Comparison of three methods for the management of fragmented medial coronoid process in the dog

A systematic review and meta-analysis

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Introduction

Several techniques have been described in the literature for the treatment of fragmented medial coronoid process (FMCP), including medical management, medial arthroscopy with removal of the fragment, coronoidectomy, ulnar ostectomy with or without medial arthroty, and arthroscopic fragment removal. There is not a clear preference of surgical over medical management of fragmented medial coronoid process (FMCP) despite the existence of a dozen scientific articles on the subject. Although surgical removal of the fragment is most commonly recommended in young dogs diagnosed with FMCP, it has been reported that dogs treated medically improved quicker than those treated with surgery (1, 2). This opinion is shared by Grondalen who proposed that removing the coronoid fragment would reduce short-term pain, but remain ineffective in treating the ensuing osteoarthritis (3).

There are several explanations for the ongoing uncertainty about management efficacy. Many of the recent articles report aspects of FMCP that are not directly related to treatment (e.g. epidemiological, genetic and radiological studies). Also, newer surgical techniques are often first reported using a case series study design. For example, Ness reported a series of 10 dogs treated with medial arthroty with ulnar ostectomy (4). These dogs were not compared to a control group which precludes inference about efficacy. Case series are useful in the initial stages of technique development, but the case series design is meant for generating hypotheses and is not the proper study design for evaluating efficacy (5). Additionally, many of the projects addressing outcomes have small sample sizes and/or are descriptive instead of comparative. For example, Bouck et al. compared surgical and medical management using 10 dogs in the surgical group and only nine in the medical group (1). Fortunately, there are methods available to compare existing publications in order to determine the best evidence for a clinical decision.

The techniques of evidence-based medicine are useful in clinical decision making because they evaluate studies based on their methodological quality, including measures that are of direct interest to clinicians and owners (e.g. improvement in lameness), rather than more esoteric measures appropriate for bench studies (e.g. joint histopathology). As an example of an evidence-based review, Aragon and Budsberg (6) evaluated the literature comparing techniques for stifle stabilization, one of the most studied issues in veterinary orthopaedics. They concluded that there was a lack of evidence to indicate that one surgical method was superior to others.

This research takes a step beyond systematic review and uses a meta-analysis to synthesize small studies to identify patterns among the results. In other words, individual studies may show a trend, but not a significant statistical difference among therapy groups (often because of the small study size); carefully combining the studies increases the overall statistical power and possibly amplifies group differences. A meta-analysis also combines the data in a way that accounts for the size of the study
and cluster (study) effect, and then tests the hypothesis of an overall effect of treatment. That way, small studies do not overly influence the outcome of the meta-analysis.

This investigation compared surgical management of a FMCP (arthroscopy and medial arthrotomy) with medical management by selecting research articles using methods from evidence-based medicine. This was followed by a meta-analysis of the most scientifically suitable studies. There are two goals for this research. The first is to evaluate the evidentiary value of the set patient centered, clinically relevant published research that compares surgical and medical methods for managing FMCP, and the second is to combine the information across the studies to provide inference for treatment methods.

Methods and materials

The Pubmed, VIN and CAB databases were searched on the terms ‘FCP’, ‘fragmented medial coronoid process’ and ‘canine elbow’. References within primary educational texts, for example Slatter (7), were hand searched to obtain a complete set of references. From the large list of candidate manuscripts a subset was selected based on rigueur of scientific method and applicability to our study. More specifically, the published study must have reported outcomes of clinical interest, be primary research, written in the English language, report a follow-up of a minimum of six months and have a comparison group. For example, bench research, cadaver studies or case series fail to meet the aforementioned conditions. The inclusion criteria permitted any age and breed of dog that weighed more than 12 kg.

Studies meeting the minimum requirements were then assessed for evidentiary value using the American Dietetic Association’s Quality Criteria Checklist (8), which consists of 14 ‘yes’ or ‘no’ questions used to ascertain the opportunity of bias to occur due to strengths and weaknesses in the study design and reporting in the manuscript. This step is critical because Schultz et al. (9) reported that manuscripts which permit more opportunities for bias show group differences 41% more often than studies that limit sources of bias. The ADA checklist classifies manuscripts into three categories. The lowest level of evidence is designated with a ‘-’, and in the meta-analysis of human medical data those studies are usually discarded. However, the veterinary literature addressing this problem had far fewer studies from which to obtain information, so we included all studies passing the basic screening criteria. In this case, knowing the ADA scores helped to evaluate the overall depth of knowledge for the management of FMCP.

One outcome measure reported in all the manuscripts was visual assessment of lameness pre- and post-therapy. This was transformed into our primary outcome for group comparison; a binary variable that indicated an improvement in lameness over pre-therapy score. That is, did the dogs improve post-therapy over their pre-therapy lameness?

There were not any studies that directly compared arthroscopy to medical management. Therefore, arthroscopy had to be indirectly compared to medical management via medial arthrotomy. In other words, the difference between arthroscopy and medical management was calculated using medial arthrotomy as an intermediate step. There are several methods for meta-analyses of indirect comparisons; the data were analyzed using a Bayesian confidence profile model (10) with the WinBUGS (11) statistical software. The Bayesian model was chosen because it lends itself to modelling multiple correlated parameters and because Bayesian theory uses direct probabilities for inference about scientific hypothesis rather than p-values (and statistical ‘null’ hypotheses) to account for the chance aspect of data driven inferences, so p-values are not reported here. Instead, we simply calculated the probability of the scientific hypotheses that one method was superior to the other for each pair of methods. For example, the probability that arthroscopy is superior to medical management. In addition we calculated the differences in the probabilities of successful therapies among the three treatment groups. In other words, the probability of a successful outcome was calculated for each treatment, and then pairwise differences were obtained to demonstrate the preferred treatment, reported with a with 95% probability interval, which are the Bayesian counterparts to a 95% confidence interval.

Results

Over 400 candidate manuscripts (including duplicate findings) were obtained in the initial search of the electronic databases. The large number of manuscripts is attributed to the sensitive nature of the search. General search terms, for example, ‘canine elbow’ are not specific to FMCP and return many manuscripts whose topics are not related to FMCP, such as ones on fractures and elbow incongruities. After the initial screening, fourteen manuscripts or proceedings were obtained for further evaluation. One manuscript was in the German language and was omitted from the analysis. An additional seven manuscripts evaluated surgical treatment, but did not include a control group for comparison. Two reports were abstracts, and the subsequent full papers could not be found; these were omitted. The remaining four manuscripts reported several different outcome variables (veterinarian or owner visual evaluation, physical exam, ground reaction forces) on all or subsets of a variety of breeds and ages of dogs, but all of them reported change in lameness for at least one variable. None of the medical management manuscripts individually reported any statistical significance between groups for change in lameness, with one manuscript revealing a trend towards medical management and the others towards surgical management as the preferred therapeutic method. A summary of all of the manuscripts can be found in Table 1. It is immediately evident from the table that most of the sample sizes for the individual studies are small. This was due, in part, to the failure of patients to return for follow-up. One of the studies (Bouck et al. [1]) received an ADA score of the highest level of evidentiary value (denoted by a ‘+’). The remainder of the studies had ADA scores of ‘-’.

There were several reasons for the weak ADA scores. Primarily, the studies were not blinded and were observational (which per-

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mit sources of bias), rather than randomized. On the other hand, all of the studies clearly stated their research objectives and used appropriate statistical analysis methods.

One paper evaluated the two surgical techniques. Meyer–Lindenberg et al. (12) compared arthroscopy to medial arthrotomy in 429 cases, using a retrospective study design (ADA score ‘-‘), and showed that 72% of patients improved by using medial arthrotomy, and that 89% of patients improved by using arthroscopy.

After the data had been combined in a meta-analysis, the effects were different among management techniques. The probability that arthroscopy is superior to medical management is 1.0, with a 17% ([10%, 25%], a 95% probability interval) increase in improvement if arthroscopy is used instead of medical management. A probability of 1.0 is inferentially similar to a very small p-value (e.g. p<0.0001). It means that it is certain that arthroscopy is superior to medical management and not due to chance. The probability that arthroscopy is superior to medial arthrotomy is 0.91 with a 14% (-7%, 35%) increase in improvement if arthroscopy is used instead of medial arthrotomy and the probability that medial arthrotomy is superior to medical management is 0.62 with a 3% (-16%, 23%) improvement of medial arthrotomy over medical management.

### Discussion

The probability that one treatment is superior to another must be interpreted with care. For example, the probability that arthroscopy is superior to medical management is 1.0 does not mean that arthroscopy will be superior to medical management in every clinical case. It means that, on average, arthroscopy is superior to medical management. In contrast, the probability that medial arthrotomy is superior to medical management is 0.62, which means that it is more likely that medial arthrotomy is superior to medical management, but there is a reasonable chance (0.38) that medical management, on average, is superior to medial arthrotomy. The negative lower bound of the corresponding confidence interval (-16%, 23%) indicates the magnitude that medical management may be superior to medial arthroscopy: as much as 16% of the cases.

Similar reasoning holds for arthroscopy vs. medial arthrotomy. The confidence interval is (-7%, 35%) which means that medial arthrotomy may have as much as a 7% improvement over arthroscopy. However, the chance that is the case is small: 0.09 = (1–0.91).

It is tempting to try to interpret the probabilities as p-values with the classic 0.05 cut-off. Sometimes p-values and probabilities disagree, but for most ‘realworld’ problems a large (or small) probability of a treatment difference would, in most real problems, lead the investigator to the same conclusion as a small (or large) p-value.

There are several factors that may influence the interpretation of the results. First, medical management techniques were inconsistent across the studies. Some used rest, some used drug therapy and others used a combination of both. If these studies are assessed independently there is too little information to make an informed decision about the preferred method of management, and the clinician is left with his or her own practice experience. An alternative approach that was used in this research was to combine studies (in order to increase power) with similar management approaches and to make clinical decisions based on data and practice experience.

Also, lameness was evaluated differently across the studies. Several manuscripts used veterinarians to evaluate the dogs, but owner surveys were used in others. However, it is common for meta-analysis to combine studies with slightly different outcome measures.

Brown (13) found that manuscripts in veterinary journals often fail to describe randomization procedures; this reporting omission is considered to be a major source of bias. Usually, biased studies show group differences, but most of the studies in this meta-analysis individually did not show any group differences, suggesting that, in spite of the weak ADA scores, the studies were able to limit bias which strengthens the justification of their use in the meta-analysis.

Conservatively, it may be that some form of medical management for FMCP is better than other forms, but overall surgical management, in particular arthroscopy for FMCP, results in an improved prognosis. Clinical judgements based on the results of the meta-analysis should be tempered by relatively weak evidentiary value of the studies.

### References


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