CASE REPORT

Traumatic diaphragmatic rupture in a cat with partial kidney displacement into the thorax

A two-year-old, male, neutered, domestic shorthair cat was presented after suspected trauma. Diaphragmatic rupture with concomitant displacement of the right kidney into the thorax was diagnosed using ultrasound and intravenous urography. Avulsion of the renal pedicle and diaphragmatic rupture were confirmed and treated surgically with excellent outcome.

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INTRODUCTION

Diaphragmatic rupture is a rare injury in dogs and cats (Kuhnt 1974). It is one of the possible outcomes in patients with blunt abdominal trauma, which is mainly attributed to automobile accidents (al-Nakeeb 1971, Hunt and Johnson 2003). The mechanism of rupture relates to the pressure gradient between the pleural and peritoneal cavities. In a series of events, the intra-abdominal pressure increases, the lungs deflate (provided the glottis is open) and the load of abdominal organs rises well over the capability of the diaphragm to resist (Fossum 2002). Almost all cranial abdominal structures have been reported to protrude into the thoracic cavity. Displacement of the kidney from the retroperitoneal to the thoracic compartment has been infrequently reported in animal as well as in human patients (Cohen and others 2000, Marolf and others 2002, Störk and others 2003).

CASE HISTORY

A two-year-old, male, neutered, domestic shorthair cat was presented at the Emergency Service of the Veterinary Hospital, University of Veterinary Medicine, Vienna, Austria, after acute loss of appetite and severe lameness in the left pelvic limb. The cat had been free roaming during the night before presentation, and a traumatic event was suspected by the owner, based upon an abrasive injury on the medial side of the right hock.

At initial examination, the cat was bright and alert, but skin elasticity was reduced, consistent with dehydration. Mucous membranes were pink and mildly dry. Rectal body temperature was 36·7°C, pulse rate was 180 beats per minute and the pulse was regular and strong. The respiratory rate was 30 breaths per minute. Heart sounds were pounding, and lung sounds were within normal limits. A small skin abrasion on the medial aspect of the right hock joint was observed as well as crepitation in the left hip joint.

Within the first three hours, packed cell volume (PCV) dropped from 39 to 30 per cent (reference value 27 to 47 per cent). Total protein was 7·4 g/dl (reference value 6·0 to 7·5 g/dl), alanine aminotransferase was 895 U/l (reference value <30 U/l) and creatinine was 1·8 mg/dl (reference value <1·6 mg/dl). All other measured parameters were within normal range.

Plain radiographs of the thorax (left lateral and dorsoventral recumbency) and abdomen (right lateral and ventrodorsal recumbency) were taken on the conscious patient after stabilisation. A homogeneous, round soft tissue opacity was observed in the caudodorsal thoracic cavity, which lay ventral to the 10th to 12th thoracic vertebral bodies, superimposed over the left diaphragmatic crus. The right dorsal diaphragmatic crus was displaced craniоventrally. Small fissure lines and an approximately 3 mm broad band of homogeneous soft tissue opacity were observed along the thoracic wall and the diaphragmatic crus on the thoracic and ventrodorsal abdominal radiographs (Figs 1 and 2). A small quantity of intrathoracic fluid was suspected, but thoracocentesis was not performed because of the small volume of fluid and lack of clinical signs of pleural disease. The right caudal lung lobe was surrounded by fluid and was mildly blunted.

Abdominal serosal definition was slightly decreased, consistent with free peritoneal fluid, and the right kidney could not be visualised on plain radiographs. Craniodorsal luxation of the left hip was

FIG 1. Intravenous urography (right lateral recumbency) five minutes after contrast agent administration. There is a soft tissue opacity in the caudodorsal thoracic cavity within which there is a slightly indistinct nephrogram of the right kidney. The left kidney shows a normal pyelogram. The urinary bladder contains contrast material. Abdominal definition is decreased. One hip is luxated craniodorsally

noted. Abdominal ultrasonographic evaluation was performed in right and left lateral recumbency with a paramedian approach. The right kidney was displayed dorsal and cranial to the normally positioned liver, and the cranial two-thirds were surrounded by a hyperechoic and hyperreflective band of air originating from the edge of the right lung (Fig 3). Corticomedullary definition was slightly blurred. No diaphragmatic contour was visible on the right but was evident on the left. Additional findings included a small volume of free fluid within the pleural space and hyperechoic particles within the urinary bladder. In order to evaluate renal function and perfusion, intravenous urography was performed on the conscious cat with 6 ml Jopamiro® 300 mg I/ml (Gerot Pharmazeutika) (450 mg I/kg). The left kidney showed a normal nephro- and pyelogram with a normal ureter. There was a discrete kidney-shaped increase in opacity in the caudodorsal thorax, suggestive of the right kidney. There was no evidence of contrast enhancement in the right renal pelvis or ureter (Fig 1). Diagnostic imaging was presumptive of diaphragmatic rupture and right renal displacement.

The cat received standard shock treatment immediately after the initial presentation (intravenous application of Hetastarch at 5 ml/kg and Ringer's solution at 10 ml/kg [Fresenius AG] concurrently for 20 minutes). Fluid therapy was continued with Ringer's solution at 4 ml/kg/hour for two hours before and during the diagnostic imaging. Analgesia was provided with 0·1 mg/kg methadone (Heptadon; EBEVE Pharma) given intravenously.

The cat was premedicated with 2 mg/kg intramuscular ketamine (Ketasol; Dr E. Graub AG) and 0·15 mg/kg intramuscular midazolam (Mayrhofer Pharmazeutika), and anaesthesia was induced with 5 mg/kg intravenous propofol (Fresenius AG) approximately three hours after initial presentation, after the dehydration was corrected. Anaesthesia was maintained with propofol (Fresenius AG) to effect at a mean rate of 13 mg/kg/hour. About 20 µg/kg/hour of fentanyl (Janssen-Cilag Pharm) was simultaneously infused. The patient received intermittent positive pressure ventilation during surgery. A midline coeliotomy was performed. Approximately 100 ml of sanguineous fluid was aspirated from the abdominal cavity. There was a circumferential tear in the diaphragm, located at the lumbocostal aspect on the right side, comprising 10 per cent of the circumference of the diaphragm. The right kidney was cranially displaced, and the cranial pole protruded through the diaphragmatic tear (Fig 4). There

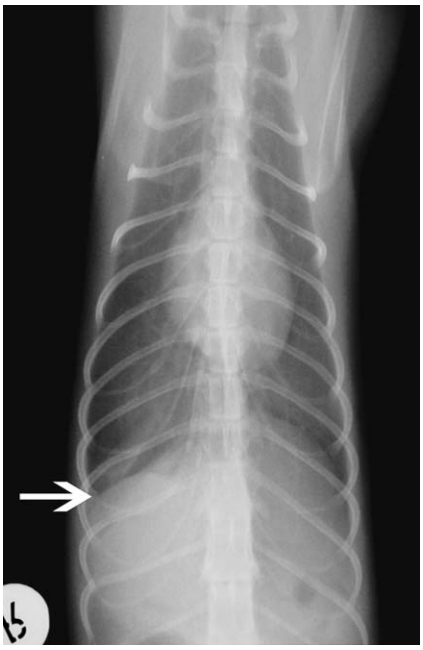

FIG 2. Ventrodorsal view of the thorax showing soft tissue opacity (white arrow) at the right hemithorax superimposing the diaphragm

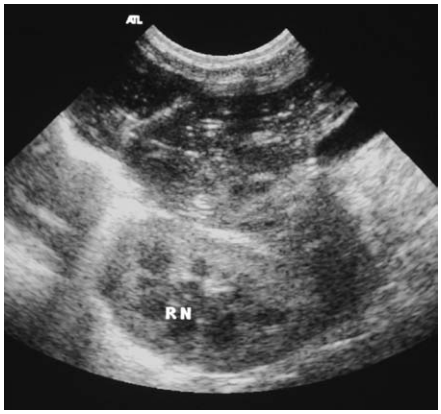

FIG 3. Ultrasound image using a median sagittal transhepatic approach. The right kidney (RN) can be distinguished dorsally and cranially displaced to the slightly hypoechoic liver parenchyma. It is surrounded by a hyperechoic band of air on its cranial two-thirds, and no clear diaphragmatic contour is visible

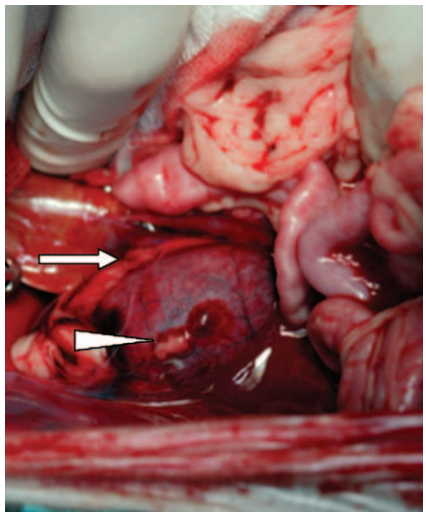

FIG 4. The right kidney (triangle) protruding through the diaphragmatic rent (arrow)

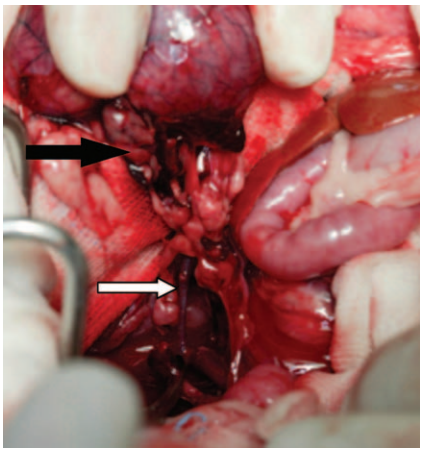

FIG 5. The right kidney showing avulsed renal pedicle (black arrow). The right renal artery (white arrow) remains intact

was a haematoma in the retroperitoneal space on the right side. The right ureter and the right renal vein were avulsed from the renal pedicle, and the right renal vein was thrombosed. The right renal artery was intact (Fig 5). The right kidney was normally shaped, retained a smooth, glossy surface but exhibited several petechiae. Additionally, there was an oval, partial tear (4×3 cm) of the left abdominal wall adjacent to the 13th rib, involving peritoneum and the internal abdominal oblique muscle. A right ureteronephrectomy was performed, and the distal stump of the right ureter, the right renal vein and the right renal artery were ligated with 2-metric polydioxanone (Surgicryl; SMI) and transected. The diaphragmatic rupture was sutured with a simple continuous pattern using 2-metric polyglyconate (Monosyn; B-Braun) with partial incorporation of the 12th rib (Fossum 2002). The partial rupture of the left abdominal wall was repaired with a simple continuous pattern using 2-metric polyglyconate (Monosyn; B-Braun). An abdominal lavage with Ringer's solution was performed. The abdomen was closed with 3-metric polyglyconate (Monosyn; B-Braun) for the rectus sheath (simple continuous pattern), 1·5-metric polyglyconate (Monosyn; B-Braun) for the subcutis (simple continuous pattern) and 1·5-metric polyamide (Dafilon; B-Braun) for the skin closure (simple interrupted pattern).

Histopathological follow-up revealed a morphologically intact kidney. For the next five days, the cat was maintained on intravenous fluid therapy, reduced gradually from 4 ml/kg/hour to 2 ml/kg/hour (Ringer's solution; Fressenius AG), owing to reduced appetite and water intake. Normal urination was noted. Postoperative pain was managed with intravenous application of 30 μg/kg buprenorphine thrice a day (Temgesic; Shering), and 20 mg/kg clavulanic-acid-potentiated amoxicillin (Clavamox; Sandoz GmbH) was intravenously administered prophylactically twice a day for five days. The cat was discharged one week after surgery and fully recovered at the one month follow-up. Excision arthroplasty of the luxated left hip was performed three months later, and the postoperative recovery was uneventful.

DISCUSSION

Respiratory compromise, concurrent injuries of organs situated within the thoracal and abdominal cavities as well as external injuries and internal haemorrhage with development of hypovolaemic shock are common and potentially life-threatening complications of traumatic diaphragmatic herniation (Worth and Machon 2005).

A "gold standard" for the early diagnosis of this condition has not been established as yet, and it still appears to pose a diagnostic dilemma (Nau and others 2001). On many occasions in human medicine, diaphragmatic rupture has been missed, causing delayed diagnosis in up to 17 per cent of cases (Beauchamp and others 1984). In a review of diaphragmatic hernias in dogs and cats, only 66 of 116 cases were diagnosed within 30 days of trauma (Wilson and others 1971). In another study, 50 cats and dogs of 250 cases were diagnosed with a diaphragmatic hernia of duration of more than two weeks (Minihan and others 2004). Acute traumatic diaphragmatic hernias may escape detection because owners may be unaware that a traumatic incident has occurred, as the condition may be asymptomatic and because a definitive radiographic diagnosis can be difficult to establish (Minihan and others 2004).

Plain radiographs of the thorax and abdomen are recommended for severely traumatised patients (Hunt and Johnson 2003). In the presented case, the radiographs showed an ovoid soft tissue opacity in the region of the right thorax (Figs 1 and 2), which was highly suggestive of the right kidney as it could not be clearly visualised in its normal position on abdominal films. As described by other authors, ultrasonography using a transhepatic approach (Spattini and others 2003) added complimentary information. This scanning technique confirmed a diagnosis of right renal displacement craniodorsally to the liver and revealed it to be surrounded by the right lung containing gas. Serum biochemistry showed mild elevation of creatinine values, and the kidneys did not exhibit severe ultrasonographic changes. Although renal function cannot be fully evaluated solely by serum biochemistry, it can give an idea whether the kidney was affected by the traumatic event. Integrity of the urinary tract might be assessed by intravenous urography, assuming filtration occurs. In this case, lack of contrast enhancement in the right kidney led to two possibilities. Either renal blood supply to the right kidney and, consequently, renal function to concentrate and excrete urine were decreased or there was an avulsion of the renal pedicle with contrast leakage, which was diluted by the free thoracic fluid, possibly blood, urine or both. The avulsion of the renal pedicle may have led to leakage of urine from the ureter and to haemorrhage from the renal vein. However, the authors did not assess the sanguineous fluid aspirated from the abdominal cavity. The preoperative drop of PCV suggested an acute blood loss, although dilution caused by intravenous fluid therapy or a combination of both could not be excluded.

The preferred surgical approach to traumatic diaphragmatic hernia rupture repair is midline coeliotomy (al-Nakeeb 1971, Garson and others 1980). However, some authors recommend thoracic approaches (Minihan and others 2004). Surgical exploration in the presented case revealed the right kidney to be craniodorsally displaced, leading to complete avulsion of the renal vein and the corresponding ureter; however, the renal artery withstood this displacement and remained intact. Ureteronephrectomy was

performed as the damage of the renal parenchyma could not be intraoperatively evaluated; thus the function of the kidney was uncertain. The technique of ureteral anastomosis, especially in cases of avulsion of the renal pedicle, is technically demanding and previous reports demonstrated a high rate of postoperative complications (Weisse and others 2002), and therefore, it was not performed.

Based upon concurrent soft tissue injuries and having classified the surgical procedure as clean contaminated, the authors opted for prophylactic use of antimicrobial drugs in this patient.

Avulsion of the kidney after blunt trauma is rarely identified in practice. If there is no acute blood loss, kidney avulsion is often overlooked and misdiagnosed (Marolf and others 2002, Störk and others 2003).

Conclusion

Early recognition and timely surgery performed on a stabilised patient were most likely essential prerequisites for successful outcome in this case. Nevertheless, because of the compounding injuries and because of the scarcity of information regarding this rare condition in veterinary literature, prognosis in such patients should be kept guarded.

Acknowledgements

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