

Effect of Medetomidine Administration on Vertebral Heart Score in Scottish Fold Cats

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Abstract

This study aimed to evaluate the impact of medetomidine on the vertebral heart score (VHS) in Scottish Fold cats. The VHS method, commonly used in veterinary practice, provides a reliable means to assess cardiac size via radiographic imaging. Understanding the effects of sedative drugs on such measurements is essential, particularly in clinical settings involving animals with potential cardiac concerns. A total of 20 Scottish Fold cats, aged between 8 and 48 months and weighing 2.8-5.9 kg, were included in the study. Sedation was induced using an intramuscular injection of medetomidine (80 µg/kg), and radiographic images were obtained at five time points: pre-sedation (T₀) and at 5, 10, 30, and 45 minutes post-administration (T₁-T₄). The VHS was evaluated from left laterolateral (LL) and ventrodorsal (VD) X-rays, and statistical comparisons were performed between these intervals. There was a statistically significant increase in VHS between the pre-sedation (T₀) and 45-minute (T₄) measurements (P<0.05). However, no significant difference was observed at earlier time points (T₁, T₂, and T₃). Additionally, while the cardiac short axis (CSA) showed a slight increase in size post-sedation (P=0.06), the cardiac long axis (CLA) remained unchanged (P=0.40). Medetomidine increased VHS in both LL and VD radiographs, particularly by the 45th minute post-administration. As this alteration impacts both cardiological evaluation and anesthesia safety, reporting these findings is critical for optimizing clinical decision-making. Given the potential for an altered cardiac silhouette, caution is advised when administering medetomidine in Scottish Fold cats with pre-existing heart conditions, as these changes may interfere with clinical assessments of cardiac health.

Key Words: Cardiac size, medetomidine, radiography, Scottish Fold cats, vertebral heart score

Scottish Fold Kedilerinde Medetomidin Uygulamasının Vertebral Kalp Skoruna Etkisi

Öz

Bu çalışma, medetomidinin Scottish Fold kedilerinde vertebral kalp skoru (VHS) üzerindeki etkisini değerlendirmeyi amaçlamıştır. VHS yöntemi, veteriner hekimlikte yaygın olarak kullanılan ve radyografik görüntüleme yoluyla kalp büyüklüğünü güvenilir bir şekilde değerlendiren bir yöntemidir. Sedatif ilaçların bu tür ölçümler üzerindeki etkilerini anlamak özellikle kardiyak sorunları olan hayvanlar için önemlidir. Çalışmaya, 8 ile 48 ay arasında ve 2.8-5.9 kg ağırlığında 20 Scottish Fold kedisi dahil edilmiştir. Sedasyon, kedilere intramüsküler olarak 80 µg/kg dozunda medetomidin enjeksiyonu ile sağlanmıştır ve radyografik görüntüler sedasyon öncesinde (T₀) ve sedasyon sonrası 5, 10, 30 ve 45 dakikalarda (T₁-T₄) elde edilmiştir. VHS, sol laterolateral (LL) ve ventrodorsal (VD) radyografilerden değerlendirilmiş ve bu zaman dilimleri arasında istatistiksel karşılaştırmalar yapılmıştır. Sedasyon öncesi (T₀) ile 45. dakika (T₄) arasındaki VHS'de istatistiksel olarak anlamlı bir artış gözlenmiştir (P<0.05). Ancak, daha erken zaman noktalarında (T₁, T₂ ve T₃) anlamlı bir fark bulunmamıştır. Ayrıca, sedasyon sonrası kalp kısa eksen (CSA) boyutunda hafif bir artış gözlenmiş (P=0.06), ancak kalp uzun eksen (CLA) değişmemiştir (P=0.40). Medetomidin, hem LL hem de VD radyografilerinde VHS artışına neden olmuş, özellikle sedasyondan 45 dakika sonra belirgin hale gelmiştir. Bu değişiklik hem kardiyolojik değerlendirmeyi hem de anestezi güvenliğini etkilediğinden, bu bulguların rapor edilmesi klinik karar alma süreçlerini iyileştirmek açısından kritik öneme sahiptir. Kalp silüetindeki bu değişiklikler göz önünde bulundurulduğunda, medetomidinin klinik kardiyak değerlendirmeleri etkileyebileceği ve mevcut kalp rahatsızlıkları olan Scottish Fold kedilerine uygulanırken dikkatli olunması önerilmektedir.

Anahtar Kelimeler: Kalp büyüklüğü, medetomidin, radyografi, Scottish Fold kedileri, vertebral kalp skoru

INTRODUCTION

Vertebral heart score (VHS) or vertebral heart size is a method used to assess cardiac size in thoracic radiographs and was first applied to cats by Lister and Buchanan (1). This technique involves measuring the long and short axes of the heart on thoracic radiographs, which are then compared to thoracic vertebrae to calculate a numerical score. The measurements are typically taken using a digital caliper or computer-based imaging software, with the length of the heart's long and short axes being compared to the vertebral bodies starting from the fourth thoracic vertebra. This measurement provides veterinarians with an estimate of heart size and is an essential tool for evaluating cardiac enlargement in animals (2-4).

Knowing the reference VHS values is crucial for veterinarians to assess potential heart enlargement. Although there are slight variations between VHS values obtained from dorsoventral (DV) and ventrodorsal (VD) thoracic radiographs in cats, the lateral thoracic radiograph is generally considered the most reliable method for VHS assessment. VHS is an important diagnostic tool in veterinary cardiology because it is easy to apply, requires no advanced equipment, and can be interpreted by clinicians to make informed decisions regarding a patient's cardiac health (1,5).

Preanesthesia, or premedication, is a preparatory stage aimed at minimizing stress in animals, facilitating the transition to anesthesia, and reducing the required dosage of anesthetic agents. This also increases the safety and consistency of the anesthesia process (6). Sedation, involving the use of sedative drugs to calm the animal, is an essential part of premedication. These approaches help to reduce stress and make the anesthesia process more comfortable and safer for the animal (6,7).

Medetomidine, an α_2 -adrenoreceptor agonist, is commonly used in cats and dogs for sedation, muscle relaxation, calm awakening, and analgesia. It can be used alone or in combination with opioids for minor surgical interventions or premedication. Medetomidine has a depressant effect on the cardiovascular system, causing hypertension followed by bradycardia and hypotension. However, bradycardia is less commonly observed in cats. Cyanosis, dysrhythmia, and bradycardia caused by medetomidine can be reversed with an α_2 -antagonist called atipamezole (6,8).

The objective of this study was to assess the effects of medetomidine on VHS and cardiac dimensions in Scottish Fold cats, a popular breed in veterinary practice. By investigating these parameters, this study seeks to provide insight into the radiographic changes induced by medetomidine, particularly its

potential to alter heart size measurements, which are vital for evaluating cardiac health in clinical settings.

MATERIAL AND METHODS

The study was conducted following the principles of animal welfare and ethics. Informed consent was obtained from the owners of all cats included in the study.

A total of 20 Scottish Fold cats (12 females and 8 males), aged between 8 and 48 months and weighing 2.8 to 5.9 kg, were selected for this study. Inclusion criteria required that all cats presented normal findings on physical examination, complete blood cell counts, and serum biochemistry analyses. To reduce the risk of aspiration from medetomidine-induced vomiting, the cats were fasted for 8 hours prior to the procedure, with water being withheld for 2 hours before sedation. The intramuscular dose of medetomidine (Domitor; Zoetis, Espoo, Finland) was calculated based on body weight, with 80 $\mu\text{g}/\text{kg}$ being administered. Doses were carefully measured using 1 ml single-use syringes (Genject; Ankara, Turkey).

After sedation, heart rate, body temperature, and respiratory rate were continuously monitored using a veterinary bedside monitor (Hasvet 838 PM), with probes attached to the tongue and rectum. Monitoring continued until the sedation was reversed. At the conclusion of the experiment, atipamezole (Antisedan; Zoetis, Espoo, Finland) was administered intramuscularly at a dose of 200 $\mu\text{g}/\text{kg}$ to counteract the sedation.

Radiographs were obtained immediately before sedation (T_0) and at 5 minutes (T_1), 10 minutes (T_2), 30 minutes (T_3), and 45 minutes (T_4) following medetomidine administration. For each time point, left laterolateral (LL) and ventrodorsal (VD) radiographs were taken using a C-arm fluoroscope (Trophy Radiologie France, Vincennes, CEDEX). For LL radiographs, settings were adjusted to 65 kV and 8 mAs, while VD radiographs were taken with settings at 63 kV and 8 mAs. The radiographs were automatically transferred to a computer-based radiography system (Fujifilm FCR Prima T2), where the VHS and cardiac axis dimensions (short and long axes) were measured. VHS was calculated by measuring the heart's short and long axes and comparing these values to the length of the thoracic vertebrae, starting from the fourth vertebra caudally. The sum of these vertebral lengths provides the VHS score. Both the LL and VD radiographs were analyzed for VHS and cardiac short/long axis measurements (Figure 1).

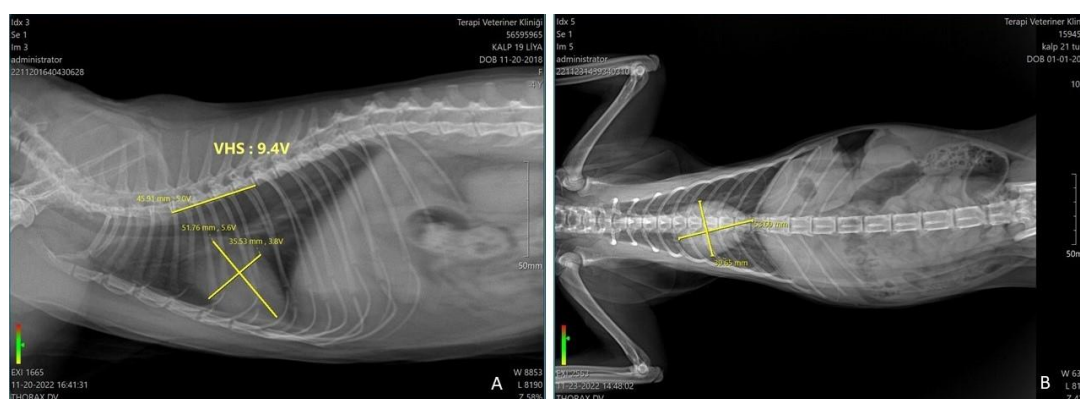


Figure 1. Measurement of Vertebral Heart Score (A) and Cardiac long and short axis (B) in a Scottish Fold cat

Statistical Analysis

All data were analyzed using commercial statistical software (MedCalc version 20.011, MedCalc Software, Ostend, Belgium). The normality of the data distribution was assessed using the Shapiro-Wilk test. Changes in VHS scores over time were analyzed using repeated measures analysis of variance (ANOVA). When the assumption of sphericity was violated, Greenhouse-Geisser or Huynh-Feldt corrections were applied. Paired sample t-tests were used to compare cardiac short axis (CSA) and cardiac long axis (CLA) measurements before (T_0) and after (T_4) sedation. All results are presented as mean \pm standard deviation, and $P < 0.05$ was considered statistically significant.

RESULTS

All 20 Scottish Fold cats successfully completed the study without any significant complications during the sedation

procedure or radiographic assessments. The average age of the cats was 22.2 ± 14.2 months, and their average body weight was 3.6 ± 0.9 kg. During the sedation process, 3 cats experienced vomiting, which resolved without further intervention. Five cats required repeated radiographic imaging due to movement during the initial attempts. All animals recovered fully after the administration of the reversal agent, atipamezole.

The mean VHS values obtained at each time point are summarized in Table 1. Statistical analysis revealed a significant increase in VHS between the pre-sedation (T_0) measurement and the 45-minute post-sedation (T_4) measurement ($P < 0.05$). However, no significant differences were observed between T_0 and the earlier time points (T_1 , T_2 , and T_3). While the VHS value increased slightly over time, only the T_0 to T_4 difference reached statistical significance, indicating that medetomidine caused a measurable change in heart size at the 45-minute mark (Table 2).

Table 1. Vertebral Heart Score measurement at different time points in Scottish Fold cats

n	Gender	Age (month)	Weight (kg)	Time-points				
				T_0	T_1	T_2	T_3	T_4
1	Female	23	3.6	9.5	9.5	9.6	9.6	9.6
2	Female	12	2.9	9.7	9.7	9.7	9.7	9.8
3	Male	27	5.9	9	9	9	9	9
4	Female	12	3.2	9.8	9.8	9.8	9.8	9.9
5	Male	9	3.1	9.3	9.3	9.3	9.3	9.3
6	Female	11	3	10.1	10.2	10.2	10.3	10.3
7	Female	38	3.5	9.9	9.9	10	10	10
8	Female	26	2.9	10.1	10.1	10.2	10.3	10.3
9	Male	14	3.2	10.4	10.4	10.4	10.4	10.4
10	Male	48	4.1	9.1	9	9	9	9
11	Female	8	3	9.4	9.4	9.4	9.4	9.4
12	Female	48	3.1	8.2	8.2	8.2	8.2	8.2
13	Male	10	3.4	9.6	9.6	9.6	9.6	9.6
14	Female	8	2.8	8.7	8.6	8.7	8.6	8.6
15	Male	10	3	8.1	8.1	8.1	8.1	8.1
16	Female	16	3.1	9.5	9.5	9.6	9.6	9.6
17	Male	22	5.4	9.5	9.5	9.5	9.6	9.6
18	Male	18	4.6	9.5	9.5	9.5	9.5	9.5
19	Female	48	3.7	9.4	9.4	9.5	9.4	9.4
20	Female	36	4.8	9.1	9.1	9.1	9.1	9.1
Mean \pm SD		22.2 \pm 14.1	3.6 \pm 0.9	9.39\pm0.6	9.39\pm0.6	9.42\pm0.61	9.43\pm0.63	9.44\pm0.64*

*Significant difference from T_0 ($P < 0.05$). Data expressed mean + standard deviation (SD).

Table 2. Cardiac short and long axis measurement at two different time point in Scottish Fold cats

Measurement	Time-points		P-value
	T_0	T_4	
Cardiac short axis	37.3 \pm 3.2	37.7 \pm 3.2	0.06
Cardiac long axis	56.6 \pm 4.6	56.9 \pm 5.0	0.40

*Significant difference from T_0 ($P < 0.05$). Data expressed mean + standard deviation (SD).

In addition to LL radiographs, VD radiographs were obtained at T_0 and T_4 to evaluate the changes in CSA and CLA. The results are shown in Table 2. Although the CSA showed a slight increase at T_4 compared to T_0 , this change was not statistically significant ($P = 0.06$). Likewise, no significant difference was found in the CLA measurements between T_0 and T_4 ($P = 0.40$).

Further analysis was conducted to assess whether there were significant differences in VHS measurements between male and female cats. No statistically significant difference was found between the VHS measurements of male cats (9.6 ± 0.7) and female cats (9.5 ± 0.6) at any time point ($P > 0.05$).

DISCUSSION AND CONCLUSION

This study aimed to evaluate the effect of medetomidine on the VHS and cardiac dimensions in Scottish Fold cats. Our findings indicate that medetomidine significantly increased VHS over a 45-minute period, particularly in LL radiographs, while its impact on the CSA and CLA in VD radiographs was less pronounced. These results are consistent with previous studies highlighting the cardiovascular effects of α_2 -adrenergic agonists, particularly their ability to alter heart size due to peripheral vasoconstriction and bradycardia (7,9).

Medetomidine is known to cause significant cardiovascular effects, including bradycardia, peripheral vasoconstriction, and changes in cardiac output. These effects are mediated by its action on central and peripheral α_2 -adrenoceptors, which reduce sympathetic outflow and increase systemic vascular resistance. The significant increase in VHS observed between the baseline (T_0) and 45 minutes post-administration (T_4) in this study suggests that medetomidine induces changes in cardiac morphology that may be linked to these physiological response (6,10).

The increase in VHS observed in this study is in line with findings from previous studies that reported increases in cardiac size following administration of α_2 -agonists such as medetomidine. This increase may be attributed to the drug's ability to prolong the diastolic filling phase due to bradycardia, thus increasing the volume of the heart visible on radiographs (9,11). Although the differences observed at earlier time points (T_1 , T_2 , and T_3) were not statistically significant, the 45-minute interval (T_4) provided enough time for the physiological effects of medetomidine to manifest fully, leading to the observed VHS increase (11).

Although a slight increase in CSA was observed between T_0 and T_4 in VD radiographs, this change did not reach statistical significance. Similarly, the CLA measurements remained unchanged throughout the study period. This suggests that while medetomidine may have a more noticeable impact on VHS in LL views, its effects on other cardiac dimensions, particularly in VD views, are less pronounced. This discrepancy may be due to the inherent differences between LL and VD radiographic projections. LL projections are typically more sensitive to changes in the cardiac silhouette, while VD views often overlap with other thoracic structures, making it harder to discern subtle cardiac changes (12,13).

The findings of this study have important clinical implications, especially in cases where medetomidine is used as a sedative in animals with suspected or confirmed cardiac disease. The increase in VHS observed following medetomidine administration suggests that the drug may artificially enlarge the heart silhouette in radiographs, potentially leading to a misdiagnosis of cardiomegaly or other cardiac abnormalities. For this reason, it is essential that veterinarians exercise caution when interpreting radiographs taken from sedated animals, particularly those with pre-existing cardiac conditions. In clinical practice, medetomidine is commonly used for its sedative and analgesic properties, often in combination with other drugs such as opioids. However, as this study demonstrates, its use can significantly impact radiographic findings, particularly those related to heart size. Clinicians should be aware of these potential changes and consider alternative sedatives when evaluating animals with known cardiovascular issues.

The results of this study align with previous research that has reported medetomidine impact on the cardiovascular system. Studies in dogs have shown similar increases in VHS following administration of dexmedetomidine, another α_2 -adrenergic agonist, further supporting the hypothesis that this class of drugs induces measurable changes in cardiac morphology (11). In one such study, dexmedetomidine administration was associated with significant increases in heart size as seen on radiographs, leading to the recommendation that this drug should be used with caution in cats undergoing cardiac evaluation (9).

Additionally, research on the effects of α_2 -agonists on cardiac output has consistently demonstrated their ability to reduce cardiac output by as much as 50%, a factor that may contribute to the changes in heart size observed in this study. Although the reduction in output is often accompanied by increases in systemic vascular resistance and blood pressure, these effects are transient and tend to normalize over time (14-15). The timing of radiographs, therefore, plays a critical role in capturing the full extent of these cardiovascular changes, which is reflected in the significant changes observed at T_4 but not at earlier time points (16).

Given that medetomidine is widely used for sedation in veterinary practice, it is critical for clinicians to be aware of its potential to alter heart size measurements in radiographs. These changes may lead to misinterpretation of radiographic findings, especially in cases where cardiomegaly or other heart conditions are suspected. For this reason, caution is advised when using medetomidine in animals undergoing cardiac evaluations, particularly those with pre-existing heart disease. Future studies should investigate the effects of medetomidine on animals with cardiovascular conditions and compare its effects to other commonly used sedatives. This would provide further insights into how different sedatives affect radiographic assessments and contribute to more accurate diagnoses in clinical practice.

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CONFLICT OF INTEREST

There is no conflict of interest to be declared by the authors

AUTHOR CONTRIBUTIONS

İÇ and SO took part in the study planning, sample collection, the writing of the study and final check.

ETHICAL STATEMENT

The study was approved by the Atatürk University Animal Experiments Local Ethics Committee (HAYDEK) on August 18, 2022, with approval number 171.

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