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Outcome of caudal superficial epigastric axial pattern flaps in dogs and cats: 70 cases (2007-2020)

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OBJECTIVES: To describe the outcome and complications associated with the use of caudal superficial epigastric axial pattern flaps in dogs and cats.

MATERIAL AND METHODS: Multicentre retrospective review and descriptive study of clinical records of dogs and cats having undergone caudal superficial epigastric axial pattern flaps between 2007 and 2020. Data retrieved included signalment, aetiology of surgical defect, tumour type, presence/absence of clean surgical margins, presence/absence of post-operative wound infection, use of peri- and post-operative antibiotics, duration of anaesthesia, duration of surgery, presence and duration of hypothermia, presence and duration of hypotension, presence/absence of post-operative surgical drain and length of caudal superficial epigastric axial pattern flap. The incidence of complications and outcomes were documented.

RESULTS: Seventy cases met the inclusion criteria; 51 dogs and 19 cats. In dogs, 67% of cases developed complications (59% minor, 8% major) and 33% had uneventful wound healing. In cats, 53% of cases developed complications, (47% minor, 5% major) and 47% had uneventful wound healing. In dogs, the percentage of cases experiencing dehiscence, necrosis, seroma, oedema and post-operative infection was 31%, 29%, 26%, 26% and 16% respectively. In cats, this was 26%, 16%, 11%, 0% and 5% respectively. A good overall outcome was seen in 77% of dogs and 79% of cats. A poor overall outcome was seen in 4% of dogs and 0% of cats.

CLINICAL SIGNIFICANCE: Caudal superficial epigastric axial pattern flaps are traditionally thought more robust than other flaps, yet complication rates remain high, despite a high overall success rate.

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INTRODUCTION

Direct cutaneous arteries provide the primary blood supply to the canine skin (Pavletic 1980a,b). The caudal superficial epigastric axial pattern flap (CSEAPF) is based on the caudal superficial epigastric artery (Pavletic 1980a,b, 1990, Remedios *et al.* 1989) which is the primary arterial supply to mammary glands 3, 4 and 5. The cranial superficial epigastric artery generally anastomoses with the caudal superficial epigastric vessel between glands 2 and 3 (Bojrab 1975, Pavletic 1980a).

First described by Pavletic in 1980 (Pavletic 1980a), the CSEAPF is reported in dogs and cats to cover multiple defects in the inguinal area, perineum, lateral body wall, prepuce and medial, lateral and caudal thigh (Lidbetter *et al.* 2002, Campbell 2003, Mayhew & Holt 2003, Woods *et al.* 2009, Clarke & Findji 2011, Watrous *et al.* 2016, Zingel & Sakals 2017, Massari *et al.* 2018). Currently, there is limited information describing the complications associated with the use of CSEAPFs (Trevor *et al.* 1992, Aper & Smeak 2005, Field *et al.* 2015). Aper & Smeak (2005), reviewed 10 cases of CSEAPF reconstructions and reported a 90% complete survival of the flap. Seroma formation ($n=3$), partial incisional dehiscence ($n=3$), flap oedema ($n=3$) and bruising ($n=7$) were also noted in these 10 cases (Aper & Smeak 2005). Field *et al.* (2015) reported a case series of 73 axial pattern skin flaps, 13 of which were CSEAPFs. With all flaps combined, an 89% complication rate was noted, although the complication rate specific to CSEAPFs was not stated (Field *et al.* 2015).

In light of the limited clinical data regarding the complications associated with CSEAPFs, a multicentre study assessing the rate and nature of complications associated with their use was warranted and hence the aims of this retrospective study were twofold. Firstly, to report and describe the outcome and complications associated with the use of CSEAPFs in both canine and feline patients. Secondly, to report and describe the following in relation to these cases: (1) patient background variables (species, breed, age, gender, neuter status, weight), (2) tumour/defect variables (aetiology of defect, complete/incomplete tumour margin, tumour classification), (3) presence or absence of post-operative wound infection, (4) anaesthesia variables (duration of anaesthesia, presence and duration of hypothermia, presence and duration of hypotension) and (5) surgical variables (placement of drain, length of flap, duration of surgery).

MATERIALS AND METHODS

Eleven referral clinics in the UK were invited to participate in the study. Ethical approval was obtained from The University of Edinburgh ethical review committee (VERC 110.20). The surgical database of each institution was searched using the words “epigastric, axial, pattern and flap.” Medical records were received from 10 institutions that met the inclusion criteria of cases that had received a CSEAPF for management of any wound, including both traumatic wounds and wound closure post-oncological resection.

Data collected included signalment, aetiology of surgical defect (neoplasia or trauma), tumour type, presence/absence of clean surgical margins, presence/absence of post-operative wound infection, use of peri and post-operative antibiotics, duration of anaesthesia and the presence/absence of long anaesthesia defined as ≥ 180 minutes, duration of surgery and the presence/absence of long surgery defined as ≥ 120 minutes, presence and duration of hypothermia ($< 36^{\circ}\text{C}$), presence and duration of hypotension (MAP < 60 mmHg), presence/absence of a post-operative surgical drain, length of CSEAPF as defined by the most cranial mammary gland raised, complications and outcome.

A “cut off” of ≥ 180 minutes for long/short anaesthesia and ≥ 120 minutes for long/short surgery duration was determined by the mean and distribution of the data set. Dogs were considered hypothermic at less than 36°C . In dogs undergoing anaesthesia, body temperature normally decreases by approximately 1.0 to 1.5°C after 1 hour of surgery (Tümsmeyer *et al.* 2009). A “cut off” of less than 36°C for defining hypothermia was therefore considered appropriate for patients most likely having a duration of surgery greater than 1 hour, as seen with CSEAPF surgery. Hypotension was defined as mean arterial pressure less than 60 mmHg (Gaynor *et al.* 1999).

Complications specific to CSEAPFs were categorised as (1) presence/absence of post-operative infection based on clinical signs and/or positive culture, (2) presence/absence of dehiscence and percentage of flap dehiscence, (3) presence/absence of necrosis and percentage of necrosis, (4) presence/absence of seroma and (5) presence/absence of oedema. Complications specific to this study were adapted from Follette *et al.* (2020) and were defined as (1) none reported, (2) minor (requiring antibiotic treatment or minor surgical management, with minor management defined as simple debridement, drain placement or open wound management) and (3) major (requiring one or more revision surgeries) (Follette *et al.* 2020).

The overall outcome was defined as (1) good, where either uncomplicated healing was noted or open wound management was utilised to achieve successful wound closure, (2) adequate, where an additional surgical procedure was required to achieve successful wound closure and (3) poor, where total flap failure was recorded.

Data analysis was performed using Microsoft Excel (Microsoft, 2021) software and StataIC 13 (StataCorp). Normality was assessed by the Shapiro–Wilk test and normal data was reported as mean (\pm sd). Data not normally distributed was reported as median and range and categorical data was reported as frequencies.

RESULTS

Seventy cases met the inclusion criteria: 51 dogs and 19 cats.

Dogs

Breeds included Labrador retriever ($n=12$), Crossbreed ($n=10$), Staffordshire Bull Terrier ($n=8$), Jack Russell Terrier ($n=4$), cocker spaniel ($n=2$) and one each of the following: boxer, Border Collie, Whippet, Dalmatian, Scottish Terrier, Pyrenees Mountain dog,

German Shepherd, Bichon, Irish Wolfhound, Smooth Collie, Greyhound, Lurcher, American Cocker, Patterdale and Shar Pei. A mean age of 6.6 (± 4.1) years and a mean bodyweight of 24.5 (± 16.2) kg were reported. Neuter status included female neutered (n=25), female entire (n=1), male neutered (n=17) and male entire (n=8).

Surgery was performed by an ECVS board certified surgeon in 49 of 51 (96%) dogs and an ECVS residency trained surgeon in two of 51 (4%) dogs. A CSEAPF was selected for oncological reconstruction in 38 of 51 (75%) cases, management of traumatic wounds in nine of 51 (18%) cases, management of skin necrosis in three of 51 (6%) cases and reconstruction following surgical management of dermatitis and folliculitis in one of 51 (2%) cases. In the 38 cases of oncological reconstruction, soft tissue sarcoma and mast cell tumour were resected in 18 of 38 (47%) and 20 of 38 (53%) of cases respectively. Of these cases, 36 of 38 (95%) achieved histological tumour free margins. In two of 20 (10%) cases where a mast cell tumour was resected, a high grade (Kiupel) tumour with incomplete margins was reported.

In 27 of 51 (53%) cases, both peri and post-operative antibiotics were administered, whilst only peri-operative antibiotics were administered in 24 of 51 (47%) of cases. All antibiotics were administered at surgeon discretion. The median duration of post-operative antibiotics was 10 (3 to 131) days. A wound drain was placed in 38 of 51 (75%) cases; 37 of 38 (97%) were active drains and one of 38 (3%) passive. Duration of wound drain management was recorded in 31 of 38 cases. Drains remained *in situ* for a median of 3 (1-7) days.

Duration of wound healing was documented in 48 of 51 cases. The median duration of wound healing was 20 (6-126) days. In two of 51 (4%) cases, the patient was euthanised due to flap failure; in one case euthanasia was based on financial reasons and in the second due to severity of flap failure and ongoing surgical management required for the patient. In one of 51 cases, duration of wound healing was not documented.

The length of the flap was documented in 26 of 51 cases. Flap length included the fifth gland only in one of 26 (4%) cases, fifth to fourth gland in two of 26 (8%) cases, fifth to third gland in 14 of 26 (54%) cases, fifth to second gland in seven of 26 (27%) cases and fifth to first gland in two of 26 (8%) cases.

Mean total anaesthesia time was 218.3 (± 107.6) minutes. Information regarding the presence of hypotension during anaesthesia was available in 32 of 51 cases. Of these cases, 13 of 32 (41%) experienced a period of hypotension and the mean duration of hypotension was 30 (± 107.6) minutes. Information regarding the presence of hypothermia during anaesthesia was available in 28 of 51 cases. Of these cases, 16 of 28 (57%) experienced hypothermia and the mean duration of hypothermia

was 159.7 (± 115.1) minutes. Mean total surgery time was 117.8 (± 107.6) minutes.

Complications were noted in 34 of 51 (67%) cases (Table 1). Minor complications were seen in 30 of 51 (59%) cases and major complications were noted in four of 51 (8%) cases. Of these complications, wound infection was noted in eight of 51 (16%) cases; in six of eight cases, infection was confirmed with a positive culture where *Escherichia coli* (n=3), *Klebsiella* species (n=1), *Enterococcus faecalis* (n=1) and *Staphylococcus pseudintermedius* (n=1) were identified. In two of eight cases, infection was based on gross clinical appearance alone. Dehiscence was noted in 16 of 51 (31%) cases. Of these cases, 11 of 16 (69%) had less than 10% dehiscence, two of 16 (13%) cases had 10 to 50% dehiscence and three of 16 (19%) cases had greater than 50% dehiscence (Figs 1 to 3). Necrosis was noted in 15 of 51 (29%) cases. Of these cases, eight of 15 (53%) had less than 10% necrosis, three of 15 (20%) cases had 10 to 50% necrosis and four of 15 (27%) cases had greater than 50% necrosis. In total, eight cases had both dehiscence and necrosis, seven cases had necrosis yet no dehiscence and eight cases had dehiscence yet no necrosis. The median time post-surgery for necrosis of the flap was 6.5 (3 to 18) days. A seroma was noted in 13 of 51 (25%) cases and generalised flap oedema in 13 of 51 (25%) cases. Overall outcome was good in 39 of 51 (76%) cases, adequate in 10 of 51 (20%) cases and poor in two of 51 (4%) cases. Cases with adequate or poor outcome are shown in Table 2.

Cats

Breeds included domestic shorthair (n=15) and one each of the following: British Blue, Bengal, Domestic Longhair and British Shorthair. A mean age of 2.7 (± 2) years and a mean bodyweight of weight 4.1 (± 1.1) kg were reported. Neuter status included female neutered (n=9), male neutered (n=8) and male entire (n=2).

Surgery was performed by an ECVS board certified surgeon in 17 of 19 (89%) cats, an ECVS residency trained surgeon in one of 19 (5%) cats and an MRCVS veterinary surgeon in one of 19 (5%) cats. A CSEAPF was selected for management of traumatic wounds in nine of 19 (47%) cases, management of chronic wounds in six of 19 (32%) cases, management of cat bite abscess in three of 19 (16%) cases and oncological reconstruction in one of 19 (5%) cases. In the single case of oncological reconstruction, a low-grade soft tissue sarcoma was resected. Margin assessment was not recorded.

In 13 of 19 (68%) cases, both peri- and post-operative antibiotics were administered, whilst only peri-operative antibiotics were administered in six of 19 (32%) of cases. The median duration of post-operative antibiotics was 10 (5-21) days. A wound

Table 1. Summary of complications and outcome of CSEAPFs in dogs and cats

Species	No of cases	Complications					Total percentage complications			Overall outcome		
		Infection	Dehiscence	Necrosis	Seroma	Oedema	Total complications	Major complications	Minor complications	Good	Adequate	Poor
Dog	51	16% (8/51)	31% (16/51)	29% (15/51)	26% (13/51)	26% (13/51)	67% (34/51)	8% (4/51)	59% (30/51)	77% (39/51)	20% (10/51)	4% (2/51)
Cat	19	5% (1/19)	26% (5/19)	16% (3/19)	11% (2/19)	0% (0/19)	53% (10/19)	5% (1/19)	47% (9/19)	79% (15/19)	21% (4/19)	0% (0/19)



FIG 1. CSEAPF elevating the fifth to third mammary gland for management of a peri-anal, low grade mast cell tumour in a Labrador retriever with evidence of less than 10% necrosis at the tip of the flap. The anus is seen in the top right of the photo, with the pelvic limbs evident

drain was placed in nine of 19 (47%) cases; eight of nine (89%) were active drains and one of nine (11%) passive. Omentum was used as a physiological drain in one of 19 (5%) cases and data regarding drain use was not available in one of 19 (5%) cases. Duration of wound drain management was recorded in eight of 19 cases. Drains remained *in situ* for a median of 3 days (range 1-7 days).

Duration of wound healing was documented in 16 of 19 cases. The median duration of wound healing was 14 (12 to 60) days. The length of the flap was documented in 12 of 19 cases. Flap length included the fifth to third gland in eight of 12 (67%) cases, fifth to second gland in three of 12 (25%) cases and fifth to first gland in one of 12 (8%) cases.

Mean total anaesthesia time was 218.5 (± 76.5) minutes. Information regarding the presence of hypotension during anaesthesia was available in nine of 19 cases. Of these cases, six of 19 (32%) experienced a period of hypotension and the mean duration of hypotension was 30 (± 18.8) minutes. Information regarding the presence of hypothermia during anaesthesia was available in nine of 19 cases. Of these cases, eight of nine (89%) experienced hypothermia and the mean duration of hypothermia was 126.9 (± 81.9) minutes. Mean total surgery time was 118.9 (± 64.1) minutes.



FIG 2. (a) CSEAPF elevating the fifth to third mammary gland for management of an intermediate grade soft tissue sarcoma on the lateral thigh in a Labrador retriever with evidence of 10 to 50% necrosis of the flap. Cranial is to the left of the photo. (b) CSEAPF elevating the fifth to third mammary gland for management of an intermediate grade soft tissue sarcoma on the lateral thigh in a Labrador retriever with evidence of 10 to 50% dehiscence of the flap. Cranial is to the left of the photo

Complications were noted in 10 of 19 (53%) cases; nine of 19 (47%) minor and one of 19 (5%) major (Table 1). Of these complications, wound infection was noted in one of 19 (5%) cases, where *E. coli* and *E. faecalis* were cultured. Dehiscence was noted in five of 19 (26%) cases. Of these cases, one of five (20%) had less than 10% dehiscence, three of five (60%) cases had 10 to 50% dehiscence and one of five (20%) cases had greater than 50% dehiscence. Necrosis was noted in three of 19 (16%) cases. Of these cases, three of three (100%) had less than 10% necrosis. In total, there were no cases that had both necrosis and dehiscence, three cases had necrosis yet no dehiscence and five cases had dehiscence yet no necrosis. The median time post-surgery for necrosis of the flap was 15.0 (12-16) days. A seroma was noted in two of 19 (10%) cases. Generalised flap oedema was not identified in any case.

Overall outcome was good in 15 of 19 (79%) cases, adequate in four of 19 (21%) cases and poor in 0 of 19 (0%) cases. Cases with an adequate outcome are presented in Table 2.



FIG 3. (a) Completed CSEAPF following resection of an intermediate grade mast cell tumour on the peri-anal region of a Labrador retriever. The fifth to third mammary glands were raised and rotated to close a left peri-anal wound. Cranial is to the top of the photo, medial thigh and groin to the bottom of the photo. (b) Peri-anal view of a completed CSEAPF for management of an intermediate grade mast cell tumour on the peri-anal region of a Labrador retriever. Most distal aspect of the flap is dorsal in this photo, to the left of the anus. (c) Peri-anal view of a completed CSEAPF for management of an intermediate grade mast cell tumour on the peri-anal region of a Labrador retriever showing greater than 50% necrosis of the flap. Most distal aspect of the flap is dorsal in this photo, to the left of the anus. (d) Peri-anal view of a completed CSEAPF for management of an intermediate grade mast cell tumour on the peri-anal region of a Labrador retriever showing greater than 50% dehiscence of the flap. Most distal aspect of flap is dorsal in this photo, to the left of the anus

Table 2. Summary of the 16 cases with either an "adequate" or "poor" overall outcome

Case	Complications				Variables								
	Infection?	Dehiscence?	Necrosis?	Seroma?	Oedema?	Long surgery time?	Long anaesthesia time?	Surgery for neoplasia?	Most cranial gland elevated?	Hypotension?	Hypothermia?	Drain placed?	Peri and post-operative antibiotics?
1	Y	<10%	<10%	N	N	N	Y	Y	First	Y	Y	Y	N
2	Y	<10%	<10%	N	N	N	N	Y	Second	N	N	Y	N
3	Y	<10%	<10 to 50%	N	N	N	N	Y	Third	N	N	N	Y
4	N	<10%	N	N	N	No data	No data	Y	Third	Y	N	N	Y
5	N	<10%	10 to 50%	N	N	No data	No data	Y	Third	No data	No data	N	N
6	N	<10%	N	N	N	No data	No data	Y	Third	No data	No data	Y	Y
7	N	<10%	10 to 50%	N	N	N	Y	N	Third	N	N	N	Y
8	N	10 to 50%	>50%	Y	N	Y	No data	Y	No data	No data	No data	Y	Y
9	N	<10%	N	N	N	Y	Y	N	Third	N	N	Y	N
10	Y	>50%	>50%	Y	N	Y	Y	N	Third	N	Y	Y	Y
11	N	>50%	>50%	N	Y	No data	No data	Y	No data	No data	No data	Y	Y
12	Y	>50%	>50%	N	N	Y	Y	Y	Second	Y	Y	Y	Y
13	N	10 to 50%	<10%	N	N	N	N	N	No data	Y	N	Y	Y
14	N	10 to 50%	<10%	N	N	N	Y	N	Third	Y	Y	N	Y
15	Y	>50%	<10%	N	N	N	Y	N	First	No data	No data	N	Y
16	N	<10%	N	N	N	Y	Y	N	Second	N	N	N	N

Cases 1 to 10: dogs with adequate outcome, cases 11 to 12: dogs with poor outcome, cases 13 to 16: cats with adequate outcome (no cats had poor outcome)

Cases 1 to 10: dogs with adequate outcome, cases 11 to 12: dogs with poor outcome, cases 13 to 16: cats with adequate outcome (no cats had poor outcome)

DISCUSSION

The data presented in this study supports the use of the CSEAPF with 79% of cats and 77% of dogs having a good outcome and provides, to date, the largest study evaluating the use of a CSEAPF in cats and dogs.

It is widely recognised that the CSEAPF is a robust flap in the clinical setting but this claim has only been supported by small clinical studies (Trevor *et al.* 1992, Aper & Smeak 2005, Field *et al.* 2015). In our study, 67% of dogs and 53% of cats developed complications and these results differ from previously reported data assessing complications of CSEAPFs.

Aper *et al.* (2005) assessed CSEAPFs in dogs alone (n=10) and found 90% of cases had uneventful wound healing with only 10% developing minor complications (requiring no further surgery). The single case that developed only minor necrosis was thought to be associated with placement of the flap around the pins associated with an external fixator and subsequent interruption of blood supply. In our study, our minor and major complication rate was much higher, with only approximately one third of cases experiencing uneventful wound healing. In both our study and the study by Aper *et al.* (2005), there were similarities between peri-operative variables; the CSEAPF was utilised for tumour reconstruction in approximately 70% of cases and the most cranial gland elevated was gland 3 in 50 to 60% of cases where data was reported. However, there were post-operative differences between the two studies. Aper *et al.* (2005) reported a higher use of post-operative antibiotic use (approximately 80% *versus* 50% with the presented data here) and 40% of cases received post-operative abdominal bandage management; both of which could affect post-operative wound infection and oedema, influencing flap success. Post-operative abdominal bandage management was not assessed in this study, being a relatively infrequently used post-operative management technique. Equally, in our study, no flaps were used in conjunction with orthopaedic implants. It is reasonable to conclude that the small cohort size in pre-existing studies limits direct comparison of both data sets. Equally, each study in the veterinary literature will have its own specific definition for complications and different thresholds for defining where there is a complication present (Follette *et al.* 2020), comparison of data sets between studies therefore remains a challenge.

Comparing the complications of CSEAPFs with post-operative complications of all axial pattern flaps combined (Field *et al.* 2015), the CSEAPFs reported in this study have a lower total complication rate and higher rate of uneventful wound healing. Field *et al.* (2015) reported an 89% complication rate and 11% rate of uneventful wound healing when assessing collective data from multiple axial pattern skin flaps (thoracodorsal, CSEAPF, reverse saphenous conduit, superficial brachial, deep circumflex iliac, superficial cervical, caudal auricular, lateral thoracic, cranial superficial epigastric, genicular and superficial temporal). The lower rate of complication with the CSEAPF (66% of cats and 53% of dogs in this study) may be explained by the more robust and anatomically consistent blood supply compared with other axial pattern flaps. Selective angiography in cats has confirmed a median external diameter for the caudal superficial epigastric

artery, thoracodorsal artery and deep circumflex iliac artery of 1.7, 1.3 and 0.4 mm respectively (Remedios *et al.* 1989). It is possible therefore that the larger vessel diameter is likely to assist in easier identification of the vessel and rotation of the flap with less vascular compromise.

Whilst 70 cases of CSEAPF are reported within this study, the relatively small data set and incomplete data for all variables precluded statistical analysis of patient background variables, tumour variables, anaesthesia variables and surgical variables with the incidence of complications. Previous studies have, however, addressed these variables in relation to the development of complications (Beal *et al.* 2000, Hussien *et al.* 2001, Stetter *et al.* 2021).

In our study, 57% of dogs and 89% of cats experienced hypothermia during surgery. This percentage likely reflects the long duration of anaesthesia and extensive soft tissue dissection during CSEAPF surgery. Beal *et al.* (2000) and Stetter *et al.* (2021) both identified a lack of association between the incidence of hypothermia and post-operative wound infection rates. These findings are important when considering the high percentage of cases experiencing hypothermia reported in our study. Stetter *et al.* (2021), however, did find an association between the duration of anaesthesia and increased surgical site infections when assessing 1524 dogs having clean surgical procedures. Further larger studies are therefore warranted to assess the effects of both hypothermia and duration of anaesthesia on the incidence of complications of CSEAPFs.

With 41% of dogs and 32% of cats experiencing hypotension during CSEAPF surgery in our study, future studies assessing the effect of intraoperative hypotension and complications is warranted. Interestingly, in human medicine literature, intraoperative hypotension has been shown to significantly affect post-operative complications with an increase in the development of wound haematomas following surgery, specifically following breast reduction surgery (Hussien *et al.* 2001). Patients who experienced intra-operative hypotension during the middle phase of surgery (where haemostasis is usually required due to resection and reconstruction at this phase) had a higher risk of developing wound haematomas, requiring subsequent drainage post-operatively. Periods of hypotension could possibly mask the meticulous haemostasis required and subsequent bleeding could well arise when the patient becomes normotensive. Whilst a similar complication could theoretically arise with the dissection of the mammary tissue in dogs and cats when elevating and rotating the CSEAPF, in our study, haematomas post CSEAPF surgery were not documented.

Limited case numbers prevented statistical analysis between dogs and cats. In cats, approximately half experienced uncomplicated wound healing, with a 5% major complication rate and a median duration of wound healing of 14 (12 to 60) days. In dogs, approximately one third experienced uncomplicated wound healing, with an 8% major complication rate and a median duration of wound healing of 20 (6 to 126) days. Interestingly, our data has not supported the existing literature regarding wound healing in cats. Comparison of cutaneous angiosomes has revealed that dogs have a much higher density of tertiary and higher order vessels than cats, especially on the

trunk (Taylor & Minabe 1992). Hence, less cutaneous perfusion is noted to the uninjured skin in cats, placing cats at higher risk for slower wound healing and greater tissue necrosis than dogs (Bohling *et al.* 2004). Contradictorily, our data indicates that the CSEAPF in cats is potentially more robust than in dogs. As wound healing and formation of granulation tissue is slower in cats (Bohling *et al.* 2004), it is possible that flaps in cats are less likely to develop inflammatory responses, such as reperfusion injury, causing oedema. Equally, meticulous dissection around the inguinal region is often easier in cats than dogs and identification of the caudal superficial epigastric artery in large breed dogs with excessive inguinal fat can be a challenge. It is possible that in cats, the elevation and rotation of the flap results in less trauma and vascular compromise than in dogs, thus reducing the complication rate.

Despite the complications identified with CSEAPFs in this study, it remains important to address this in a clinical setting. Total flap failure, resulting in a poor outcome, was identified in only 4% of dogs and 0% of cats; both species had an approximate 75% good outcome. There was no association between complications and outcome. As such, this flap remains a viable option in the clinical setting for reconstruction of inguinal, perineal, lateral body wall, preputial and thigh wounds.

The limitations of this study include those inherent to multicentre retrospective studies. Data was collected from 10 clinics, involving multiple surgeons. Complete data sets were not fully available for all variables resulting in a descriptive case series rather than a statistical analysis of each variable with the incidence of complications. Equally, whilst this is the largest study assessing CSEAPFs, the small cohort size of 51 dogs and 19 cats limits our ability to statistically compare the two species. The retrospective data collection also required analysis of photographs for assessment of length of flap, percentage necrosis and percentage dehiscence. In some cases, assessment of the percentage surface area affected by post-operative wound complications was challenging. For this reason, the percentage necrosis and percentage dehiscence were divided into three ranges, assisting standardisation of data collection.

In conclusion, the CSEAPF has a high overall success rate, despite a high complication rate. In comparison with previously reported data, we have demonstrated a lower total complication rate and higher rate of uneventful wound healing when compared with pre-existing data of all axial pattern flaps combined, suggesting it is overall a more robust flap.

Conflict of interest

No conflicts of interest have been declared.

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