

C. Rusbridge^{1,2} J. R. Rusbridge³

¹ School of Veterinary Medicine, University of Surrey, Guildford, UK C.Rusbridge@surrey.ac.uk @neurovet_clare

² Fitzpatrick Referrals, Easing, UK. (Wear Referrals, County Durham from April 2022)

³ St Johns College, University of Cambridge, Cambridge, UK

Introduction

- Chiari-like malformation (CM) is a developmental condition, characterised by a conformational change and overcrowding of the brain and spinal cord with obstruction of CSF channels. CM frequently results in pain (CM-associated pain; CM-P) and fluid cavitation of the spinal cord (syringomyelia; SM).
- Nasal septum deviation (NSD), in which the nasal septum is displaced to one side, reduces the size of one nasal air passage. If severe or combined with other features such as hypertrophic and aberrant nasal turbinates then obstructive airway syndrome may result (**Figure 1**).
- NSD, CM, CM-P and SM are common in flat-faced brachycephalic dogs. NSD may be clinically irrelevant¹ but has been associated with sleep disordered breathing (SDB) in dogs² and humans.³
- SDB affects glymphatic drainage of cerebrospinal fluid which could predispose CM-P and SM.⁴ In a previous publication - 3 of 5 SDB affected cavalier King Charles spaniels (CKCS) with NSD had confirmed or suspected SM.²
- SDB is a serious welfare concern especially if in conjunction with other comorbidities which cause pain and sleep disturbance
- This study investigated correlation between presence and extent of NSD and CM and SM.



Figure 1. Dorsal CT (bone windows) of the nasal cavity from a Griffon Bruxellois which presented with seizures associated with sleep apnoea, due to a brachycephalic flat-faced conformation. The deviation of the nasal septum is so extreme that it extends to the wall of the left nasal cavity (arrow). Airflow through the left nasal chamber is obstructed by the NSD and turbinates

Hypothesis

- Brachycephalic dogs with clinically relevant Chiari-like malformation and syringomyelia more likely to have nasal septum deviation compared to normal dogs.
- Dogs with CM-P and SM have more severe NSD than dogs of the same breed without CM-P and SM.

Methods

Study population - 76 dogs with head CT (Ethics Approval: NASPA-1819-10) and known CMSM status (based on MRI and medical history). Comprising 53 CKCS (7 CM-N i.e. MRI determined breed-associated CM but clinically normal; 14 with CM-P but no SM; 32 with SM); 12 Chihuahua (5 MRI and clinically normal, 7 with SM); 11 other brachycephalic toy dog breeds and crosses (10 with SM). Transverse CT of the nasal cavity in bone windows was reviewed. Presence of NSD was recorded. A previously described¹ method of determining the NSD angle was attempted but was not reproducible and was abandoned. A new method - the NSD ratio was calculated (maximum distance of NSD from midline divided by distance from midline to nasal cavity wall (**Figure 2**)).

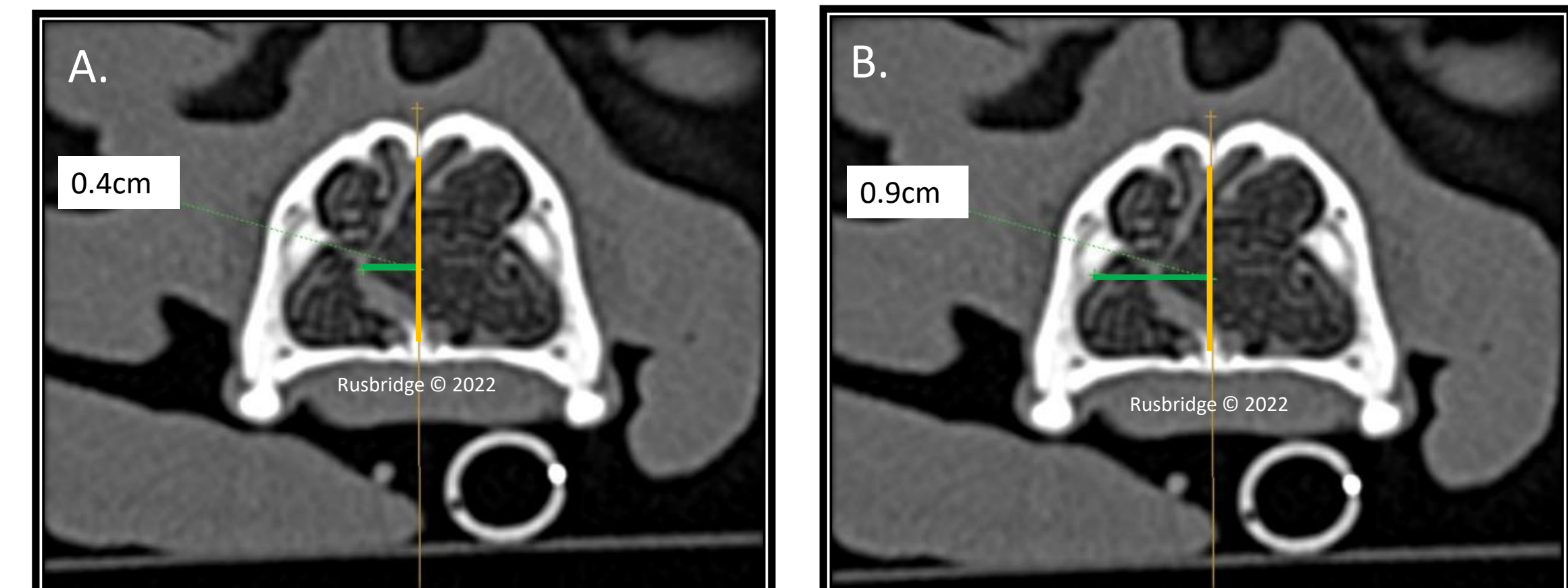


Figure 2. Method of determining NSD ratio. **A.** The transverse slice with maximum NSD is identified in DICOM viewing software EFILM™. A vertical line (orange) marking midline is placed. The distance from midline to the maximum extent of the NSD is measured (green) **B.** The distance from midline to the wall of the nasal cavity is measured (green). NSD ratio is the maximum distance of NSD from midline divided by distance from midline to nasal cavity wall. Animals with no septal deviation have a value of 0 and animals with a completely deviated septum have a value of 1.

Data analysis included descriptive statistics. For the CKCS, One-Way ANOVA compared the CM-N, CM-Pain and SM groups. A Tukey test was used post-hoc to examine pair-wise group comparisons. For Chihuahua, a Welch's t-test was used to compare normal and SM affected groups. Statistical comparison between the "other breed" group (comprising 4 Pomeranian, 3 Griffon Bruxellois, 1 Pug, 1 Affenpinscher, 1 Cavapoo and 1 Chihuahua x Pug) was not possible because of low numbers.

Results

- The 1st hypothesis was not proved. NSD was almost ubiquitous in the study population; Only 3 of 63 dogs had a midline nasal septum and symmetrical nasal cavities (1 Chihuahua, 1 CKCS, 1 Cavapoo; all SM affected).
- The nasal deviation was often "S" shaped in a dorsal plane (**Figure 3**) as if the septum was "predetermined" to be longer but must conform to a shorter space.

Results

- The 2nd hypothesis was not proven. There was no correlation between NSD ratio and CM-P or SM.
- One-Way ANOVA for CKCS groups $p = 0.469$.
- Tukey multiple comparisons of mean (95% confidence) did not find a significant difference between CKCS groups.

Comparison	p value
CM-N versus CM-P	0.625
CM-N versus SM	0.435
CM-P versus SM	0.960

- Welch's t-test for Chihuahua groups $p = 0.555$
- Study was limited by being underpowered

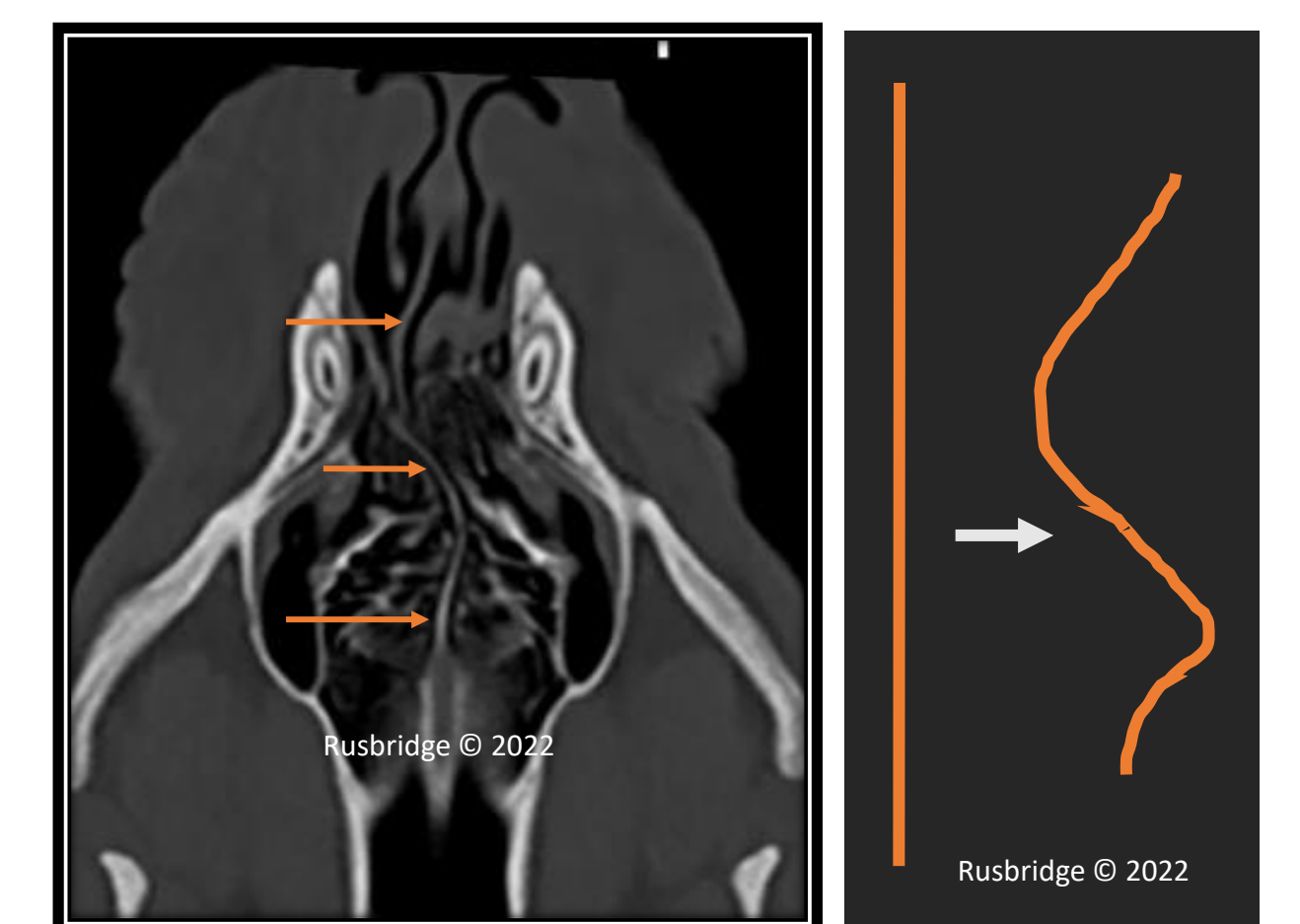


Figure 4. Typical "S" shaped NSD (arrows) with appearance of a longer septum "folded" into a shorter space

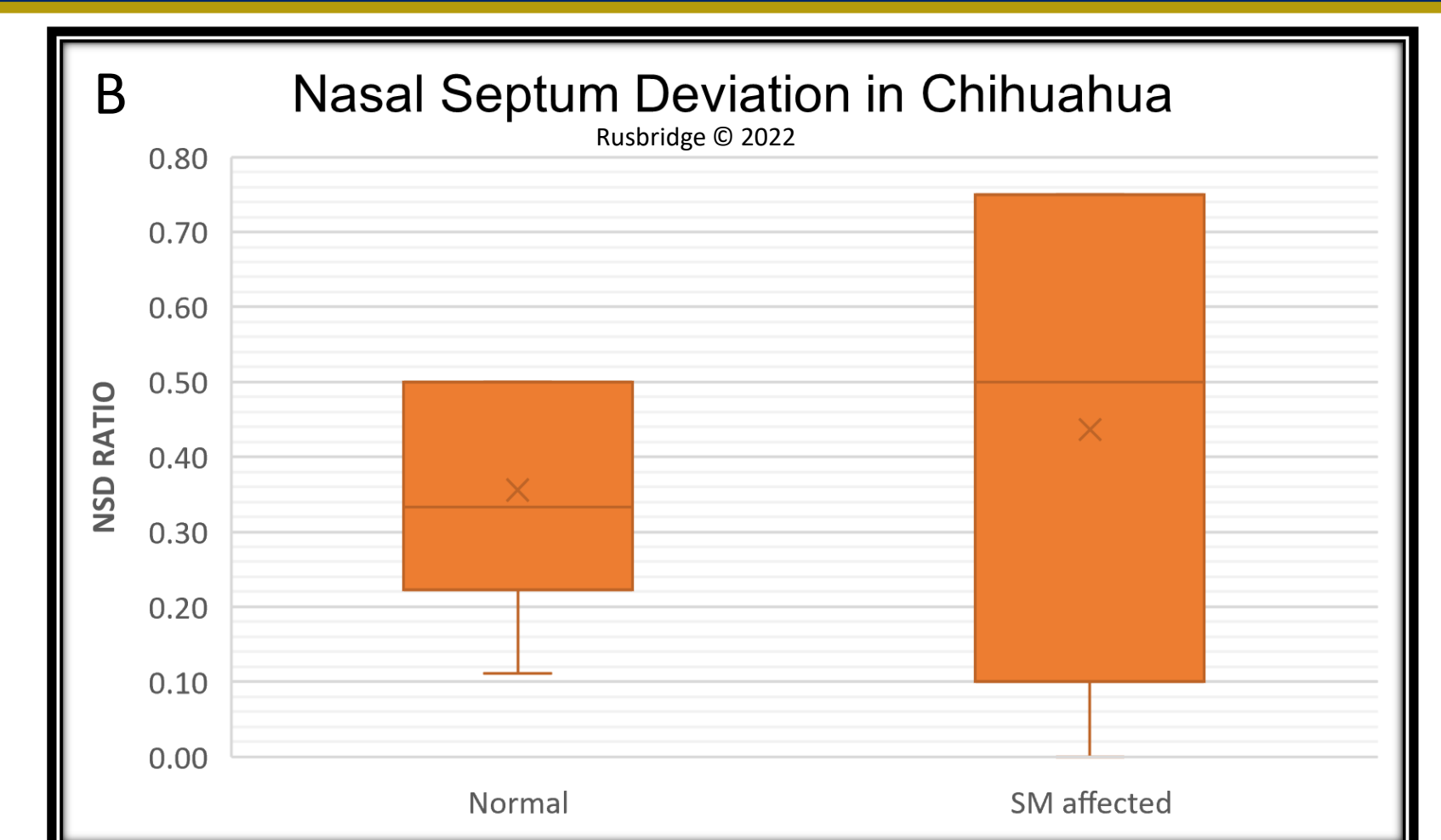
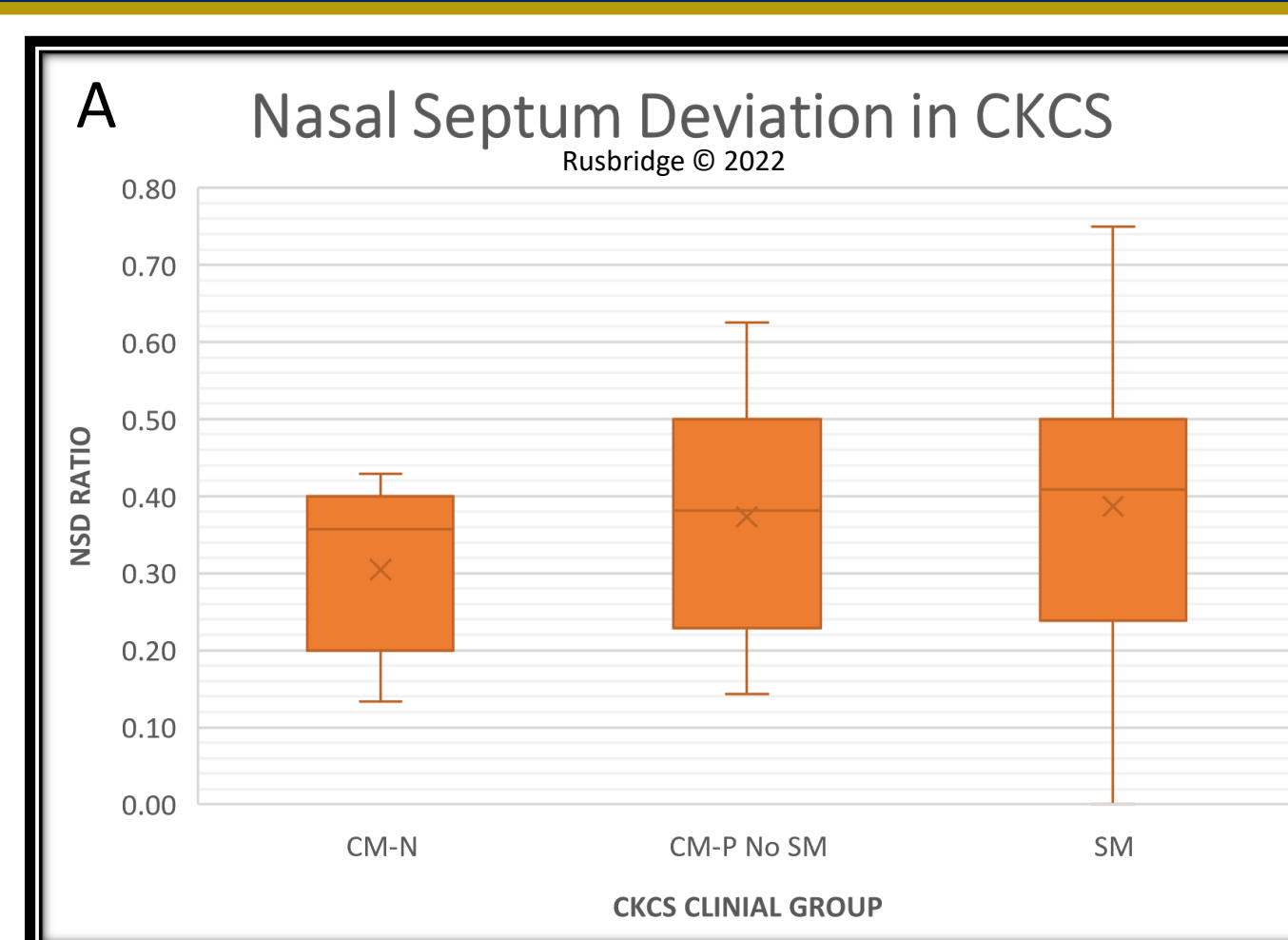


Figure 5. Nasal Septum Deviation (NSD) in **A.** cavalier King Charles spaniels and **B.** Chihuahuas. The line indicates the median NSD ratio and box defines the interquartile range; the cross marks mean NSD ratio. There is a trend towards increasing NSD ratio with increasing CMSM spectrum severity but no significant difference between the groups. CKCS – cavalier King Charles Spaniels; CM-N – CKCS with (ubiquitous) breed associated Chiari-like malformation (CM) and clinically normal; CM-P CKCS with CM associated pain but no syringomyelia ; SM syringomyelia.

Impact

- NSD is common in dog breeds predisposed to CMSM. Care should be taken before attributing clinical relevance.
- Association of NSD to CMSM is unproven. More extreme brachycephaly is associated with both NSD, CM-P and SM and therefore the conditions may co-exist.
- Airway obstruction, SDB and apnoea may be relevant in the pathogenesis of CMSM or be a important comorbidity. More sophisticated methods of investigation are recommended for example polysomnography to monitor respiratory effort.

Acknowledgements

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