Journal of Feline Medicine and Surgery (2003) **5**, 335–343
doi:10.1016/S1098-612X(03)00066-4

jfms

Ultrasonographic findings of intestinal intussusception in seven cats

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The medical records of seven cats with intestinal intussusception that were diagnosed by abdominal ultrasonography and exploratory laparotomy were reviewed. In transverse ultrasonographic sections the intussusception appeared as a target-like mass consisting of one, two or more hyperechoic and hypoechoic concentric rings surrounding a C-shaped, circular or non-specific shaped hyperechoic centre. Part of the intestine representing the inner intussusceptum, located close to the hyperechoic centre and surrounded by concentric rings, was also detected. In longitudinal sections the intussusception appeared as multiple hyperechoic and hypoechoic parallel lines in four cases and as an ovoid mass in three cases. In one case the ovoid mass had a 'kidney' configuration. Additional ultrasonographic findings associated with intestinal intussusception included an intestinal neoplasm in one cat. The results of the present study demonstrate that the ultrasonographic findings of intestinal intussusception in cats bear some similarities to those described in dogs and humans, are relatively consistent, and facilitate a specific diagnosis.

Date accepted: 3 July 2003

Introduction

A simple intussusception occurs when a portion of the gastrointestinal tract invaginates into the part of the tract that precedes or follows it (Bellenger et al 1982). The invaginated portion of the intestine, called intussusceptum, consists of an entering tube termed outer intussusceptum and a returning tube termed inner intussusceptum; the portion into which the intussusceptum invaginates is called intussuscipiens (Lewis and Ellison 1987). Occasionally, the intussusception is double where five layers are present (Bellenger et al 1982, Bellenger and Beck 1994). Intussusceptions are most often seen in young cats (Lewis and Ellison 1987, Bellenger and Beck 1994) and the most common location is near the ileocolic valve (ileocolic intussusception) (Bellenger and Beck 1994, Bright and Bauer 1994). However, gastroesophageal, jejunojejunal, ileojejunal and colorectal intussusceptions have been also reported in cats (Bennett 1973, Wolfe 1978, Lansdown and Fox 1991, Levitt and Bauer 1992). Very little is known about the predisposing factors for intestinal intussusceptions in cats although intestinal foreign body, neoplasia and parasitism have been incriminated as underlying causes (Wilson and Burt 1974, Bellenger and Beck 1994). The clinical signs in cats with intestinal intussusception usually include anorexia, weight loss, dehydration and a palpable abdominal mass, while vomiting and diarrhoea are less frequent (Bellenger and Beck 1994, Bright and Bauer 1994).

Intestinal intussusception in cats is usually suspected on the basis of abdominal palpation and can be confirmed by radiography and/or ultrasonography. Plain abdominal radiographs may or may not show excessive bowel distension, gas (usually proximal to the obstruction), fluid-filled intestinal loops, and an ill-defined mass effect caused by the intussuscepted bowel (Farrow 1994). A contrast study typically reveals bowel distension proximal to the obstruction, including the intussuscipiens. The entrapped intussusceptum appears relatively lucent, behaving in this respect, as filling defect (Wilson and Burt 1974).

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1098-612X/03/060335+09 $30.00/0

Ultrasonography is a safe and accurate diagnostic method that has totally replaced conventional radiology in the diagnosis of intestinal intussusception in children (Daneman and Alton 1996, Irish et al 1998). Advantages of ultrasonography compared to a barium enema/meal in the diagnosis of intussusception include: lack of ionizing radiation with the technique, no need for anaesthesia/sedation, reduction in the time required, and examination of adjacent structures such as lymph nodes that are not usually visible radiographically (Lamb and Mantis 1998). Recently, ultrasonography has been used successfully to specifically diagnose intestinal intussusception in dogs — a target-like mass consisting of hyperechoic and hypoechoic concentric rings in transverse ultrasonographic sections (ultrasound beam perpendicular to the bowel axis) and multiple hyperechoic and hypoechoic parallel lines in longitudinal ultrasonographic sections (ultrasound beam parallel to the bowel axis) are the most commonly described ultrasonographic patterns in young and adult dogs (Lamb and Mantis 1998, Patsikas et al 2003). These patterns are created from the juxtaposition of the intussuscepum and inner and outer intussuscipiens as well as from the different echogenicity of the intestinal wall layers. However, few reports on ultrasonographic findings of intestinal intussusception in cats have been published (Penninck et al 1990). This paper describes the ultrasonographic findings of intestinal intussusception in seven cats and compares them with those described in dogs.

Materials and methods

The medical records at the Surgery Clinic of the School of Veterinary Medicine, Aristotle University of Thessaloniki, were reviewed from 1996 to 2002. Criteria for inclusion to this retrospective study were cats that had abdominal ultrasonography and a surgical and histopathological diagnosis of intestinal intussusception. Ultrasonography was performed using a 7.5 MHz mechanical sector transducer.[†] Ultrasound images were reviewed with respect to appearance of the intussusception in transverse and longitudinal ultrasonographic sections, maximal size of the lesion in both sections and evidence of underlying disease. In cases where radiographs were available, their findings were included in the study. Confirmation of the intussusception was made by gross examination of the intussusceptum and intussuscipiens. Tissue samples taken from the intussuscepted bowel as well as from sites proximal and distal to the intussusception were fixed in 10% neutral buffered formalin embedded in paraffin wax, sectioned at 4–6 μm and stained with haematoxylin and eosin. The ultrasonographic findings were compared with surgical and histopathological findings.

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Results

Seven cats were suitable for inclusion in this study. The clinical data and radiological, ultrasonographic, surgical and histopathological findings from the affected cats are summarized in Table 1. There were four Siamese and three domestic short hair cats. Two of the cats were male and five female. The median age of the cats was 2 years (range 1–10 years). Anorexia was reported in all cats, vomiting in one cat, diarrhoea in one cat and both vomiting and diarrhoea in two cats. The median duration of clinical signs was 7 days (range 5–10 days). An abdominal mass was found by palpation in all cases.

Plain abdominal radiographs revealed small intestine dilation in four cases (cases 1, 4, 6, 7); a soft-tissue opacity compatible with an intestinal mass was identified in two of these cases (cases 1, 4). Reduced serosal detail and large intestine dilation were found in one case (case 5), and in two cases radiology was not undertaken.

In transverse ultrasonographic sections a target-like mass consisting of concentric rings surrounding a hyperechoic centre was observed in all cases (Figs 1 and 2). The median maximal width of the target-like mass was 2.5 cm (range 1.6–3.2 cm). Multiple hyperechoic and hypoechoic concentric rings were found in four cases (cases 2, 3, 6, 7) (Figs 1 and 2). In the remaining cases, one (cases 1, 5) or two (case 4) concentric rings were observed (Figs 3 and 4). The median width of the concentric rings was 0.8 cm (range 0.4–0.9 cm). A focal increased thickness of the outer concentric ring was detected in one case (case 4) (Fig 4). Histopathology of this case showed an intestinal lymphoma. The hyperechoic centre that was C-shaped in one case (case 1), circular in another (case 4) and a non-specific shape in the remaining cases, was identified as mesenteric fat following surgery (Figs 2–4). Small circular anechoic areas within the hyperechoic centre, probably representing mesenteric vessels and dilated mesenteric lymphatics were found in one case (case 6) (Fig 2). In three cases (cases 3, 6,

Table 1. Clinical data and radiological, ultrasonographic and surgical findings in seven cats with intestinal intussusception

Case	Age (years)	Breed	Sex	Symptoms	Duration (days)	Survey radiography	Ultrasonographic findings		Surgical findings	Underlying disease	Therapy
							Transverse section	Longitudinal section			
1	9	DSH	F	A, V, D	8	Soft-tissue opacity in the middle abdomen, small intestinal dilatation	Target-like mass of 3.2 cm in maximal width. Isoechoic ring of 0.8 cm in width surrounds a C-shaped hyperechoic centre	Ovoid mass of 2.5 cm in maximal width. Hypoechoic rim of 0.8 cm in width surrounds a hyperechoic centre	I-C	Intestinal lymphoma	Eu
2	3	DSH	F	A, V, D	5	NA	Target-like mass of 2.5 cm in maximal width. Multiple, hyperechoic and hypoechoic concentric rings of 0.8 cm in width, surround the hyperechoic centre	Multiple, hyperechoic and hypoechoic parallel lines of 2.1 cm in maximal width	I-C	Parasitic enteritis	IRA
3	1	S	F	A	7	NA	Target-like mass of 2.4 cm in maximal width. Multiple, hyperechoic and hypoechoic concentric rings of 0.8 cm in width, around hyperechoic centre. Part of small intestine into the centre	Multiple, hyperechoic and hypoechoic parallel lines of 2.1 cm in maximal width	J-J	Parasitic enteritis	IRA
4	10	S	M	A	7	Small intestinal dilatation, possible intestinal mass	Target-like mass of 1.6 cm in maximal width. Outer hyperechoic of 0.2 cm in width and inner hypoechoic of 0.2 cm in width concentric rings around a circular hyperechoic centre. Focally increased thickness of the outer concentric ring compatible with intestinal mass	Kidney-like mass (ie pseudo-kidney) of 1.8 cm in maximal width	I-C	Intestinal lymphoma	Eu
5	2	S	M	A, D	10	Reduced serosal detail, large intestinal dilatation	Target-like mass of 3.2 cm in maximal width. Hypoechoic ring of 0.9 cm in width surrounds a small hyperechoic centre	Ovoid mass of 2.5 cm in maximal width, consisting of 0.8 cm in width hypoechoic rim around hyperechoic centre	I-C	Intestinal lymphoma	Eu
6	1	S	F	A, V	5	Small intestinal dilatation	Target-like mass of 2 cm in maximal width. Multiple, hyperechoic and hypoechoic concentric rings of 0.6 cm in width around hyperechoic centre and part of small intestine. Anechoic areas into the centre	Multiple, hyperechoic and hypoechoic parallel lines of 1.6 cm in maximal width	I-C	Intestinal lymphoma	IRA
7	1.2	DSH	F	A	6	Small intestinal dilatation	Target-like mass of 2.6 cm in maximal width. Multiple, hyperechoic and hypoechoic concentric rings of 0.6 cm in width around hyperechoic centre. Part of small intestine into the centre	Multiple, hyperechoic and hypoechoic parallel lines of 2.2 cm in maximal width	I-C	Parasitic enteritis	IRA

A palpable abdominal mass was revealed in all cases.
DSH, domestic short hair; S, Siamese; F, female; M, male; A, anorexia; V, vomiting; D, diarrhoea; NA, not available; I-C, ileocolic intussusception; J-J, jejunojejunal intussusception; Eu, euthanasia; IRA, intestinal resection and anastomosis.

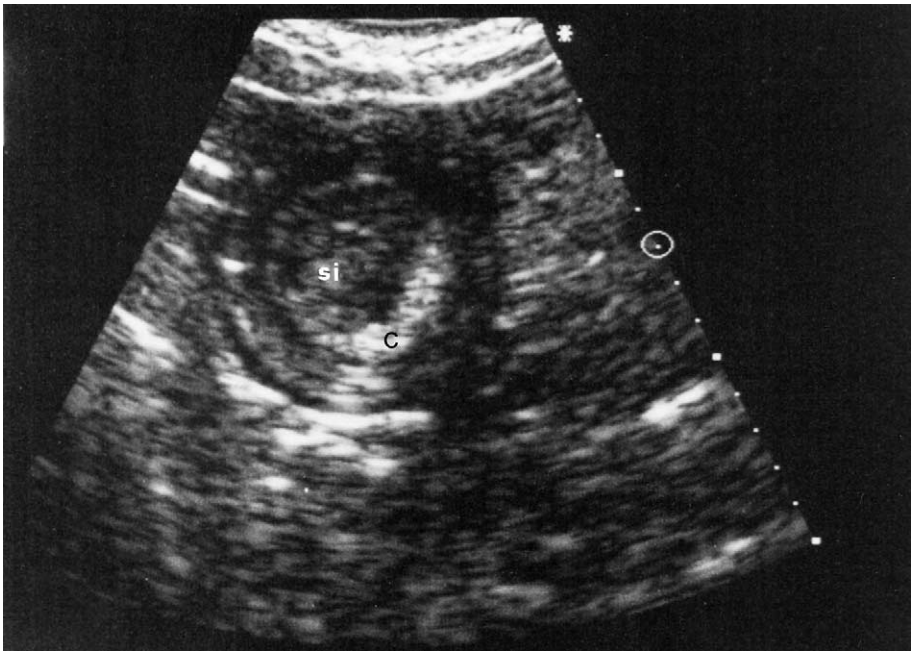

Fig 1. Transverse ultrasonographic section of a feline jejunojejunal intussusception (case 3). A target-like mass is seen consisting of multiple hyperechoic and hypoechoic concentric rings around hyperechoic centre (c) and part of small intestine (si).

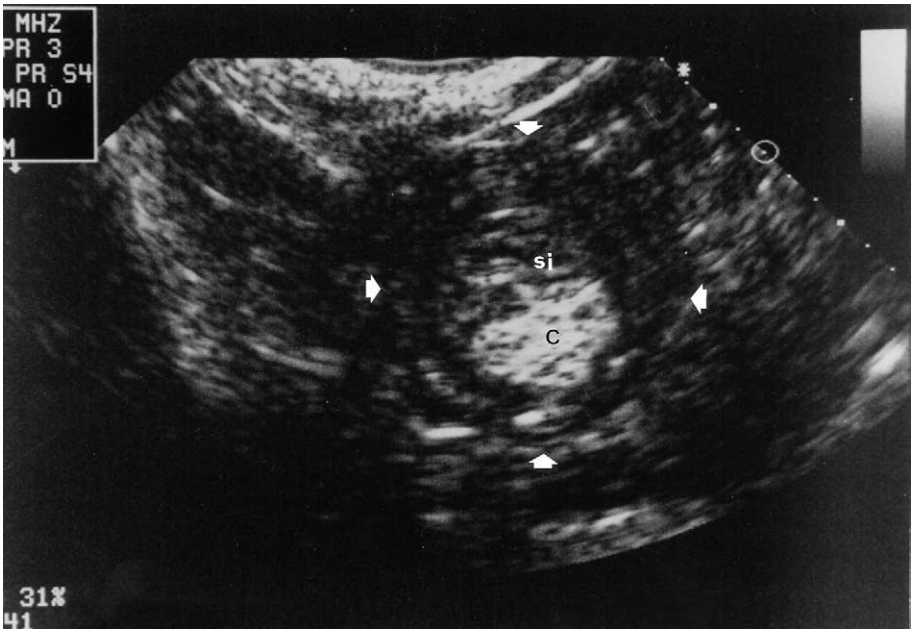

Fig 2. Transverse ultrasonographic section of an ileocolic intussusception in a cat (case 6), showing a target-like mass consisting of multiple hyperechoic and hypoechoic concentric rings surrounding a hyperechoic centre (c) and part of small intestine (si). Anechoic areas in the hyperechoic centre represent small vessels and dilated lymphatics (arrows are pointing at the intussusception's border).

7) part of intestine located close to the hyperechoic centre and surrounded by concentric rings, represented the inner intussusceptum (Figs 1 and 2).

In longitudinal sections multiple hyperechoic and hypoechoic parallel lines were found in four cases (cases 2, 3, 6, 7) (Fig 5). In the remaining cases an ovoid mass was detected; and in one of

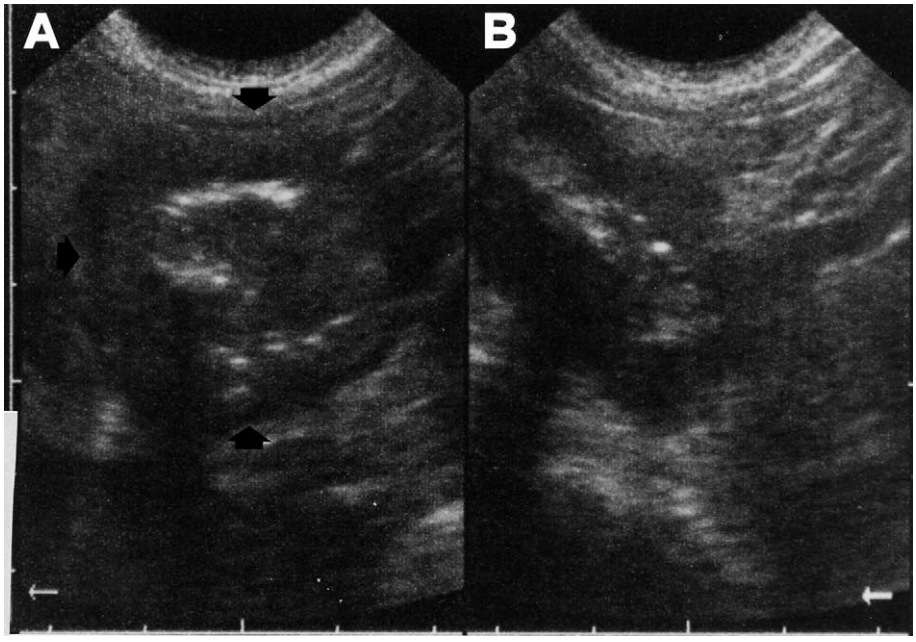

Fig 3. (A) Transverse ultrasonographic section of an intussusception in a cat with intestinal lymphoma that was part of the intussusception (case 1). An isoechoic ring around a C-shaped hyperechoic centre is depicted (arrows are pointing at the ring's periphery). (B) Longitudinal section of the same case showing an ovoid mass with no clear periphery margins, consisting of an outer hypoechoic rim around a hyperechoic centre.

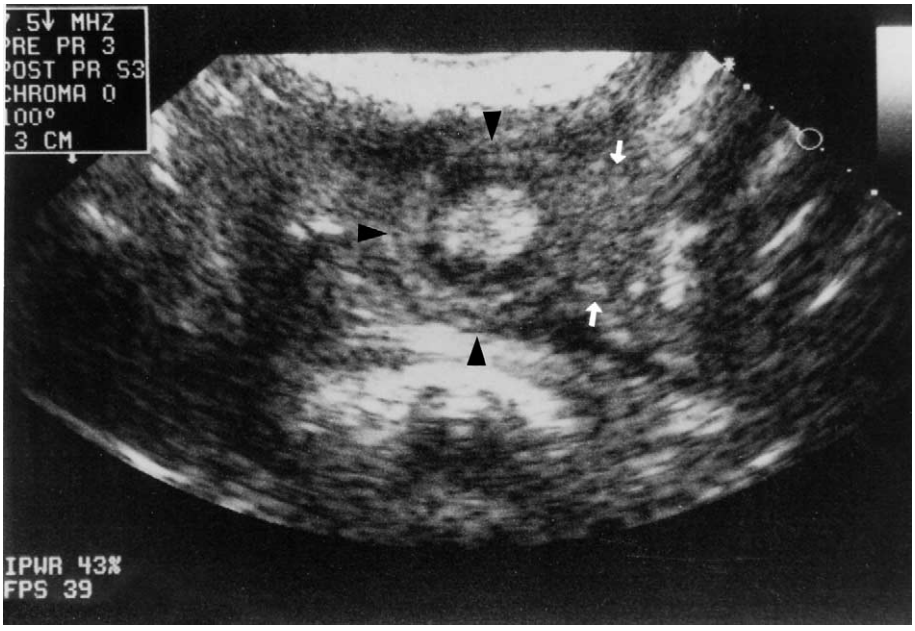

Fig 4. Transverse ultrasonographic section of ileocolic intussusception (cat case 4). A target-like mass (arrowheads) is seen consisting of outer hyperechoic and inner hypoechoic concentric rings around a circular hyperechoic centre. Increased thickness of the outer ring (white arrows), compatible with intestinal mass is also evident. Biopsy and histopathology revealed intestinal lymphoma.

these cases (case 4) the mass had a 'kidney' configuration (Fig 6). The median maximal width of the parallel lines was 2.1 cm (range 1.6–2.2 cm) and the median maximal width of the ovoid mass was 2.5 cm (range 1.8–2.5 cm).

Exploratory laparotomy revealed six ileocolic (cases 1, 2, 4, 5, 6, 7) and one jejunojejunal (case 3) intussusceptions. Intestinal neoplasia in three cases (cases 1, 4, 5) and parasitic enteritis in four cases (cases 2, 3, 6, 7) were confirmed,

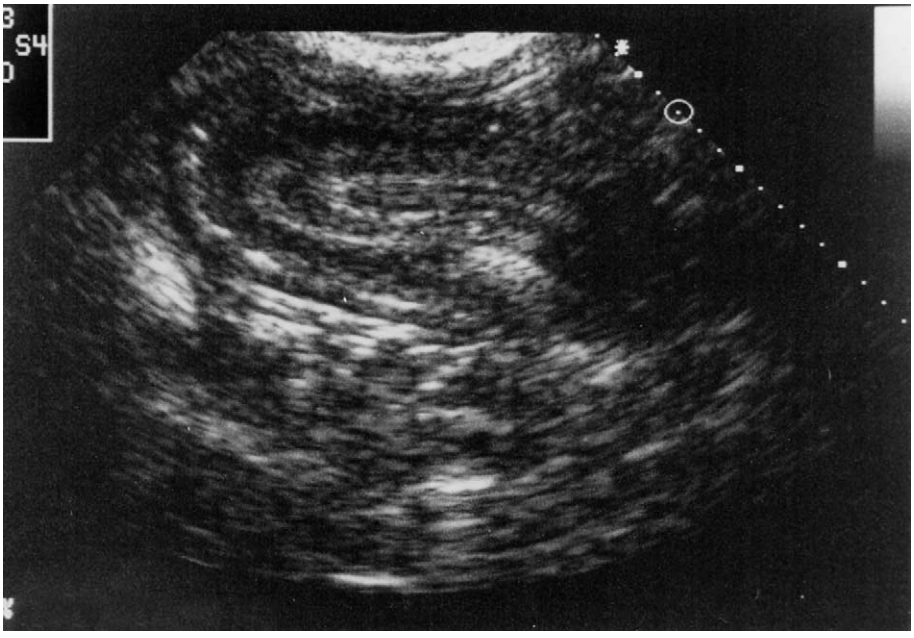

Fig 5. Longitudinal ultrasonographic section of ileocolic intussusception in a cat (case 7) showing multiple hyperechoic and hypoechoic parallel lines.

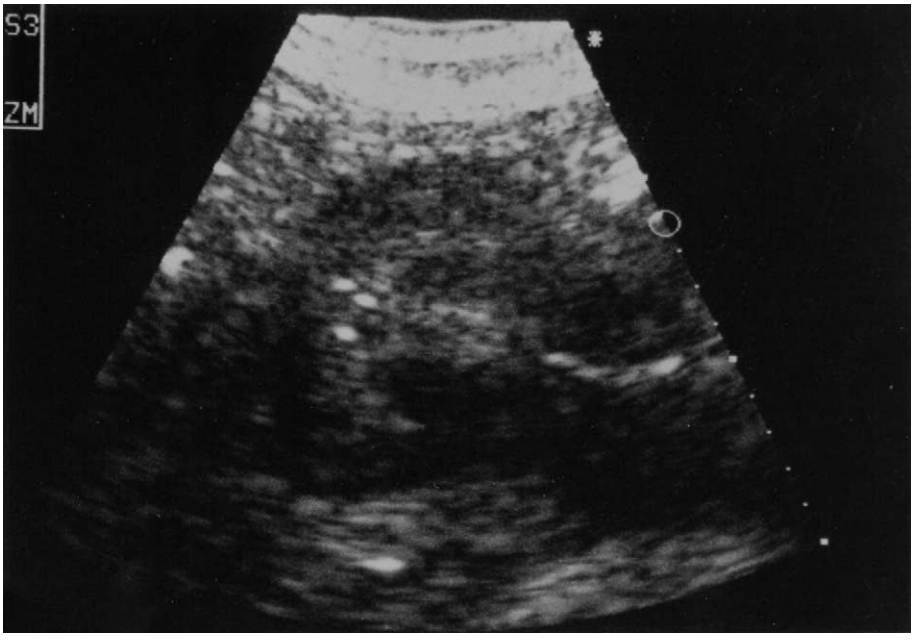

Fig 6. In a cat with intestinal lymphoma that was part of the intussusception (case 4) the longitudinal ultrasonographic section of the intussuscepted bowel has a 'kidney' configuration.

with biopsy and histopathology, as underlying diseases. The malignancies were part of the intussusception in two cases (cases 1, 4) and associated with the intussusception in one case (case 5). Intestinal resection and anastomosis were performed in all cats, except in case 4 where euthanasia was performed at the time of surgery at the owner's request. Following histopathology results, euthanasia was also performed in cases 1 and 5 at the owners' request, 6 days after surgery. All cats that underwent intestinal resection and anastomosis (cases 2, 3, 6, 7) were normal for at least 6 months after surgical treatment.

Discussion

In this small number of cases the breed, age, sex and clinical findings were similar to those described in cats with intestinal intussusception (Wilson and Burt 1974, Levitt and Bauer 1992, Bellenger and Beck 1994). Young cats were most commonly affected and anorexia was a consistent sign in all cases in this study. The palpable abdominal mass that was found in all cases in the present study, and in 11 of 12 cases by Bellenger and Beck (1994), may be considered the most consistent clinical finding of intestinal intussusception in cats. However, an accurate diagnosis cannot be based on this finding only.

Intestinal dilation was revealed in most plain abdominal radiographs in this series; however, this finding is not specific for intestinal intussusception (Levitt and Bauer 1992, Bellenger and Beck 1994). A mass effect caused by the intussuscepted bowel, which has been considered as the most representative appearance of intestinal intussusception in cats (Farrow 1994), was detected in two of the seven cases in this study. However, in emaciated animals, as it is usually the case in cats with intestinal intussusception, poor contrast between abdominal soft-tissue structures makes the radiographic detection of a mass or mass effect difficult.

Five layers are normally visible ultrasonographically in the feline intestinal wall (Goggin et al 2000): the hyperechoic mucosal surface, hypoechoic mucosa, hyperechoic submucosa, hypoechoic muscularis, and hyperechoic serosa. The ultrasonographic pattern of intestinal intussusception is the result of the juxtaposition of the wall layers of the inner and outer intussusceptum and the wall layers of the intussuscipiens (Penninck et al 1990). In transverse sections this juxtaposition creates too many hyperechoic and hypoechoic complete concentric rings. However, these concentric rings are usually indistinctly visible in vivo probably because of compression of the mucosal and serosal surfaces and the presence of bowel oedema (Bowerman et al 1982). So, the most commonly described ultrasonographic pattern in transverse sections in dogs consists of two or three thick hyperechoic and hypoechoic concentric rings (Patsikas et al 2003), although, multiple hyperechoic and hypoechoic concentric rings have been also described (Lamb and Mantis 1998, Patsikas et al 2003). A target-like mass consisting of multiple hyperechoic and hypoechoic concentric rings was detected in four cases in this study. In the remaining cases one (cases 1, 5) or two (case 4) concentric rings were observed. It is unclear whether the intestinal neoplasia found in cases 1, 4 and 5 altered the normal intestinal wall architecture and decreased the number of the hyperechoic and hypoechoic concentric rings. It is possible that intestinal neoplasia which increases the intestinal wall thickness may contribute to a tighter intussusception, where subsequent oedema formation might obscure the clear visualization of the intestinal wall layers. In humans, the thicker and more hypoechoic the peripheral rings, the more complicated the intussusception is to treat, whereas the presence of well-differentiated wall layers is usually associated with loose and reducible intussusceptions. In dogs with clearly delineated layers in the wall of the intussusceptum and intussuscipiens, a reducible intussusception can be expected (Patsikas et al 2003). However, non-reducible intussusceptions were found in cats with multiple hyperechoic and hypoechoic concentric rings in this study (cases 2, 3, 6, 7). The width of the hypoechoic external ring, or the width of the concentric rings, has been considered useful in determining the reducibility of intestinal intussusceptions in children (Marilas et al 2001). The median width of the concentric rings in non-reducible intussusceptions of the present study was 0.8 cm (range 0.4–0.9 cm). However, the lack of comparative data in cats prevents any correlation and conclusions being drawn. No similar data have been reported in dogs.

The concentric rings of the target-like structure usually surround a hyperechoic or anechoic centre; the latter being due to fluid accumulation into the intussusception lumen (Patsikas et al 2003). The hyperechoic centre that was found in the target-like structure in all cases in this study had a similar component to that described in dogs. In humans, a semi-lunar or G-shaped hyperechoic centre is typical of a loose or reducible intussusception, in contrast to a circular homogeneous hyperechoic centre that is usually a sign of a non-reducible intussusception (Bowerman et al 1982). A G-shaped hyperechoic centre was found in both reducible and non-reducible intussusceptions in dogs (Patsikas et al 2003). In the cats presented here, all intussusceptions—one with a C-shaped, one with circular shape and five with non-specific shape hyperechoic center—were non-reducible.

The part of the intestine representing the inner intussusceptum, located close to the hyperechoic centre and surrounded by concentric rings, as was demonstrated in three cases in this study, has also

been described in dogs (Patsikas et al 2003). This finding has been considered useful in differentiating intestinal intussusceptions from other target-like abdominal structures in dogs (Patsikas et al 2003). In humans, the size of the target-like mass has been used for differentiation of intestinal intussusceptions from other abdominal structures; ultrasonographic demonstration of a 20–30 mm in size, short, doughnut-like or target-like lesion, especially located in the left abdomen or paraumbilical region in paediatric patients, should lead to strong suspicion of small bowel intussusception (Tiao et al 2001, Ko et al 2002). No reports were found on the size of the target-like mass or the width of the concentric rings of the intussuscepted bowel in animals. Based on the wall thickness of the normal jejunum (mean 2.3 mm), ileum (mean 2.8 mm) and colon (mean 1.5 mm) in cats (Goggin et al 2000), the juxtaposition of the intussusceptum and the inner and outer intussuscipiens may create a target-like structure with a width not less than 11.6 mm when the colon invaginates into the ileum. The diameter probably increased in jejunojejunal and ileoiliac intussusceptions. The presence of mesentery and oedema formation may also increase this diameter. The minimum diameter of the target-like structure found in the present study was 16 mm in a case of ileocolic intussusception (case 4). This size could potentially be used to differentiate the intestinal intussusception from other abdominal structures, as mesenteric lymph nodes, that sometimes may have a target-like appearance and may mimic intestinal intussusception (Mattoon and Nyland 1995).

In longitudinal ultrasonographic sections of the intussuscepted bowel, multiple hyperechoic and hypoechoic parallel lines are the most commonly described patterns in dogs and humans (Irish et al 1998, Lamb and Mantis 1998, Patsikas et al 2003). Other signs including a mass, a pseudo-kidney mass, an hourglass, a hayfork, a trident configuration and fused targets have also been reported (Alessi and Salerno 1985, Swischuk et al 1985, Patsikas et al 2003). Multiple hyperechoic and hypoechoic parallel lines were found in longitudinal ultrasonographic sections in four cats of the present study. However, an ovoid mass in two cats and a kidney-like mass in one cat were also detected. The latter was found in cats with intestinal neoplasia, however, it is not clear if neoplasia has contributed to the appearance of these patterns as has been discussed before for the transverse sections. The median maximal widths of the parallel lines and the ovoid masses were 2.1 cm (range 1.6–2.2 cm) and 2.5 cm (range 1.8–2.5 cm), respectively. However, the lack of relative data in dogs and cats prevents any correlation.

Despite the small number of the cases, the results of the present study demonstrate that the ultrasonographic findings of intestinal intussusception in cats bear some similarities to those described in dogs and humans, and are relatively consistent, facilitating a specific diagnosis. However, to establish accurate measurements relating to the size of the target-like structure, the width of the parallel lines, the width of the ovoid mass, the width of the concentric rings, the configuration of the parallel lines, as well as to establish ultrasonographic criteria that may predict the reducibility of the intussusception, more cases should be investigated.

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