Treatment of canine cranial cruciate ligament disease

A survey of ACVS Diplomates and primary care veterinarians

F. M. Duerr1; K. W. Martin1; M. Rishniw2; R. H. Palmer1; L. E. Selmic1

1Department of Clinical Sciences, Veterinary Teaching Hospital, Colorado State University, Fort Collins, CO, United States; 2Veterinary Information Network, Davis, CA, United States

Keywords
Cranial cruciate disease, tibial plateau levelling osteotomy, TPLO, extracapsular stabilization, online survey

Summary
Objective: To describe veterinarians’ treatment recommendations and decision-making factors for dogs with cranial cruciate ligament disease (CCLD).

Methods: An online survey of American College of Veterinary Surgeons (ACVS)-Diplomates (surgeon group) and primary care veterinarians (practitioner group) was performed. The survey included questions on treatment recommendations for common case scenarios (small or large breed dog with complete or partial CCLD), treatment decision factors, non-surgical treatment options, and actual treatment, if any, provided for a client-owned dog as well as one owned by their family or close friend.

Results: The response rate was 42% for the surgeon group (n = 305/723) and four percent for the practitioner group (n = 1145/27,771). Extracapsular stabilization (ES) was the most common treatment recommendation for CCLD in small (9.1 kg) breed dogs amongst surgeons and practitioners. Tibial plateau levelling osteotomy (TPLO) was the most common treatment recommendation for CCLD in large (27.2 kg) breed dogs amongst both groups. The two most important treatment decision factors were dog size (78% of practitioners, 69% of surgeons) and activity level (63% of practitioners, 52% of surgeons). The most common treatment provided for a dog of their own or close relation in the surgeon group was TPLO (64%) followed by ES (15%), whereas in the practitioner group it was ES (38%) followed by TPLO (30%).

Clinical significance: Extracapsular stabilization and TPLO are the most commonly employed surgical procedures in the surveyed population; dog size and activity level (but not age) are the major factors influencing treatment decisions.

Introduction

Injury to the cranial cruciate ligament is a common cause of pain, osteoarthritis, and hindlimb lameness in canine patients (1). In 2003, an estimated 1.7 million dogs were treated for cranial cruciate ligament disease (CCLD) in the United States (2). Despite this high prevalence and obvious clinical problem, there is still controversy about the best treatment (3, 4). Level III evidence has provided the basis for veterinarians recommending non-surgical treatment of CCLD for dogs weighing less than 15 kg (5-7). On the other hand, Level II evidence suggests that surgical treatment for medium and large breed dogs is superior to non-surgical treatment (8). While various surgical techniques rise and fall in popularity, the ideal surgical treatment for the canine patient with cruciate disease remains unknown, and may vary according to patient-specific variables (4, 9-12).

The individual components that comprise modern non-surgical CCLD treatment are variable but are likely to include rehabilitation therapy (8, 13). Other non-surgical treatment components (such as stifle orthoses, shock wave treatment, acupuncture, stem cell therapy, and low-level laser therapy) have been recommended in the non-peer-reviewed literature, but to the authors’ knowledge no data exist to support their use or to justify the frequency of their clinical use.

Ideally, treatment decisions should be based on Level I evidence such as meta-analyses of randomized, blinded clinical trials. However, given the lack of such trials comparing all available treatment options, it is left to individual veterinarians to decide which CCLD treatment to recommend. It is unknown which treatments (surgical and non-surgical) are currently recommended by specialist surgeons or primary care veterinarians in the United States, how frequently these are chosen, and on what basis these recommendations are made.

Filling of this knowledge void would be likely to direct future outcome-based research of various CCLD treatments, in-
fluence the direction of continuing education programs, stimulate research on CCLD treatment decision-making, and aid pet owners in making a decision based on multiple rather than just one veterinarian’s opinion. The primary goal of this study was to determine the CCLD treatment recommendations and factors influencing these decisions, as currently made by two expert groups: American College of Veterinary Surgeons (ACVS) Diplomates and primary care veterinarians in the U.S. The secondary goal of the study was to describe CCLD treatment recommendations by the same veterinary groups if a member of their own family or close friend owns the pet (hereafter referred to as ‘own dog’).

Materials and methods

Participants

The ACVS online directory (www.acvs.org) was searched for U.S.-based Diplomates to identify ACVS-board certified veterinary surgeons (surgeon group). Individuals had to specialize in small animal care and have a publicly available email address listed to be included in the survey. Survey invitations were sent from one of the authors’ personal e-mail address (FMD) to request participation via an online survey toola. This request was sent twice to this group. Veterinary Information Network (VIN) members (excluding veterinarians employed in industry) were invited to participate in the survey via bulk email from VIN to identify primary care veterinarians (practitioner group). This request was sent once to this group, and an email reminder linking to the survey was sent a week later. VIN-members were excluded if they were certified by any surgical specialty college (e.g. ACVS, ECVS, FACVS, RCVS) or resided outside the U.S. The survey for this group was provided using proprietary (developed by VIN) survey software. Minor wording changes were necessary to adjust the survey to the target group (i.e. to also address veterinarians that solely refer cases for surgical treatment).

Demographics and common case scenario questions

The survey (Table 1) included questions on the following categories: the veterinarians’ current clinical setting, the frequency at which they perform CCL surgeries, their treatment recommendations (including surgical, non-surgical and referral) for common CCLD cases, scenarios for the treatment of CCLD, if any, that they personally per-

<table>
<thead>
<tr>
<th>Category</th>
<th>Question</th>
<th>Answer option (examples)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demographic information</td>
<td>Please provide the following</td>
<td>• Name</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Clinic name</td>
</tr>
<tr>
<td>Clinical setting</td>
<td>What is your clinical setting?</td>
<td>• Specialty clinic</td>
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<tr>
<td></td>
<td></td>
<td>• General practice</td>
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<tr>
<td>Orthopedic surgery</td>
<td>Orthopedic surgery/consultations currently occupy approximately what</td>
<td>• 6 categories from 0% to 75–100%</td>
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<tr>
<td>consultations</td>
<td>percent of your clinical activities?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Approximately how many CCL surgeries do you perform on clinical cases</td>
<td>• 5 categories from 0 to &gt;192/year</td>
</tr>
<tr>
<td>Case scenarios</td>
<td>What type of surgeries do you currently perform on clinical cases for</td>
<td>• ES, TR, TPLO, TTA, Other</td>
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<tr>
<td>(for 20/60 lb* dog, partial/</td>
<td>treating CCLD?</td>
<td></td>
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<td>complete CCLD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meniscal treatment</td>
<td>Select the procedure that you would most likely recommend for a 5-year-old</td>
<td>• ES, TR, TPLO, TTA, other, no surgery</td>
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<tr>
<td></td>
<td>dog with a moderate, weight-bearing lameness due to CCLD.</td>
<td></td>
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<tr>
<td>Treatment factors</td>
<td>Which of the following best describes your preference regarding meniscal</td>
<td>4 available options, including:</td>
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<td></td>
<td>evaluation/treatment?</td>
<td>• always, never, and sometimes</td>
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<td></td>
<td>What, if anything, would you (most commonly) do if the meniscus was</td>
<td>• Caudal release</td>
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<tr>
<td></td>
<td>found to be INTACT during stifle exploration?</td>
<td>• Midbody release</td>
</tr>
<tr>
<td>Non-surgical Treatment</td>
<td>Please rank non-surgical treatments that you would recommend if surgical</td>
<td>11 available options, including:</td>
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<td></td>
<td>treatment is not possible/chosen by the owners</td>
<td>• rest, NSAID, and omega-3 fatty acids.</td>
</tr>
<tr>
<td>Treatment of ‘own dog’</td>
<td>Animal information (the dog that was treated for CCLD)</td>
<td>• Breed, weight, age</td>
</tr>
<tr>
<td></td>
<td>What was performed to treat the dog’s CCLD?</td>
<td>• Activity level</td>
</tr>
<tr>
<td></td>
<td>Were any complication(s) observed?</td>
<td>• ES, TR, TPLO, TTA, other, no surgery</td>
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<tr>
<td></td>
<td>How would you personally grade the dog’s return to function after the</td>
<td>4 options: full, acceptable, unacceptable function</td>
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<td></td>
<td>CCLD treatment?</td>
<td>and “don’t recall”.</td>
</tr>
</tbody>
</table>

CCL = cranial cruciate ligament; CCLD = cranial cruciate ligament disease; ES = extracapsular stabilization; TR = tightrope; TPLO = tibial plateau levelling osteotomy; TTA = tibial tuberosity advancement; NSAID = non-steroidal anti-inflammatory drugs. *20/60 lb = 9.1/27.2 kg.

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a Survey Monkey; Available at: www.surveymonkey.com
form, and the considerations made when choosing a treatment.

The common case scenarios for which surgeons and practitioners were asked to give their treatment recommendations were a 9.1 kg and a 27.2 kg dog with a partial or complete CCL rupture.

**Treatment decision factor questions**

Surgeons and practitioners were asked to rank on a modified four-point Likert scale (very, somewhat, or very important and irrelevant) a number of factors that they consider when making CCLD treatment recommendations.

### Non-surgical treatment questions

Participants were asked to rank on a modified four-point Likert scale (very likely, likely, unlikely, and very unlikely to recommend) non-surgical treatment options such as rest, medications, nutraceuticals, acupuncture, low-level laser therapy, shock wave therapy, stem cell therapy, therapeutic ultrasound, orthoses and physical therapy/veterinary rehabilitation.

**Treatment of ‘own’ dog**

If veterinarians had treated their ‘own’ dog for CCLD, they were surveyed on pertinent details (such as patient age, activity level, breed, etc.) and treatment provided.

The entire survey is available online (Appendix Table 1: available at www.vcot-online.com; an abbreviated version can be found in Appendix Table 1).

### Statistical analysis

Descriptive statistics were calculated utilizing a spreadsheet program.b

### Results

Detailed results of the survey are available online (Appendix Table 1: available online at www.vcot-online.com); an abbreviated summary is displayed in Table 2 and Appendix Figures 1 to 4 (available online at www.vcot-online.com).

### Demographics

Seven hundred and twenty-three ACVS Diplomates and 27,771 practitioners were invited to participate. The response rate was 42% for surgeons (n = 305/723) and four percent for practitioners (n = 1145/27,771). Most surgeons were employed in specialty clinics (65%), followed by teaching hospital (19%), mobile surgery (9%) and general practice (2%). Practitioners mostly worked in general practice (90%), followed by specialty clinics (4%) and mobile surgery (2%). The majority (75%) of surgeons spent at least 50% of their time performing orthopaedic surgery and consultations, while most practitioners (88%) spent less than 25% of their time on orthopaedic surgery and consultations. Similarly, 77% of surgeons performed more than one to four CCLD surgical procedures

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b Microsoft Office: Microsoft Corp., Redmond, WA, USA

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**Table 2** Abbreviated survey results for both groups (in % of respondents). For the full results please see the online supplementary information (available at www.vcot-online.com). Total numbers of respondents varies from 213 to 301 (surgeon group) and 590 to 684 (practitioner group) depending on the question.
per week, while 52% of practitioners performed only one to four CCLD surgical procedures per month and 35% of practitioners did not perform any CCLD surgery. For those practitioners that did perform CCLD surgery, 90% performed ES and 17% performed TPLO with other procedures (tibial tuberosity advancement (TTA), tightrope (TR), and others) each being performed by less than 15% (▶Table 2). For surgeons, 84% performed ES, 75% performed TPLO, 36% performed TTA and 17% performed TR. Twelve percent of surgeons performed ‘other’ procedures including closing wedge osteotomy (n = 6), fibular head transposition (n = 5), intra-articular ligament replacement (n = 3), CORA based levelling osteotomy (n = 3), arthroscopic debridement only (n = 3), fascial imbrication (n = 3), and triple tibial osteotomy (n = 2).

Common case scenarios
For all scenarios provided (partial or complete CCL rupture in a 9.1 or 27.2 kg dog), the first choice amongst both groups was surgery (TPLO and ES). Non-surgical treatment was recommended by less than six percent of respondents from both groups for animals with a complete tear of the CCL regardless of size. See ▶Table 2.

Meniscal evaluation/treatment
When asked about their evaluation of the meniscus during CCLD surgery, the majority of both surgeons and practitioners (96% and 83%, respectively) said that they always evaluate the meniscus, while one percent of surgeons and three percent of practitioners stated that they never evaluate the meniscus (▶Table 2). For all of the common case scenarios discussed previously, more than 50% of both surgeons and practitioners would not perform any type of meniscal procedure if a healthy and intact meniscus was identified at the time of surgery (▶Appendix Table 2: available online at www.vcot-online.com).

Treatment decision factors
When both surgeons and practitioners were asked to rank factors that influenced treatment recommendations, the two factors that were ranked as ‘very important’ by the majority of respondents were dog size (practitioners: 78%; surgeons: 69%) and activity level (practitioners: 63%; surgeons: 52%). Concomitant patellar luxation, tibial plateau angle, and tibial morphology were reported to be “very important” factors by 39%, 36% and 32% of the surgeons, respectively, compared to 44%, 19% and 18% of the practitioners. Thirty percent of practitioners and 13% of surgeons stated that the degree of lameness was a very important factor to consider when making treatment recommendations. The other four treatment decision factors (age, amount of degenerative joint disease), meniscal status and degree of CCL tearing) were considered to be very important by less than 25% of both groups (▶Appendix Figure 1: available online at www.vcot-online.com). Meniscal status, degree of CCL tear and degree of lameness were considered ‘irrelevant’ by more than 25% of the surgeons; no factor was considered ‘irrelevant’ by more than 25% of respondents in the practitioner group (▶Appendix Figure 2: available online at www.vcot-online.com).

Non-surgical treatment
When asked to rank non-surgical treatment options, the majority of surgeons and practitioners stated that they would be very likely to recommend non-steroidal anti-inflammatories (practitioners: 93%; surgeons: 85%), rest (practitioners: 88%; surgeons: 73%) and glucosamine/chondroitin sulfate supplementation (practitioners: 77%; surgeons: 65%). Other treatments selected as ‘very likely to recommend’ by at least 40% in at least one group were rehabilitation (surgeons: 57%; practitioners: 39%) and supplementation with omega-3 fatty acids (practitioners: 56%; surgeons: 48%) (▶Appendix Figure 3: available online at www.vcot-online.com). Treatments selected as ‘very unlikely to recommend’ by more than 40% in at least one group were stem cell therapy (45%), shockwave therapy (43%), orthoses (42%) and therapeutic ultrasound (37%) in the surgeon group, and shockwave therapy (63%), therapeutic ultrasound (55%), orthoses (52%) and stem cell therapy (50%) in the practitioner group (▶Appendix Figure 4: available online at www.vcot-online.com).

Treatment of ‘own’ dog
Eighty-three percent (n = 245) of the respondents in the surgeon group and 74% (n = 801) in the practitioner group had treated (or made treatment recommendations) for their ‘own’ dog. Data for the weight of the dogs in the surgeon group were available for 211 cases (mean 31 ± 10 kg) and the most common treatment performed or recommended was a TPLO (64%) followed by ES (15%), TTA (10%), no surgery (5%), and TR (2%). Data for the dogs in the practitioner group were available for 683 cases (mean bodyweight was 28 ± 11 kg) and the most common procedure performed or recommended was ES (38%) followed by TPLO (30%), no surgery (16%), TTA (8%), and TR (6%).

Discussion
Tibial plateau levelling osteotomy and ES are by far the most commonly performed and recommended procedures amongst the ACVS-surgeons and primary care veterinarians surveyed. Furthermore, veterinarians most commonly recommended these procedures for treatment of their ‘own’ dog in addition to their clients’ dogs; thus, there appears to be no disconnect between what they recommend for clients in comparison to their close family and friends.

Veterinarians probably base their decision regarding surgical versus non-surgical treatment for patients with CCLD on many factors including assessment of the available literature, prior experience, expert opinions, patient factors, cost and personal preference. The results of this study suggest that dog size is one of the more important treatment factors used by the surveyed veterinarians to make recommendations. Non-surgical treatment has been reported to be pursued as the first treatment step in dogs weighing <15 kg by 84% of 161 responding veterinarians in the UK (7). Interestingly, the results from our study suggest that surgical treatment is more frequently recommended in the US with less than 10% of the
veterinarians surveyed in this population suggesting non-surgical treatment for a 9.1 kg dog with a complete rupture of the cranial cruciate ligament. In our study, dog size appeared to be more so a determining factor for the choice of surgical procedure, rather than whether or not surgery should be performed, with the majority of veterinarians recommending ES over TPLO for 9.1 kg patients. Another important treatment factor amongst the surveyed population of surgeons and practitioners was patient activity level. This finding is consistent with a common clinical impression that active dogs benefit from TPLO over ES and is supported by the findings of recent studies indicating that TPLO is superior to ES and dogs do not return to full function after ES (9, 10). The practitioner group in this survey employed ES more frequently than the surgeon group; this may be related to the technical difficulty and equipment necessary to perform TPLO or the potential for significant complications with the TPLO procedure.

Primary care veterinarians more commonly recommended non-surgical treatment for animals with partial CCLD. This is probably because of the decreased lameness seen with this presentation. However, it is important to consider that animals with an intact meniscus and a partially intact cranial cruciate ligament recover faster from surgery and have a lower incidence of surgical complications (14, 15). Dogs that undergo surgery while having a partial tear may protect the remaining fibres of the cranial cruciate ligament against further degeneration that in turn may result in a lower rate of subsequent meniscal tears (16). In people with anterior cruciate ligament injuries, non-surgical treatment is frequently used and has been shown to result in acceptable function for many patients, including some athletes (17). Less information is available regarding non-surgical management of CCLD in dogs, despite the large number of cases treated non-surgically. Wilke and colleagues reported that approximately 11% of cases presented to a surgeon and 30% of cases seen by primary care veterinarians whose practice was limited to small animals were managed without surgery (2). Non-surgical management may be performed for a variety of reasons including comorbidities or financial constraints. Surprisingly, only a few studies have evaluated the effectiveness of non-surgical care for CCLD in dogs (5, 6, 8, 18). Recent developments in veterinary rehabilitation have changed the non-surgical management of CCLD. Rehabilitation after surgical treatment of CCLD has been shown to improve function in dogs (8, 13, 19, 20). However, other non-surgical treatment options (such as stifle orthoses, shockwave therapy, stem cell therapy and therapeutic ultrasound) have little scientific data to support their use with or without surgery. This lack of peer-reviewed outcome-based research was reflected in this survey since these modalities were least likely to be recommended by either group. The most commonly selected non-surgical treatment options in this survey included non-steroidal anti-inflammatory drugs, rest, glucosamine and chondroitin sulfate. However, the literature suggest that omega-3 fatty acids have the greatest strength of evidence amongst nutraceuticals for symptomatic control of osteoarthritis (21, 22).

The majority of the surgeons and practitioners did not perform meniscal release procedures on intact menisci. This survey finding is supported by reports that the meniscus is an important stabilizer of the canine stifle (23). Surprisingly, some surgeons and practitioners reported that they do not routinely evaluate the meniscus during surgery. This may reflect the technical challenge associated with comprehensive meniscal assessment, the desire to forego an arthroscopy due to its invasiveness or possibly to reduce surgery time.

This survey study was used to reach a large number of veterinarians but has some limitations inherent to the utilization of survey techniques that should be considered when evaluating this data. The response rate for the surgeon group (42%) is similar to response rates in previously performed surveys that ranged from 31–34% (2, 24, 25). The response rate for the practitioner group was much lower (4%), however, this was expected since this group was contacted via bulk email and included any veterinarian in general practice. Given that we received responses from 18% of all ACVS Diplomates (total number of ACVS Diplomates in 2013: n = 1698), it is likely that the surveyed population represents the opinion of ACVS-surgeons (26). However, for the practitioner group, we only collected responses from 1.3% of all active veterinarians (based on the estimated number of active veterinarians in 2013: n = 90,705) (27). Furthermore, the method of solicitation for the practitioner group may be more likely to trigger a response from individuals with an interest in CCLD treatment which may have biased the survey towards practitioners performing cranial cruciate ligament surgery. Based upon the different response rates between the surveyed populations, the authors believe that statistical comparison would not be valid.

In conclusion, TPLO and ES were the most commonly employed surgical procedures in the surveyed populations; dog size and activity level (but not age) were the major factors influencing treatment decisions amongst US veterinarians. Non-surgical treatment was rarely recommended for animals with a complete tear of the cranial cruciate ligament regardless of size. Rest, non-steroidal anti-inflammatory drugs, glucosamine and chondroitin sulfate were the most commonly recommended non-surgical treatments. This information may be useful to direct future research into clinical decision-making in CCLD, direct continuing education and provide opportunities for targeted research into the identified popular treatment types.

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Conflict of interest

None declared.

References


