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Evaluation of prognostic factors for return of urinary and defecatory function in cats with sacrocaudal luxation

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Abstract

Objectives: to evaluate outcome and prognostic factors for cats with sacrocaudal luxation.

Methods: Medical records and radiographs were reviewed for cats with sacrocaudal luxation. Information obtained from the clinical records included signalment, clinical presentation, concurrent traumatic injuries, treatment details, outcome and survival time. Severity of neurological signs was graded from 1 to 5, based on previous grading systems for cats with sacrocaudal luxation. Degree of vertebral displacement was calculated on survey radiographs. Outcome was collected from serial neurological examinations and telephone interviews. Cats had to be given a minimum of 30 days to regain urinary function to be included in this study.

Results: Seventy cats were included. Fifty-five of 61 cats (90%) regained voluntary urinary function. Higher neurological grade was associated with a decreased likelihood (P=0.01) and longer duration (P=0.0003) of regaining urinary function. No significant associations were found between urinary outcome and age, sex, anal tone, perineal sensation, tail base sensation, degree of craniocaudal or dorsoventral sacrocaudal displacement, concurrent orthopaedic injury, tail amputation, defecatory function at diagnosis, and survival. Cats that regained defecatory function had longer survival times than those that did not recover defecatory function (P=0.03). Defecatory outcome was not significantly associated with any other variables.

Conclusions and relevance: In agreement with previous studies, neurological grade is the most important prognostic indicator for cats with sacrocaudal luxation. Determination of the severity of neurological signs can also aid in advising owners

the time frame in which urinary function is expected to return. Faecal incontinence may be a more important prognostic factor than previously suspected.

Introduction

Sacrocaudal luxation, also known as 'tail-pull injury', is a commonly encountered traumatic injury in cats caused by traction on the tail.[1-4] This condition typically occurs when the tail gets trapped under a vehicle's wheel while the cat tries to escape.[2,4,5] It occurs often in combination with pelvic trauma [5-7] and neurological deficits result from haemorrhage, oedema and avulsion of nerve roots in the terminal spinal cord.[2,4,8] Clinical signs include urinary and faecal incontinence, paraparesis and tail paralysis.[2,5,9] Caudal nerve lesions are responsible for tail paralysis, whilst damage to either the pelvic or pudendal nerves can result in urinary and faecal dysfunction.[10,11] Making a diagnosis of sacrocaudal luxation is usually straightforward and is based on a combination of characteristic clinical signs and radiological evidence of sacrocaudal luxation, subluxation or fracture. [4]

The prognosis of cats with sacrocaudal luxation is variable and depends on the severity of nerve injury.[2,5,9] Whilst paraparesis is usually transient, urinary and faecal continence can be slow to return, if at all.[4,8,12] Neuronal injury associated with sacrocaudal injury is predominantly considered to reflect peripheral nerve injury and can be graded from spontaneously reversible injuries (i.e. neuropraxia and to some extent axonotmesis) to irreversible injuries in which the axons and supporting structures are transected (i.e. neurotmesis).[2,9,13] It is currently difficult or almost impossible to determine the severity of peripheral nerve injury, and hence the likelihood for recovery, shortly after the traumatic incident has happened.[9] Previous studies have suggested an association between the severity of initial neurological signs and prognosis.[2,5] Intact tail base sensation, anal tone and perineal sensation are considered positive prognostic indicators, with more than 75% of cats regaining urinary continence within the first month.[2,5] However, absence of tail base sensation, anal tone or perineal sensation at presentation does not preclude eventual recovery with around 60% of animals lacking these positive prognostic indicators still regaining control of urination within 30 days.[2,5] This lack of 'negative' prognostic indicators complicates clinical decision making in the early stages after the injury, especially in cats with concurrent pelvic trauma. It is likely that the possibility of permanent urinary dysfunction will influence owners of affected cats to decide against or postpone expensive treatment of concurrent conditions. Despite the common nature of this disorder in general practice, only a few studies have evaluated the outcome and possible prognostic factors of sacrocaudal luxation in cats.[2,5] The aim of this retrospective study was to evaluate prognostic factors for cats diagnosed with sacrocaudal luxation, which could hopefully enable veterinary practitioners to give more accurate prognoses.

It was hypothesised that cats with more severe neurological signs and a higher degree of vertebral displacement would be less likely to regain urinary function compared to cats with milder neurological signs and less severe displacement of the luxated vertebral segments.

Materials and Methods

Case selection

This retrospective study was approved by the ethics and welfare committee of the Royal Veterinary College (RVC, URN SR2017-1152). The digital medical database of the small animal referral hospital, RVC was searched for records of cats diagnosed with sacrocaudal or proximal caudal vertebral luxation between January 2002 and July 2017. Search terms used included sacrocaudal luxation, sacrococcygeal luxation, and tail-pull injury. Cats were included if they had clinical signs compatible with sacrocaudal luxation, were presented within 48 hours after the injury had occurred, underwent a complete neurological examination, a diagnosis of sacrocaudal luxation was confirmed by radiography, and cats had to be available for a follow-up period of at least 30 days. Radiological confirmation was defined as assessment of available radiographs or a sufficiently detailed description of radiological findings in the clinical case records from radiographs submitted by referring veterinary surgeons at the time of referral. Cats were excluded if the medical records were incomplete, if they were presented more than 48 hours after the injury had occurred, the imaging studies were not available or not described in sufficient detail to unequivocally confirm a diagnosis of sacrocaudal luxation, or if cats were not available for a follow-up period of at least 30 days after a diagnosis of sacrocaudal luxation was made. Cats with concurrent traumatic injuries were not excluded. Cats with concurrent pelvic trauma were therefore also included in this study. All medical records and imaging studies were reviewed by a board-certified neurologist (SDD) to determine study eligibility. For all included cases, the following information was retrieved from the medical records: signalment; clinical signs; neurological examination findings, including tail base sensation, tail tone, tail movement, perineal reflex and sensation, anal tone and bladder tone; urinary and defecatory function; concurrent traumatic injuries, specifically pelvic trauma; anatomic level and degree of displacement of luxated vertebrae; type of treatment, including tail amputation and medical management; and neurological status at the time of discharge from hospitalisation. The severity of neurological signs was graded from 1 to 5, based on the classification systems described by Smeak and Olmstead (1985)[5] and Tatton et al. (2009)[2] (Figure 1). This grading system took into account the presence of tail movement, tail base sensation, anal tone, perineal reflex, urinary function, and bladder tone. Grade 1 and 2 injuries were considered consistent with lesions to the caudal nerve only. Grade 3 injuries were considered consistent with lesions to the caudal and pelvic nerves, whilst grade 4 and 5 injuries were considered consistent with lesions to all three nerves (caudal, pelvic and pudendal).

The degree of vertebral displacement was expressed as a relative percentage of displacement to account for differences in size between cats and magnification factors of different radiography units. Craniocaudal displacement was expressed relative to the length of the first caudal vertebra, and ventrodorsal displacement was expressed relative to the height of the vertebral canal of the more cranially located vertebra (Figure 2).

Follow-up and outcome

In agreement with previous studies [2,5], cats had to be given a minimum of 30 days to regain urinary function to be included in this study. In accordance with local ethical committee guidelines, the referring veterinary surgeons were initially contacted for a telephone interview to obtain information on each patient that had survived to be discharged from our hospital. If the cat was deceased, the date and reason for euthanasia were recorded, as well as the record of the last neurological examination and more specifically its urinary and defecatory function. The owners of these cats were not contacted further. Owners were only contacted if the cat was still alive.

Introductory letters were posted two weeks in advance of a telephone interview, explaining the aim of the study and giving clients the opportunity to opt out. A copy of the standardised telephone questionnaire was also enclosed to let clients know the questions to be answered (see Appendix 1). These questions related to their animal's tail function, urinary management and defecatory function. After two weeks, owners were contacted by telephone and asked the enclosed questions. Successful urinary outcome was defined as the ability to initiate and cease voluntarily urination. Time to urination was defined as the number of days from presentation to the date the patient first showed signs of voluntary urination. Successful faecal outcome was defined as the ability to defaecate voluntarily. Lack of defecatory function included faecal incontinence and constipation.

Statistical analysis

Statistical analysis was performed by one of the authors (EC) and data were analyzed using statistical software (SPSS; Statistical Package for the Social Sciences V.21.0.1).

D'Agostino & Pearson normality test was used to determine data distribution and decide whether parametric or non-parametric tests were appropriate. All variables except neurological grade were shown to be non-parametric. Continuous variables were represented with median and range only, whilst categorical variables were also reported in percentages. Categorical variables were cross-tabulated and comparisons were made using Chi-squared analysis and Fisher's exact tests. Comparisons between categorical and continuous variables were performed using Mann-Whitney tests for two independent groups and Kruskall-Wallis tests for five independent groups. Pairwise comparisons of neurological grades were performed using Mann-Whitney and Fisher's exact tests. Spearman correlation was also used to make comparisons between two continuous variables. A P-value of <0.05 considered statistically significant.

Results

Clinical presentation and treatment

Ninety-seven cats met the diagnostic inclusion criteria of this study. However, 27 cats were euthanised within 30 days and therefore only 70 cats were finally included. Twenty-one of these 27 cats were euthanised in the first 4 days, while the remaining 6 cats were euthanised between 9 and 18 days after making a diagnosis of sacrocaudal luxation. The group of 70 included cats consisted of 43 males (40 neutered) and 27 females (26 neutered) aged between 6 months and 9 years 1 month (median, 33 months). The domestic shorthair was the most common breed (n=41), followed by domestic longhair (n=9), and domestic semi-long hair (n=4). The remaining 16 cats represented 11 other breeds.

At presentation, 60 cats had absent tail tone and 53 cats had absent tail base sensation. Perineal reflex was absent in 20 cats and 10 cats had reduced perineal sensation. Anal tone was absent in 23 and reduced in 13 cats. Fifty-three cats were unable to urinate voluntarily, 16 of which had an increased bladder tone, and 8 had a decreased bladder tone. Twenty-nine cats were not able to defecate voluntarily; 8 cats were faecally incontinent and 21 were constipated at the time of presentation. Paraparesis was present in a further 18 cats. Six cats were diagnosed with a grade 1; 11 with a grade 2; 22 with a grade 3; 23 with a grade 4; and 8 cats were diagnosed with a grade 5 sacrocaudal luxation. One or more traumatic injuries were present in 30 cats, including pelvic fractures (n=26), sacroiliac luxation (n = 14), and other orthopaedic injuries not related to the pelvis (n=6). For 40 cats, the survey radiographs were available for review. In 29 of these 40 cats the luxation was located between the sacrum and the first coccygeal vertebra (S3-Cd1). For the remaining cats, the luxation was located between S1-S2 (n=6) or S2-S3 (n=5). The degree of craniocaudal displacement ranged from 0% to 487.2% (median 0%) and the degree of dorsoventral displacement ranged from 0% to 453.9% (median 71.14%). In cats with 0% craniocaudal or 0% dorsoventral displacement, the luxation was in a pure dorsoventral or pure craniocaudal direction, respectively. Neither craniocaudal or dorsoventral displacement were significantly associated with neurological grade (P= 0.069 and 0.82, respectively).

Tail amputation was performed in 36 cats (51%). In 2 cats, the tail was amputated due to direct damage (degloving injury) whereas amputation in the remaining 34 cats was performed between 0 and 49 days due to tail paralysis (median, 6 days). The remaining 34 cats (49%) were managed conservatively. Urinary dysfunction was managed by one or a combination of the following; manual intermittent bladder expression (n=21), intermittent catheterisation (n=18), and permanent catheterisation (n=14). Fourteen cats received medication to aid with urinary function, including diazepam (n=6), prazosin (n=3), bethanechol (n=2), a combination of diazepam and prazosin (n=2), or a combination of diazepam, prazosin and bethanechol (n=1). Faecal constipation was managed with lactulose in 20 cats, 4 of which also received intermittent enemas. One cat was treated with liquid paraffin.

Outcome

Follow-up information was obtained from the referring veterinary surgeon (n=47) or a combination of the veterinary surgeon and owner (n=23) and ranged from 30 days to 12 years 3months (median, 3 years 8 months).

Detailed information on urinary outcome was available for 61 cats, 55 of which (90%) regained the ability to urinate voluntarily. Regaining voluntary urination was significantly associated with neurological grade (P= 0.01), and faecal outcome (P <0.0001). Cats with higher neurological grades were significantly less likely to regain voluntary urination and cats that had not regained defecatory function at follow-up were more likely to also have urinary incontinence. Pairwise comparisons showed that cats with grade 5 injuries were less likely to regain urinary function than cats with grade 2 (P=0.029) or grade 3 (P=0.022) injuries. All cats (100%) with neurological grades 1 or 2, 95% of cats with neurological grade 3, 89% of cats with neurological grade 4, and 50% of cats with neurological grade 5 regained the ability to urinate. There were no significant associations between likelihood of regaining voluntary urination and age, gender, tail base sensation, anal tone, perineal sensation, faecal function at the time of presentation, degree of vertebral displacement, concurrent traumatic injuries, tail amputation and survival time (P>0.05).

The time to regain urinary function ranged from 0 to 52 days (median, 5 days), with 87% of cats that regained urinary function, doing so within the first 30 days. Thirty-three of 55 cats (60%) that regained urinary function, did so in the first week after a diagnosis of sacrocaudal luxation was made, 9 (16%) did so between the first and second week, 6 (11%) between 14 and 30 days, and 7 of the 55 cats (13%) that regained the ability to urinate did so between 31 and 52 days after a diagnosis of sacrocaudal luxation was made. Six cats (10%) did not regain voluntary urination during the study period. There was a significant association between the median number of days to regain urinary function and neurological grade (P= 0.0003). Higher neurological grades were significantly associated with longer times to recover urinary function (Figure 3). Pairwise comparisons showed that cats with grade 5 injuries (median, 33 days) took significantly longer to recover urinary control than those with grade 1 (median, 0 days), grade 2 (median, 4 days) and grade 3 (median, 2 days) injuries. Cats with grade 4 (median, 12 days) injuries took significantly longer time to recover urinary function than those with grade 1 or grade 3 injuries. Cats with grade 3 or grade 2 injuries also took significantly longer to regain urinary function than those with grade 1 injuries. Cats that were treated with medication to facilitate urination took significantly longer to recover urinary function than those that were not receiving such medication (P-value <0.0001). There were no significant associations between the time to regain voluntary urination and age, gender, tail base sensation, anal tone, perineal sensation, defecatory function at the time of presentation, degree of vertebral displacement, concurrent traumatic injuries, tail amputation, recovery of defecatory function and survival time ($P>0.05$). Of the 55 cats that regained the ability to urinate, 9 were euthanised between 10 and 164 days. In four cases, the cause of death was related to the sacrocaudal luxation; 2 cats were euthanised due to unmanageable faecal incontinence, one because of listlessness and perceived poor quality of life and one cat was euthanised because of repeated self-trauma to the tail stump after tail amputation.

Information on defecatory function was available for 53 cats. Twelve cats were incontinent, 19 were constipated and 25 had normal faecal control at diagnosis. Three cats remained incontinent and 13 were constipated at follow-up. Five cats that had been incontinent and 10 that were constipated had regained normal faecal control at follow up. Regaining the ability to defaecate normally was significantly associated with survival time ($P= 0.033$). Patients that regained the ability to defaecate voluntarily had a longer survival time than patients that did not have voluntary control over defaecation. No other variables were associated with the likelihood or duration of regaining defecatory function (P>0.05)

Seventeen of the 34 cats (50%) that were managed medically, regained, according to the owners, normal tail motility.

Discussion

This study evaluated the likelihood and prognostic factors for recovery of urinary and defecatory function in cats with sacrocaudal luxation. The results of this study confirm, in agreement with previous studies [2,5], that severity of clinical signs should be considered the most reliable factor to predict the likelihood of regaining voluntary urinary control in cats with sacrocaudal luxation. Cats with milder neurological grades were very likely to regain urinary function, while only half of cats with the most severe neurological grade regained urinary continence. Cats with more severe neurological grades also needed longer time to regain voluntary urinary function.

In this study, we used a grading system adapted from two previous studies. [2,5] Hatton et al. demonstrated that presence of tail base sensation is a reliable predictor of urinary control in cats with sacrocaudal luxation.[2] Although this is an easy to use and objective clinical variable, it remained difficult to predict recovery of urination despite loss of tail base sensation.[2] We therefore included tail base sensation in our grading system but felt the need to also include more clinical variables. Although Smeak and Olmstead [5] included several clinical variables in their grading system, their system can be considered more complex and difficult to use in general practice.[2] We therefore used a grading system that incorporated several objective clinical variables that are easy to use, such as tail base sensation, anal tone, perianal reflex, and bladder tone. Although the likelihood and duration to regain voluntary urination were negatively associated with higher neurological grades, half of cats with the most severe grade still regained the ability to urinate. Our results therefore do not answer all questions and this study is therefore only partially successful in its aim of developing prognostic variables for cats with sacrocaudal luxation. Although our results identified a combination of 'positive' neurological examination findings that can be used to predict recovery of urination, it remains difficult to identify those cats that are unlikely to recover urinary function at all. This is especially important because, in agreement with previous findings [5,7], a large number of cats with sacrocaudal luxation had concurrent pelvic trauma. Veterinary surgeons and owners are currently faced with the difficulty of selecting appropriate treatment options for variable degrees of pelvic trauma, while being uncertain if the animal will regain urinary function.

It has previously been suggested that loss of faecal control should not be considered a common long-term problem in cats with sacrocaudal luxation.[5] Despite appropriate and prompt treatment, only half of cats in this study that presented with loss of defecatory function regained the ability to defaecate voluntarily. Furthermore, loss of defecatory control was associated with a shorter survival time. This finding can potentially be explained by the challenges associated with caring for a pet with faecal incontinence. These observations suggest that permanent loss of defecatory control might occur more commonly than previously considered and can probably be considered an important prognostic factor. It can therefore be considered to include defecatory function in future grading systems for cats with sacrocaudal luxations.

Duration to regain urinary function was further negatively associated with the use of medication to facilitate urination. This finding should be interpreted with caution and can likely be explained by the retrospective nature of this study. Included cats did not receive standardised treatments and the decision to add medication in an individual animal was based on a combination of neurological status and clinician's preference. It is therefore likely that mainly cats with severe neurological injuries received additional medication to facilitate urination.

There is some debate about the most appropriate treatment option for cats with sacrocaudal luxation.[2,3,4,9] Early tail amputation has been recommended to relieve ongoing neuronal traction caused by a combination of persistent motion at the fracture site and the 'hanging weight' of the paralysed and atonic tail.[3] However, it has been shown that it can take several months for tail movement to return[5] and it has therefore also been suggested to wait four to six weeks before reassessing tail function.[14] Although cats can have a good quality of life after tail amputation, a normally functioning tail has several functions, including maintaining balance and social interaction.[15] In this study, tail amputation was not associated with a higher likelihood or duration of regaining urinary function. The results of this study do therefore not support the practice of early tail amputation as treatment for cats with sacrocaudal luxation. Although primary internal tail stabilisation has been suggested as a treatment option which combines reducing instability, minimising ongoing neuronal traction, and sparing the tail [9,16], it remains unclear if this treatment option results in better outcomes than medical management or tail amputation. Half of owners in this study reported return of normal tail function. This outcome variable was however not thoroughly evaluated in this study and it remains therefore necessary to evaluate the likelihood and timeframe of returning tail function in future studies.

It is currently unclear in which timeframe cats with sacrocaudal luxation are expected to regain urinary function. One study suggested a 30-day time period in which cats were seen to regain urinary control. After this period, recovery of urination function was no longer seen.[5] Another study suggested that cats typically regain urinary control in the first week after onset of clinical signs.[2] In agreement with these findings, most cats that regained urinary control in our study did so in the first two weeks after a diagnosis of sacrocaudal luxation was made. Although almost 90% of cats that regained urinary function did so in the first 30 days, more than 10% did so in a period between 31 and 52 days after a diagnosis of sacrocaudal luxation was made. One possible reason for this delayed recovery of urination is that we, in contrast to one previous study[2], also included cats with concurrent traumatic injuries. It can be hypothesised that concurrent traumatic injuries, such as pelvic fractures could complicate assuming a normal urinating posture, thereby delaying the recovery time of cats with sacrocaudal luxation and concurrent traumatic injuries. We however decided to include cats with concurrent traumatic injuries, because it was assumed this would best reflect the presentation of cats with sacrocaudal luxation seen in veterinary practice. In agreement with a previous study[5], the majority of cats with sacrocaudal luxation had indeed concurrent pelvic trauma. The presence of such injuries was however not significantly associated with the likelihood and duration of recovery of urinary function.

In agreement with previous studies [2,5], only cats that were available for a minimum follow-up period of 30 days were included in this study. More than 25% of cats initially diagnosed with sacrocaudal luxation were however euthanised in this period and could therefore not be included. Although this could have potentially biased the results of our study towards inclusion of animals with an intrinsically better prognosis, the majority of these cats was euthanised in the first 4 days after presentation. It is therefore fair to assume that these cats did not necessarily receive enough opportunity to demonstrate a positive outcome. Although the exact reason for euthanasia could not be identified for most cases, this finding illustrates the importance of identifying reliable prognostic parameters in cats with sacrocaudal luxation. This will not only facilitate management of owner's expectations; it might also improve clinical decision making in cats with concurrent traumatic injuries.

This study is further limited by its retrospective nature. Cats did not receive standardised treatment protocols and treatment decisions were influenced by neurological status and clinician's preference. It therefore remains difficult to reliably compare results of different treatment options. The retrospective nature of this study did further not allow reliable assessment of all outcome variables, such as the likelihood and duration of recovery of tail function.

Conclusions

Although this study confirms that severity of neurological signs is the most reliable prognostic indicator in cats with sacrocaudal luxations, it remains difficult to accurately distinguish between cats that will regain urinary function and those that will not. The results of this study further suggest that cats with more severe neurological grades will need longer time to regain urinary function and that loss of defecatory function is a more common and more important problem than previously assumed. Further, ideally prospective, studies are therefore necessary to evaluate prognostic factors in cats with sacrocaudal luxations. More specifically, further studies should aim to identify cats that are unlikely to recover urination, compare the effects of different treatment modalities, and evaluate the likelihood, degree and duration of recovery of tail function in cats with sacrocaudal luxation.

Acknowledgements

None.

Conflict of Interest

The authors do not have any potential conflicts of interest to declare.

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Ethical Approval

This work involved the use of non-experimental animal(s) only (owned or unowned), and followed established internationally recognised high standards ('best practice') of individual veterinary clinical patient care. This study was approved by the ethics and welfare committee of the Royal Veterinary College (SR2018-1663).

Informed consent

Informed consent (either verbal or written) was obtained from the owner or legal custodian of all animal(s) described in this work for the procedure(s) undertaken.

Informed consent for publication

No animals or humans are identifiable within this publication, and therefore additional Informed Consent for publication was not required.

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Figure legends:

Figure 1: Flow-chart demonstrating neurological grading in cats with sacrocaudal luxation

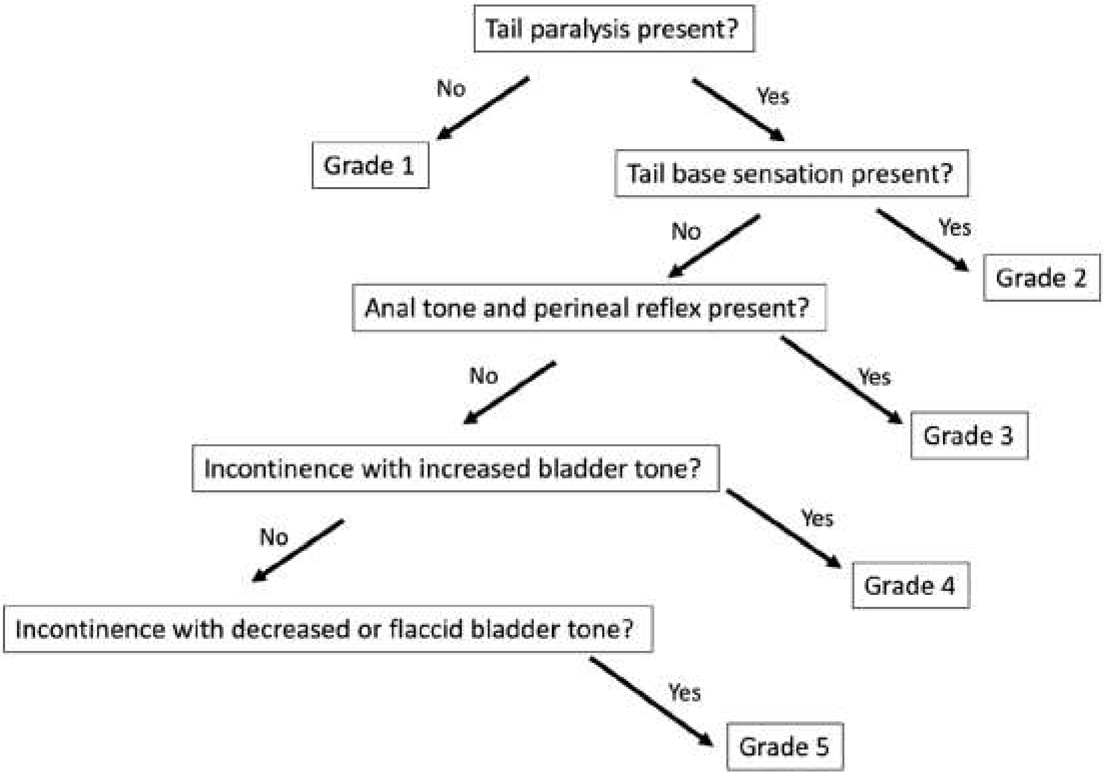

Figure 2: The degree of vertebral displacement was expressed as a radiographic ratio to account for differences in cat size and magnification factors. (A) Craniocaudal displacement was calculated by dividing the length of the gap between both luxated vertebrae (A) by the length of the first caudal vertebra (B). A value >1 represents more than 100% displacement relative to the length of the first caudal vertebra. (B), Ventrodorsal displacement was calculated by dividing the distance between the dorsal margin of both luxated vertebrae (A) by the height of the vertebral canal of the more cranial vertebra (B). A value >1 represent more than 100% displacement relative to the more cranial vertebra.

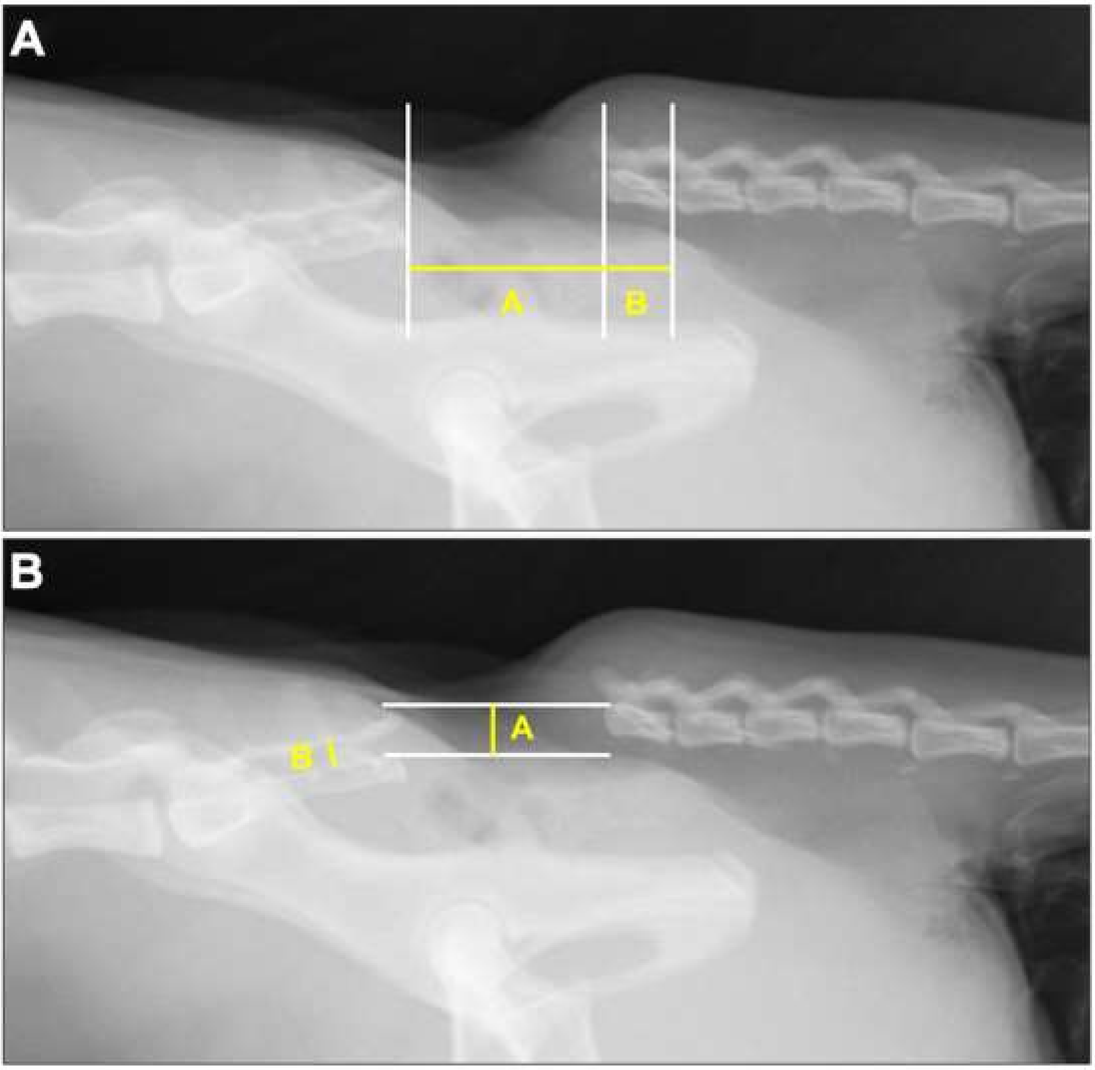

Figure 3. Scatter plot illustrating the association between neurological grade and duration to regain urinary function in cats with sacrocaudal luxation.