

ORIGINAL ARTICLE



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Evaluation of the health-related quality of life in dogs following intracranial meningioma resection using a specifically developed questionnaire

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Abstract

As advanced treatments are becoming increasingly feasible in veterinary medicine, the evaluation of the health-related quality of life (HRQOL) of treated animals is becoming more relevant. We evaluated owner-perceived HRQOL of 10 dogs that underwent craniotomy for meningioma resection between 2002 and 2022 at our institution through telephone interview. For this purpose, we developed a disease-specific questionnaire containing 52 items (mostly of scoring nature) patterned after previously validated instruments and organised into eight domains. Approval by the Human Ethical Committee and respondents' consent were obtained. We analysed the scores for all domains and dogs. The effect of different variables on the HRQOL score was determined via log-rank test and Pearson correlation. Scores for all included dogs (range, 0–235 points) were totaled, with a higher number of points indicating a better HRQOL. The dogs included in this study yielded a mean score of 200.6 points (range, 176–227 points), implying a good overall quality of life. There were no significant associations between individual parameters and outcomes. Our questionnaire represents a structured tool for the specific evaluation of postoperative HRQOL in dogs with meningioma, placing a minimal burden on respondents. Few instruments have been developed to assess animal welfare in a disease-specific context. Implementing these tools, however, is essential to accurately evaluate not only the impact of treatments on biologic parameters, but also their implications on patient welfare. Thus, treatment plans may consider HRQOL for a more comprehensive clinical decision-making process.

KEYWORDS

dog diseases, health-related quality of life, intracranial meningioma, surveys and questionnaires

1 | INTRODUCTION

Primary intracranial tumours are common in middle-aged to older dogs of different breeds,¹ with an estimated incidence of 14.5 cases per 100,000 dogs² and 2%–4.5% of dogs admitted for necropsy.^{2,3} Meningioma, the most commonly reported type, accounts for

approximately 50% of cases.^{1,3} The World Health Organisation (WHO) classification scheme for canine meningiomas distinguishes two broad groups: slow-growing tumours containing eight subtypes and anaplastic tumours.⁴ Owing to their location, meningiomas are among the few primary brain tumours suitable for surgical resection. Advances in surgical techniques and refined adjunctive therapy

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protocols have led to the prolonged survival of dogs with intracranial meningioma,⁵ simultaneously promoting the importance of welfare assessment in these patients. Such assessments are novel in veterinary medicine and structured approaches to quality of life (QOL) evaluation are uncommon.⁶ Although the definitions of the term QOL are diverse, there seems to be an agreement on it considering various aspects of the evaluation of well-being. A proposed definition applicable to veterinary patients is that QOL encompasses the three elements of physical fitness, health, and naturalness,⁷ based on the World Health Organisation's definition of health as a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity.⁸ QOL in a veterinary context can best be assessed by determining parameters that are deemed important to a certain patient population and are interpretable from the animals' and observers' perspectives.⁶ In most studies, welfare assessments are conducted by animal patient owners,⁹ who are reportedly capable of observing behavioural disturbances in their pets.¹⁰ Although QOL assessments aim to provide an all-encompassing evaluation of animal welfare,⁷ general instruments may not be sensitive enough to accurately capture changes in health-related quality of life (HRQOL) with regard to a specific disease. Thus, the development of disease-specific HRQOL assessment tools is invaluable as they capture issues directly attributable and relevant to the condition of interest.¹¹ In humans, these tools are applied to ensure treatments go beyond improving health, provide prognostic indicators, and assess patient perceptions of the illness and treatment in question.⁶ With advancements in therapeutic options in veterinary medicine, the need to evaluate treatments and their implications on the QOL of affected animals is becoming more relevant.⁹ Although fewer assessment instruments are available in veterinary medicine than there are in human medicine,⁷ several tools for the evaluation of animal welfare in a general¹² and disease-specific context have been described (e.g., for chronic pain, cardiac disease, pain secondary to cancer, and intracranial diseases).^{10,13–15} Instruments specifically developed to evaluate HRQOL in human patients with meningioma were lacking until recently, when Baba et al. published a meningioma-specific QOL questionnaire in 2021, designed to compensate for the major limitations of general QOL assessment tools with regard to capturing issues specifically important to this patient population.¹¹ During conduction of this study, Weiske et al. published a questionnaire evaluating the HRQOL of dogs affected by various intracranial diseases.¹⁵ However, to the best of our knowledge, no meningioma-specific or cranial surgery specific quality of life assessment tool has been published for domestic animals. To address this, we developed a questionnaire specifically designed to evaluate the postoperative HRQOL in canine patients affected by intracranial meningioma and applied it for the preliminary assessment of postoperative welfare in the declared patient population treated at our institution.

2 | MATERIALS AND METHODS

2.1 | Study population

The owners of dogs that underwent craniotomy for the excision of histopathologically confirmed meningiomas between 2002 and

2022 at our institution were invited to participate in the study conducted throughout 2022. Dogs treated with surgery alone and those receiving adjunctive radiotherapy were included. Dogs that died or were euthanized intraoperatively or within the first 24 h thereafter and those with owners not traceable or available at the time of study conduction were excluded. All dogs received similar state-of-the-art treatments, adhering to a standard protocol, with adjustments made according to the individual course of therapy and recovery. Craniotomy and marginal tumour resection were performed by a board-certified veterinary surgeon under general anaesthesia operated or directly supervised by board-certified veterinary anesthesiologists. Postoperative observation and medical care were provided at the hospital's intensive care unit. At discharge, the owners were advised to adhere to a standard protocol that mainly incorporated exercise restriction, administration of adequate pain medications, and gradual reduction of corticosteroids. Patient information, including signalment, history, clinical and neurologic signs before and after surgery, laboratory and diagnostic imaging findings, surgical and anaesthetic protocols, medication administered, hospitalisation time, and overall outcome data, were retrieved from the hospital's medical records.

2.2 | Development and implementation of a disease-specific questionnaire

A questionnaire designed to specifically evaluate the HRQOL of the declared patient population was developed, patterned after the validated "cancer treatment form" published by Lynch et al. in 2011¹⁶ and influenced by the validated meningioma-specific questionnaire for human kind recently published by Baba et al.¹¹ Some items were modified from the questionnaires if deemed necessary; others were generated based on clinical experience and review of the disease-specific veterinary literature and the patients' medical records. The questions and statements were phrased using simple terminology and rating scales. Items were adjusted, excluded, and/or reworded for enhanced clarity based on experts' (neurosurgeon, general practitioner and statistician) revisions and feedback from dog owners without a professional medical background ($n = 10$). HRQOL was assessed relating to the time the survey was conducted or to the time prior to deterioration before death, except when asked to evaluate items in question for a certain point or period throughout the pre- and postoperative phase. After approval by the ethics committee of the Medical University of Vienna and acquisition of the owners' consent, we used the final questionnaire (Appendix S1) to interview the owners via telephone. The participants' answers and ratings, basic patient information, and the duration of the interview were documented.

2.3 | Statistical analysis

Face validity, defined as whether the questionnaire, on its surface, seems to reflect what it was designed to measure,¹³ was established by adapting questions from validated questionnaires and through

informal discussions with experts and dog owners. Criterion validity, which is supposed to show how well the questionnaire correlates with an established standard of comparison, could not be determined because there is currently no gold standard measure of QOL in companion animals. Construct validity, concerning the extent to which the questionnaire accurately assesses what it is supposed to, was assessed by comparing the individual domains and overall HRQOL scores using Spearman's rank correlation analysis. Correlation coefficients $\geq .25$ generally indicate an acceptable degree of internal consistency.¹³ For internal reliability, the overall Cronbach's alpha coefficient was calculated from all 8 domains, with $r \geq .7$ being considered sufficiently reliable.¹⁷ The results obtained from the scored items were summed to obtain overall scores for each domain and an overall owner-perceived HRQOL score for each patient. The mean scores and ratings were calculated for each item, domain, and patient. Test-retest reliability could not be assessed because most of the dogs had passed away at the time of the survey. The effect of different variables, such as signalment and various tumour characteristics on overall HRQOL scores and survival times was determined using the log-rank test and Pearson's correlation. Statistical significance was set at $p < .05$. The frequency distribution evaluation within groups via the Chi²-Test and differences between groups could not be verified because of the sample size.

3 | RESULTS

3.1 | Study population

Of 15 dogs ($n = 15$) that underwent intracranial meningioma resection at our institution between 2002 and 2022, two were euthanized within the immediate postoperative period due to neurological deterioration. Three owners of dogs showing a satisfactory course of recovery during hospitalisation and at follow-up appointments (last follow-up appointment range, 5 months–4 years after surgery) could not be tracked down at the time of survey conduction. Thus, 10 canine patients comprising 4 females (all spayed) and 6 males (2 neutered, 4 intact) representing a range of breeds (mixed breed, Beagle, Malinois, Pembroke Corgi, Tibet Terrier, and Yorkshire Terrier) were ultimately enrolled in this study. Patient characteristics are listed in Table 1. The resected meningiomas were assigned to seven different subtypes: transitional ($n = 3$), fibromatous ($n = 1$), meningothelial ($n = 1$), psammomatous ($n = 1$), anaplastic subtypes ($n = 1$), and indifferentiable subtypes ($n = 2$); additionally, one showed characteristics of both meningothelial and transitional subtypes ($n = 1$). Regarding tumour location, the resected meningiomas were assigned to predefined regions, including the frontal ($n = 3$), parietal ($n = 2$), frontoparietal ($n = 2$), temporal ($n = 2$), and occipital ($n = 1$) regions. The age at the time of surgery ranged from 3 to 11 years, with a mean of 7.8 years. For most patients, the ASA class was determined to be 3 ($n = 7$), other patients were assigned to ASA class 2 and 4 ($n = 1$ and $n = 2$, respectively). The mean hospitalisation time from surgery to discharge was 3.8 days (range, 2–9 days). The immediate

postoperative complications recorded were transient neurological deficits ($n = 3$) and transient urinary incontinence ($n = 1$). Four dogs received adjunctive radiotherapy, which was administered 13 ($n = 1$) or 16 times ($n = 3$) at an interval of 2–3 days, starting at 29–40 days after surgery. In two cases, radiotherapy was considered a contributing factor to remission and/or preventing detectable recurrence, as follow-up cross-sectional imaging did not show signs of tumour regrowth. The median survival time of the eight dogs that had already died at the time of the survey was 678 days (range, 19–1696 days). In the latter group, the median survival time of dogs that received radiotherapy ($n = 3$) was 851 days and that of dogs that did not receive radiotherapy was 573.8 days ($n = 5$). Cause of death included euthanasia due to tumour recurrence and associated clinical deterioration ($n = 4$), euthanasia for reasons not associated to the intracranial disease (heart failure, severe gastroenteritis, and chronic progressive orthopaedic disease) ($n = 3$), and natural death for unknown reasons ($n = 1$).

3.2 | Development and implementation of the disease-specific questionnaire

In total, 52 items in the form of questions or statements to be answered or rated were established to assess owners' perceptions of the HRQOL of their dogs for the specific disease and treatment in question (Appendix S1). The items were organised into eight domains: happiness and mental state, pain, appetite, hygiene, hydration, mobility and neurological signs, general health, and decision making. Of the 52 items, 46 were scorable either directly ($n = 36$) on a scale ranging from 1 to 5, indicating increasing agreement and quality of life regarding the specific aspect in question; or indirectly ($n = 10$) by providing time intervals for temporal progress. The remaining items were scored on a similar scale (1–5 points), with a score of 5 for immediate improvement (0 days) or the absence of observed abnormalities, and accordingly decreasing scores the longer the convalescence period (1–7 days, 1–4 weeks, 1–12 months, no improvement) or the higher the frequency of abnormal incidents (every few months, monthly, weekly, daily). There were three open-ended and three multiple-choice questions offering 4–6 possible answers each. Within the general health domain, general postoperative health status was evaluated in comparison to the situation before tumour-associated clinical signs were initially observed and before surgery, allowing for a longitudinal assessment. An open-ended question asking the owners to share any information regarding their dog's disease and treatment completed the survey. Three scoring items (pain, mobility, and decision-making) were designed using a supporting visual assessment scale in addition to the scale of numbers. A total score ranging from 0 to 235 points was achievable. Higher scores in each domain and a higher overall score were indicative of a better HRQOL. All the questionnaires were completed correctly, resulting in usable data. The mean time for survey conduction was 11.3 minutes (range, 8.5–15 minutes), and the mean time between surgery and survey conduction was 89 months (range, 9–221 months).

TABLE 1 Characteristics of the dogs enrolled into the study evaluating the postoperative health-related quality of life in dogs after intracranial meningioma resection.

	Breed	Sex	Age (years) at surgery	Weight category (kg)	ASA class (1–5)	Tumour subtype	Tumour localization	Tumour size (mm) (length × height × width)	Hospitalisation time (days)	Adjuvative therapy	Time from surgery to survey (months)	Survival (days)	Cause of death
Dog 1	German Shepherd Dog	Male	10	30–50	3	Fibromatous	Frontoparietal	8 × 12 × 12	7	Radiation	170	555	Euth not TA
Dog 2	Mixed Breed	Female spayed	5	10–30	3	Transitional	Frontoparietal	28 × 16 × 22	4	Radiation	168	1696	ND
Dog 3	Yorkshire Terrier	Male neutered	11	<10	3	Transitional	Frontal	16 × 12 × 10	9	None	151	66	Euth TA
Dog 4	Mixed Breed	Female spayed	11	10–30	3	Transitional	Parietal	4 × 4 × 13	2	None	83	1241	Euth not TA
Dog 5	Beagle	Male	9	10–30	4	Not differentiable	Occipital	20 × 20 × 15	3	None	55	1497	Euth not TA
Dog 6	Mixed Breed	Male neutered	10	10–30	2	Meningothelial	Frontal	24 × 17 × 23	4	Radiation	15	Alive	NA
Dog 7	Mixed Breed	Male	8	10–30	3	Transitional + meningothelial	Parietal	17 × 15 × 12	2	None	10	Alive	NA
Dog 8	Penbroke Corgi	Male	5	10–30	3	Anaplastic	Temporal	20 × 19 × 23	2	None	8	46	Euth TA
Dog 9	Mixed Breed	Female spayed	6	10–30	3	Psaunomatous	Frontal	22 × 15 × 25	2	None	221	19	Euth TA
Dog 10	Tibet Terrier	Female spayed	3	10–30	4	Not differentiable	Temporal	20 × 12 × 10	3	Radiation	11	302	Euth TA
Mean values			7.8		3.1				3.8		89	677.8	

Abbreviations: euth not TA, euthanasia, not tumour-associated; euth TA, euthanasia, tumour-associated; NA, not available; ND, natural death.

3.3 | Statistical analysis

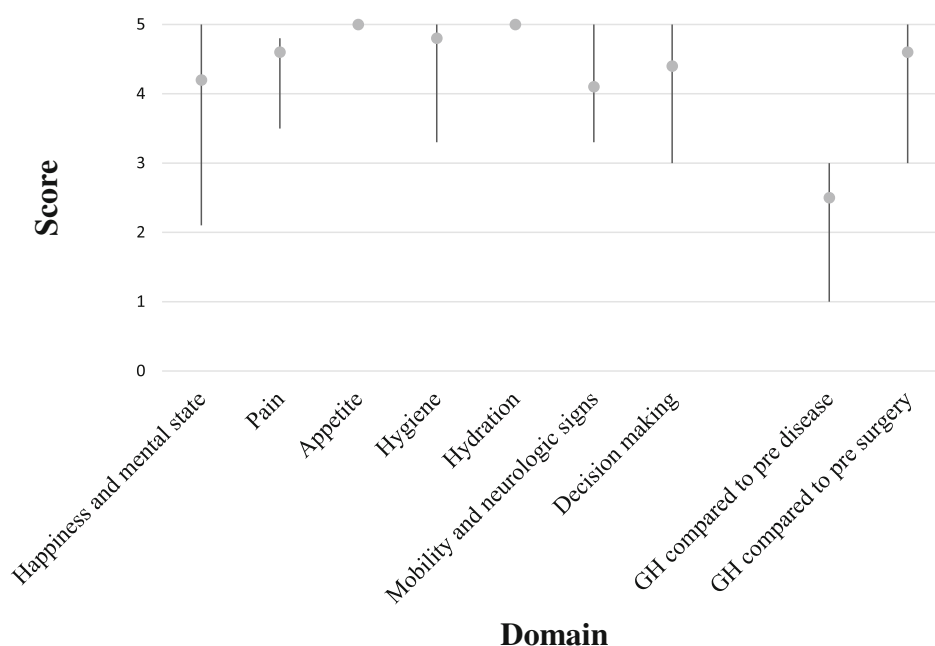
The study participants yielded an average HRQOL score of 200.6 points (range, 179–226 points), equating 85% (range, 76%–96%) of the highest possible score. There was no distinct difference in mean overall HRQOL scores for dogs receiving and not receiving radiotherapy (205.5 and 197.3 points, respectively). The mean values of the scorable items calculated for each domain are shown in Figure 1. Within the two domains evaluating food and water intake (appetite and hydration), all items were rated with the highest possible score (5 points) by the participants, yielding the maximum number of points (20 and 15 points, respectively) for those domains. Items within the hygiene domain were rated with the highest possible score by all but one participant resulting in an average of 14.4 of 15 possible points (range, 10–15 points) and a mean score of 4.8 (range, 3.5–5.0). Concerning pain, an average score of 27.6 points of the maximal amount of 30 points (range, 21–30 points) and a mean score of 4.6 (range, 3.5–4.8) was achieved. Items within the happiness and mental state domain were rated with an average of 38.1 points of the maximal possible 45 points (range, 19–45) with a corresponding mean score of 4.2 (range, 2.1–5.0). Of the domains evaluating clinical parameters, the one covering mobility and neurologic signs yielded the lowest mean score (4.1; range, 3.3–5.0). An average of 73.9 points (range, 53–90 points) was awarded for this domain. General postoperative QOL was estimated to be worse than before the clinical signs associated with intracranial neoplasia were initially recognised; whereas it was estimated to be considerably better than that prior to surgery. When asked for the owners' opinion regarding the overall therapy process ('decision making'), an average mean score of 4.3 (range, 3.0–5.0) was yielded implying that surgical therapy would be provided again for the respective dogs if given the chance. The open-ended question concluding the questionnaire resulted in an overall positive response, with

five participants independently stating that they felt that their pet was cared for very well. The remaining participants ($n = 5$) did not comment. The mean Spearman's correlation coefficient was .5 for comparing the individual domains and the overall scores of each completed survey. Cronbach's alpha coefficient was .7. No variable had significant prognostic value in terms of survival time or HRQOL within our study population.

4 | DISCUSSION

Our questionnaire represents a structured tool for the specific evaluation of postoperative HRQOL in patients with canine meningioma, placing a minimal burden on respondents. Few instruments have been developed to assess animal welfare, especially in a disease-specific context. Implementing these tools, however, is essential to accurately evaluate treatments and their implications on the patients' welfare. Consequently, therapeutic measures may be directed at considering HRQOL rather than solely improving biological parameters and guidance for a more comprehensive clinical decision-making process may be provided. The ultimate therapeutic goal, especially in an oncological context, is to reduce morbidity while improving HRQOL without compromising survival rates.¹⁶ Thus, it is important to objectively quantify morbidity. However, since well-being is subject to individual genetic backgrounds, personalities, learned experiences, and priorities,¹² attempts of objective evaluations alone have limitations. In veterinary medicine, there is an additional difficulty in QOL evaluation in general necessitating proxy reporting, which involves the decisive influence of the observer's subjective perception on the assessment of the welfare of another species' individual.¹⁸ However, owners have been found to be able to observe behavioural disturbances in their pets,¹⁰ given that they truly know their normal

FIGURE 1 Results obtained from the scored items presented by domain. The mean values (represented as dots) and ranges (represented as vertical lines) for the scored items of each domain contained in the questionnaire designed to evaluate the postoperative health-related quality of life in dogs after intracranial meningioma resection. The y-axis displays the possible score range (0–5) for the calculated mean values, the x-axis comprises the questionnaire's individual domains. The two items of the general health (GH) domain are listed separately to allow a visual comparison between the patients' estimated postoperative general health status and the situations before onset of the disease and before surgery.



activities and behaviours.¹⁴ Caregivers have been shown to be superior in evaluating the QOL of sick family members or pets compared to physicians in both human¹⁹ and veterinary medicine.²⁰ Again, owners and veterinarians may introduce bias in the assessment by subconsciously contributing to the most positive outcome of the welfare assessment, as owners might want to justify their choice of treatment for their pet, and veterinarians might want to be eligible and promote certain treatments in their field of expertise.⁹ However, independent of the assessor, questionnaires covering all aspects of HRQOL relevant to a certain target group are of utmost importance to address the lack of sensitive, adequate, and relevant tools for outcome evaluation, apart from conventional measures such as complications and survival,²¹ and to determine the most appropriate way to cure, care for, and support the respective patient population.²² Therefore, our questionnaire was designed to specifically evaluate postoperative HRQOL in dogs with intracranial meningioma. Statistical analysis of the final questionnaire resulted in a mean correlation coefficient of .5 for comparison between scores for individual domains and owner-assigned overall HRQOL score, and an overall Cronbach's alpha coefficient of .7 indicating a moderately positive correlation and sufficient reliability.^{13,17} Surveys were conducted by presenting the developed questionnaire to the respective proxies via telephone interview, an approach shown to be applicable.^{13,23} The time spent completing the questionnaire (mean value of 11.3 min) was comparable to that of another study evaluating HRQOL¹⁵ and subjectively observed to be appropriate for maintaining the participants' focus. The mean score of overall HRQOL in our study population was 200.6 points, representing 85% of the highest achievable result, which is difficult to assemble with the scoring results of other questionnaires, but implies a good overall postoperative HRQOL. Through a longitudinal assessment of HRQOL in human meningioma patients, a 50% improvement in HRQOL was observed postoperatively compared to that before surgery, while in 20% of cases, HRQOL decreased following surgery.²¹ The dogs enrolled in our study experienced short convalescence periods, as most owners stated that observed abnormalities (e.g., pain and behavioural changes) distinctly improved or disappeared immediately or within the first 7 days following surgery. Regarding the individual domains of the questionnaire, as expected, the rating of the domain covering mobility and neurologic signs was lower compared to the other domains addressing clinical signs; although a mean score of 4.1 (range, 3.0–5.0) can be considered as a good outcome regarding the issues in question. Postoperative general health was expectably estimated to be worse than before the onset of clinical signs attributable to intracranial disease, whereas it was estimated as considerably improved in comparison to the situation prior to surgery (Figure 1). The overall median survival time of dogs included in this study that had already died at the time of study conduction ($n = 8$) was 21.8 months (range, 0–55 months), with distinctively prolonged mean survival times for recipients of adjunctive radiotherapy compared to dogs treated solely surgically (851 vs. 574 days, respectively). Despite the small sample size and bias in excluding patients who died during and immediately after surgery and those still alive, the reported

survival times are in accordance with those of other studies.^{24,25} Survival reportedly depends on the tumour type, with meningothelial, psammomatous, and transitional subtypes being associated with a more favourable prognosis than other subtypes.²⁵ Associating the animal survival times and HRQOL scores of this study to variables such as tumour subtypes, did not produce significant results, which is most probably attributable to the sample size. However, the tumours resected from the two dogs with the longest survival times and from the two dogs living at the time of the survey displayed histological characteristics of transitional subtypes. Despite prolonged survival times, no significant difference was observed in the overall and domain-specific postoperative HRQOL of these patients. Other factors, such as age, sex, breed, and tumour location did not have prognostic value in terms of survival time or postoperative HRQOL, similar to a previous study's findings.²⁵ More than half of the owners participating in the survey ($n = 6$) declared the highest possible willingness to choose surgical therapy again for their dogs, if given the chance, while the other participants stated that they had a neutral ($n = 2$) or positive attitude ($n = 2$) towards the proposition. Collectively, these results imply high owner satisfaction, supposedly concomitant with good outcomes regarding the postoperative HRQOL of the treated dogs.

The reliability of the results is limited as they may be positively biased since the survey was not offered to the owners of the two dogs euthanized in the immediate postoperative period. These scores, possibly having a negative impact on the outcome measures, were not considered during the analysis of the results. The small sample size ($n = 10$) and the retrospective nature of the study, which precluded repeated HRQOL assessments, are further limitations. The latter issue was addressed by including items inquiring about certain aspects at multiple points or periods, thus providing a foundation for longitudinal assessment. Furthermore, the long surgery to survey interval in some cases (range, 9–221 months) brings the reliability of the owners' answers, particularly regarding (time-) specific issues, into question. A limitation of questioning HRQOL in patients with canine meningioma might be that middle-aged and older dogs are generally affected by and treated for intracranial meningioma. The patients' general health conditions, comorbidities, and procedural risks might influence postoperative outcomes concerning HRQOL and survival time.²³ Radiotherapy, involving multiple anaesthetic procedures and predisposing to immediate and late adverse effects, could influence outcome in regards of quality of life. In our study animals, no distinct difference in mean overall HRQOL scores was found between dogs receiving radiotherapy ($n = 4$; 200.5 points) and those not receiving radiotherapy ($n = 6$; 197.3 points). This may be attributable to the small sample size, which precludes a relevant conclusion.

Further research is required to refine consistency and reliability of the developed questionnaire, and to verify its validity. This would help assess HRQOL before, during, and after different therapeutic approaches for intracranial meningioma or neoplasia in general. Moreover, correlations between the occurrence of certain characteristics of the disease or treatment and the outcome regarding HRQOL and survival might be observed.

Our preliminary conclusion is that the presented questionnaire could be a promising instrument for the evaluation of the HRQOL of dogs treated surgically for intracranial meningioma and surviving the immediate postoperative period, and it constitutes an addition to the small group of disease-specific HRQOL assessment tools in veterinary medicine.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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