3 cases (12.5%), at 12 o'clock in 2 cases (8%), and along the length in 1 case (4%). According to the scale from Bjorling and Sicard (2004), the localization of the defect was determined as circumferential in 21 cases (87.5%), radial in 2 cases (8%), and a combination in 1 case (4%).

In this study, the herniated organs in the defects on the right side were the liver, small intestine, and omentum, while the stomach and small intestine herniated in the defects on the left side. The spleen was in the thorax in only one case (with a longitudinal defect).

A total of 3 (12.5%) cats died, 2 during the operation and 1 within two hours after the operation. During the operation, it was determined that both cats that died had lung lacerations and excessive secretions. In 2 of these cats, the diaphragm defect was on the left side. In other words, 2 of 4 cats (50%) with defects in the left half of the diaphragm (3 cats only left, 1 cat left + right half) died, which was found to be quite high. Another cat with a right diaphragmatic rupture died 24 hours after the operation. Despite all interventions (tocaricocentesis, IV support, oxygen support, cardiopulmonary resuscitation) in this cat with excessive secretion in the thoracic region, the cat could not be saved.

The mortality rate was calculated to be 8% in 2 cats where only the right half was affected.

In this study, no complications such as bleeding, organ rupture, or surgical site infection were encountered during the organ rejection operation. It was found remarkable that clinical findings such as difficulty in breathing, abdominal breathing and open mouth breathing improved within 24 hours after surgery.

Discussion and Conclusion

Diaphragmatic hernias, other than congenital ones, in cats develop due to traumatic causes and are among the critical life-threatening surgical cases in small animal practice (Borges et al., 2023). In this study, we aimed to provide information to clinical practice and our colleagues about the factors affecting the survival rate, as well as clinical observations in cats with traumatic diaphragmatic hernia.

Although it is more common especially in falls from height and traffic accidents, it can also occur in other types of trauma. A patient with trauma should be examined for cleft palate and diaphragm rupture (Borges et al., 2023; Fucks de Souza et al., 2021). In all cats included in the study, the etiology of diaphragmatic hernia was traumatic, primarily falling from heights and traffic accidents. The clinical presentation times of the cases were between 1 and 7 days after the trauma. Deveci et al. (2022) stated that traumatic diaphragmatic hernias that have been present for 15 days or more are chronic. Some authors emphasize that in order to reduce mortality in traumatic diaphragmatic hernia, surgery should not be performed within the first 24 hours following trauma and that surgery should be planned after the patient's physiological parameters are stable (Deveci et al., 2022; Mehrjerdi et al., 2022; Özer et al., 2007). Deveci et al. stated that due to advances in equipment and care conditions in the field of surgery, the patient can be operated on within the first 24 hours if appropriate conditions are provided in the preoperative, operative and postoperative process after stabilization. Therefore, diaphragmatic hernia may not be considered an emergency. However, the hemodynamic status of the patient should be stable after the trauma. In this study, all operative procedures were planned and performed after the patient's general condition was stable.

Many different studies have emphasized good trauma management of traumatic diaphragmatic hernias. Oxygen support should be taken into consideration, especially in addition to taking the necessary interventions and precautions to keep the animal alive. In addition, if fluid therapy is to be performed, fluid selection and administration rate should be adjusted very well (Fucks de Souza et al., 2021; Subramaniam et al., 2020). As a matter of fact, in this study, first of all, it was tried to keep people alive and a good trauma management was carried out. Oxygen support was provided and surgeries were planned after the general condition of the patients was improved.

The main systems affected in patients with diaphragmatic hernia are the circulatory and respiratory systems. Therefore, clinical symptoms such as tachypnea,

respiratory distress, and abdominal breathing are extremely prominent (Aulia et al., 2022; de Oliveira, 2020; Subramaniam et al., 2020). In addition, symptoms such as vomiting, difficulty breathing, and relaxation by holding the front of the body up may also be observed (Aulia et al., 2022). In our study, all patients had tachypnea, respiratory distress, open-mouth breathing, abdominal breathing, and exercise intolerance. In addition, cases of anorexia (15 cats, 62.5%) and vomiting (3 cats, 12.5%) were also encountered. In our study, radiology played an important role in diagnosing diaphragmatic rupture. In addition, intestinal segments in the thorax, where abdominal organs are displaced, were more easily identified.

When the localization of the defect was evaluated according to the Deveci et al. (2022) scale and the Bjorling and Sicard (2004) scale, the relationship between the diaphragm defect and the herniated organs is very clear according to the data in this study. On the other hand, it is questionable whether there is a relationship between diaphragm defect and survival. Although it is not certain, it can be said that the mortality rate is higher in left-sided hernias. This situation can be interpreted as follows; diaphragmatic hernias from the left side or along the length are always more serious. It can be explained by both the pressure on the organs and the change in venous pressure.

In defects on the right side of the diaphragm, the liver and small intestine herniated, while in defects on the left side, the stomach and small intestine were displaced (Cariou et al., 2009; Hyun, 2004; Mehrjerdi et al., 2022; Tsioli et al., 2020). In our study, the herniated organs in defects on the right side were the liver, small intestine, and omentum. However, the relationship between the defect or herniated organ and prognosis or survival is not fully known. In this sense, we think that each case should be decided according to its own clinical picture.

In summary, a total of 4 cats died in this study and all of the remaining 20 cats (83%) survived. Postoperative survival rate was reported as 82.2% by Beşaltı et al. (2011), 73.3% by Yaygınül et al. (2019), 71% by Mehrjerdi et al. (2022), 83.3% in acute cases and 69.2% in chronic cases by Deveci et al. (2022). Özer et al. (2007) reported the mortality rate as 6.8% in their study. Our study results are parallel to the results obtained by Deveci et al. (2022) and Beşaltı et al. (2011). It has been reported that (Oliveira, 2020; Deveci et al., 2022; Ozer et al., 2007) deaths may occur during or even after surgery in cats with diaphragmatic hernia, but these deaths are not as high as expected. Additional measures must be taken to reduce the mortality rate further. Preoperative planning, intraoperative support and postoperative care conditions are also important. In order for the patient to be operated on, physiological parameters must be stable. In addition, preoperative oxygen support and postoperative oxygen support are very important. During the operative procedure, care should be taken to ensure that the lungs do not collapse and the negative pressure within the rib cage should be adjusted (Deveci et al., 2022; Mehrjerdi et al., 2022; Ozer et al., 2007).

It has been reported by different researchers that clinical symptoms such as difficulty breathing, abdominal

breathing, and open-mouth breathing improve very quickly after surgery (Besalti et al., 2011; Hyun, 2004; Minihan et al., 2004; Nikiphorou et al., 2016; Pereira et al., 2023). In our study, these symptoms also improved in the first 24 hours postoperatively.

Some authors who have assumed two weeks as chronic cases, pneumothorax, diseases that occur during the separation of the organs, characteristic lobe torsion, intestinal ganglion diseases increase mortality (Beşaltı et al., 2011; Minihan and Işık., 2004). During the operation, the spurting organs should be carefully placed back in their original place so that they are not seen and do not undergo torsion. Compression applied to the caudal vena cava will cause venous components (Souza et al., 2021). The lobes where the microorganism herniates should be removed separately and care should be taken not to undergo torsion. In all cases with this effect, the operation was performed by observing this situation and no complications were encountered. In the case that occurred in the postoperative period, rather than these components, the forces that can be obtained from the excessive secretion ability in the thorax.

Traumatic diaphragmatic hernia in cats, location, size, type of defect in the diaphragm and other accompanying disorders or pathologies, if any, affect the mortality rate. For this reason, the priority in trauma patients should be to keep them alive and especially breathing support is needed. It is clinically easy to suspect a diaphragmatic hernia and confirm the diagnosis. If necessary, support can be obtained from contrast radiography for this purpose. In case of a traumatic diaphragm rupture, it would be beneficial not to act in a hurry and wait for the first 24 hours for the operation. Once the general condition of the patient is stable, the operation can be performed by making the necessary planning.

Conflict of Interest

The authors stated that they did not have any real, potential or perceived conflict of interest.

Ethical Approval

This study is not subject to HADYEK permission in accordance with Article 8 (k) of the "Regulation on Working Procedures and Principles of Animal Experiments Ethics Committees".

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Author Contributions

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Analysis or interpretation: SY, BEK, NS

Literature Search: EÇ, BEK, SA

Writing: BEK

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