TITLE: Retrospective evaluation of pericardial catheter placement in the management of pericardial effusion in dogs (2007–2015):18 cases

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Abstract

Objective

To describe the use of pericardial catheters in dogs with pericardial effusion (PE), and detail any associated adverse events.

Design

Retrospective study.

Setting

University teaching hospital.

Animals

Eighteen client-owned dogs that had pericardial catheters placed for pericardial fluid drainage between May 2007 and January 2015.

Interventions

None.

Measurements and main results

All pericardial catheters were placed within 5 hours of presentation, usually within 1 hour (median 72.5 minutes, range 45-300 minutes, mode 60 minutes). Ten of 18 cases were sedated with butorphanol, and 4 with additional midazolam. Four had pericardial catheters positioned for single drainage only and were immediately removed. The other 14 pericardial catheters remained in situ for a median of 18 hours (range 2-88 hours). Ten of the remaining 14 cases were re-drained after pericardial catheter placement. The main adverse events reported were new arrhythmias in 6/18 cases, with 4 of these 6 patients being administered anti-arrhythmic therapy. No infectious or functional complications were reported. Ten patients were discharged, 1 died and 7 were euthanised.

Conclusions

Thoracic drainage catheters inserted into the pericardial space via a modified-Seldinger technique can be positioned in dogs to aid management of pericardial effusions. The main associated adverse event is arrhythmia. Minimal sedation is required for placement, and dogs tend not to require post procedural analgesia. Catheters can remain in situ for repeated drainage, potentially decreasing staffing time requirement and repeat sedation. Their use is associated with a rate of arrhythmia requiring treatment of 22%, compared to that of needle pericardiocentesis alone at 13%. They are easy to position using equipment available in many facilities.

Abbreviations

PE, Pericardial effusion.

Keywords

Tamponade, treatment, extended catheter drainage.

Introduction

In dogs, the pericardial space usually contains approximately 0.25ml/kg bodyweight of clear, serious fluid as lubrication between the visceral and parietal pericardium; an excess or inappropriate fluid presence is termed a pericardial effusion (PE).[1,2] The etiology of canine pericardial effusion is most frequently neoplastic or idiopathic, with less common causes including coagulopathy, left atrial rupture, local septic effusions and congestive heart failure.[1,3-5]

In the emergent situation, pericardial effusion can lead to cardiovascular instability involving cardiac tamponade, reduced preload and compromised cardiac output. This may necessitate drainage of fluid from the pericardial space. Needle pericardiocentesis is well described as a simple and efficacious technique for treating cardiac tamponade.[1] However, pericardial effusion can recur and cause clinical signs, requiring repeated drainage. Repeated pericardiocentesis has been reported to be necessary in 25-31% of cases of canine pericardial effusion, although the timescale to re-effusion is highy variable.[4,6] Should it occur during the same hospital visit this may increase animal stress and staffing requirements, and may necessitate further sedation in a cardiovascularly unstable patient.

Pericardial catheter placement and 'extended pericardial catheter drainage' is well documented in human medicine, being the standard of care for management and repeated drainage of pericardial effusions, and has been shown to prevent further fluid accumulation in both malignant and idiopathic effusions.[7,8] Extended pericardial catheter drainage refers to the process of continued, elective drainage of pericardial effusion by indwelling catheter every 4-6 hours until the effusion is minimal in volume (25-30ml/day). This is usually for approximately 4 days. In human pericardial catheter placement, the incidences of major complications, such as myocardial or coronary artery laceration, and severe arrhythmias (usually vasovagal bradycardia) are both less than 2%.[7] Although over the needle central venous catheters have been recommended for single drainage previously,[9] there have been no studies reporting or investigating extended pericardial catheter drainage in veterinary medicine. The equipment required for pericardial catheter placement and extended drainage is readily available but there is no evidence indicating a clear advantage or disadvantage of its use or information regarding its safety.

This retrospective study serves to describe the use of pericardial catheters in dogs with pericardial effusion, including reported adverse events to aid assessment of whether they are beneficial in case management.

Materials and methods

Medical records at a veterinary teaching hospital were searched for cases of canine pericardial effusion which were managed with a pericardial catheter between May 2007 and January 2015. Animals with incomplete records were excluded from the study. Information collected included signalment, weight, whether needle pericardiocentesis had been performed prior to pericardial catheter placement, time from presentation to pericardial catheter placement, sedatives or local anesthetic drugs used to aid catheter placement, adverse events reported, presence of arrhythmias, whether arrhythmias were treated, details of repeated drainages, length of drain persistence, analgesics used post placement, final diagnosis and outcome.

Statistical methods

All continuous data was assessed for normality using a Shapiro-Wilk Test and descriptive data calculated as appropriate using commercially available software.[a]

Results

Ethical approval was granted by the Clinical Research Ethical Review Board (CRERB) (reference number M2016 0087). Twenty-five cases of canine pericardial effusion in which pericardial catheters were placed were identified. Seven cases were excluded due to incomplete records leaving 18 cases in the study. In the same period there were 94 additional cases of pericardial effusion managed by needle pericardiocentesis alone. The breeds represented were Labrador Retrievers (4), German shepherds (3), Golden Retrievers (3),

Greyhounds (2) Bull Mastiffs (2) and one each of the following breeds: Pyrenean Mountain Dog, Bull Terrier, Rottweiler, Crossbreed. The mean (± SD) age of dogs involved in this study was 96 (± 30) months. Eleven males (7 neutered) and 7 females (6 neutered) were included. The mean weight (± SD) of the dogs was 41.8kg (± 9.3) kg with the smallest weighing 26.7kg

Twelve dogs had a presumed neoplastic cause of PE based on echocardiography by a board certified cardiologist (mass lesion identified), 4 had a presumed idiopathic cause (no mass lesion identified) and 2 did not undergo complete investigations prior to death or euthanasia and a cause was not determined. The majority of presumed neoplastic sites were right atrial or auricular in origin and there were no examples of iatrogenic or post-surgical effusions requiring drainage.

All catheters were 20cm chest tubes[b] placed percutaneously by a modified-Seldinger technique as follows: 1) Aseptic preparation of skin between ribs 4 and 6 over right hemithorax. 2) Peripheral cannula insertion (usually with a small skin incision made with a surgical blade and often ultrasound guided or planned) into the pericardial sac followed by removal of cannula stylet. 3) Guide wire insertion via peripheral cannula access. 4) Cannula removal and catheter positioning over guidewire. 5) Guide wire removal and securement of catheter to overlying skin with sutures. (Fig 1.) Catheters were covered with a sterile adhesive dressing and often secured with elastic tubular netting.[c] (Fig 1.) Tunneling of the catheter subcutaneously may not be necessary, but a slight cranially directed insertion can maintain the tube flush with the skin surface.

Three dogs had needle pericardiocentesis prior to re-effusion and subsequent pericardial catheter placement within 24 hours. The other 15

131 catheters were used for first time drainage. All pericardial catheters were placed
132 within 5 hours of presentation with a median time to placement of 72.5 minutes
133 (Range 30-300).

134 Ten of the 18 dogs were sedated for pericardial catheter placement with
135 butorphanol[d] (median 0.2, range 0.1-0.5mg/kg) which was combined with
136 midazolam[e] (0.2mg/kg) in 4 cases. Four dogs received lidocaine[f] local anesthesia
137 in the cutaneous and muscle layers where the drain was to be placed, two
138 without concurrent systemic sedation. Six cases had neither sedation nor local
139 anesthesia documented, and no patients were fully anaesthetized.

140 Two animals (11%) were described as having ongoing bleeding into the
141 pericardial space. Of these, one had been bleeding within the pericardium prior
142 to or after an initial needle pericardiocentesis, having a catheter placed after a
143 second pericardiocentesis and died hours later, with coagulopathy excluded as
144 the cause of the PE. The other had a right atrial mass identified as the cause of
145 the PE and was euthanized electively after 3 further large volume drainages
146 (237ml, 265ml and 346ml within 5.5 hours) due to tamponade after the initial
147 drainage by catheter.

148 A total of 10 dogs had arrhythmias documented during their
149 hospitalization. As is standard procedure in this hospital, animals were
150 monitored by continuous electrocardiogram (ECG) during and immediately post
151 procedure, and occasionally pre-procedurally. Post-procedural ECGs were
152 performed based on stability. In 4 cases arrhythmias were documented pre-
153 procedurally (ventricular arrhythmias, two episodes of ventricular tachycardia
154 and one of electrical alternans). Six of 18 cases (33%) had new arrhythmic
155 events reported at the time of pericardial catheter placement and subsequently.

These were nearly exclusively ventricular arrhythmias. Ventricular premature complexes and accelerated idioventricular rhythms predominated, with ventricular tachycardia reported in 3 of these dogs and second degree atrioventricular block in one dog. Two of the 4 dogs with ventricular arrhythmias documented pre-procedurally required lidocaine bolus treatment (2mg/kg) prior to the procedure, followed by continuous rate infusions (50-80mcg/kg/min). Four of the 6 dogs with new arrhythmic events were treated with lidocaine boluses, with 2 requiring adjunctive continuous rate infusions. Two dogs with arrhythmias noted pre-catheter placement and 2 dogs with arrhythmias noted during or after placement were not treated with anti-arrhythmic therapy.

Six cases received post procedural analgesia (butorphanol 0.1 mg/kg or methadone[g] 0.1mg/kg) which was presumed to have been administered for perceived or anticipated discomfort due to the pericardial catheter.

Overall, 40 pericardial drainage events were performed using the pericardial catheters. Four dogs had pericardial catheters positioned for immediate drainage only which were subsequently removed (in one of these no fluid was retrieved, but it relieved the effusion and was immediately removed). The other pericardial catheters remained in situ for a median of 18 hours (Range 2-88). Ten of the 14 dogs with catheters kept in situ after first drainage had repeat pericardial effusion drainage via the catheter, 7 of these due to a perceived clinical deterioration such as tachycardia or worsening arrhythmias, and 3 electively on a routine basis. Among the 7 cases re-drained out of apparent necessity, there were 12 re-drainage events.

Pericardial catheters were placed and removed at the clinician's discretion, but appeared to be removed due to euthanasia or stability being achieved and animals being discharged. No infectious or functional adverse events were reported.

Ten of the 18 cases survived to discharge, 7 were euthanized and 1 died during hospitalization. The patient that died was hemorrhaging catastrophically prior to drain placement, having had two needle pericardiocentesis events already at the QMHA.

Discussion

This retrospective study describes the use of pericardial catheters in dogs with pericardial effusion, demonstrating an alternative to needle pericardiocentesis in this disease process, either in the first instance or in cases requiring repeated drainage. Caution should clearly be exercised before considering this procedure in the first instance without more rigorous demonstration of safety or benefit, however. The population described in this study is consistent with previous retrospective studies of canine pericardial effusion, with Golden Retrievers, German Shepherd Dogs and males apparently over-represented.[4] There were high numbers of presumed neoplastic aetiologies (66% of the population), with 31-68% reported previously.[4,10]

The pericardial catheters in this study were positioned easily, under minimal sedation and with occasional local anesthesia only. Six patients received no procedural sedation nor local anesthesia. This is presumed to be a function of both the retrospective nature of this study, and occasional moribund patients that may well have been drained without these drugs. There was one report of a

lack of retrieval of pericardial fluid after placement of the catheter, however, the effusion was relieved in this case. All other catheters were placed on the first attempt and pericardial fluid was obtained. In some cases, it appeared that pericardial catheters were placed as repeated pericardiocentesis was required (3 cases); however, in other cases it was unclear why this choice was made over standard needle pericardiocentesis and it is likely there was a degree of clinician preference. Procedural length was rarely documented nor collated but in the authors' experience it takes approximately 20 minutes from skin preparation to dressing the catheter, including drainage. Previous reported use of the same equipment for management of pleural space disease documented placement times of less than 10 minutes in the vast majority of cases.[11]

No adverse events that could be definitively directly attributable to pericardial catheter placement were noted. One of the catheters failed to recover any volume of effusion and so was removed immediately but it was noted that the effusion had resolved, presumably due to pericardial penetration.

New ventricular arrhythmias were identified in 6 of 18 dogs (33%) at the time of pericardial drain placement, 4 requiring treatment (22%). It is not possible to state whether these arrhythmias were related to pericardial catheter placement specifically, were manifestations of the underlying disease or were secondary to pericardial stimulation which would have occurred with any fluid drainage technique. Arrhythmias are commonly reported in dogs with pericardial effusion[4,6] and in this study 4 of the dogs had ventricular arrhythmias reported prior to catheter placement, one of which had a needle pericardiocentesis performed previously. It is possible that arrhythmias were present prior to catheter placement but not recognized until an ECG was

performed during the procedure and monitored post-procedurally as is standard practice at our hospital. It could be that the cases selected for catheter placement were considered less stable resulting in closer monitoring and more consistent documentation of adverse events in a slightly more complex procedure than needle pericardiocentesis. It is also possible that the catheters themselves initiated or perpetuated the arrhythmias. In human pericardial catheter placement, the major complications are laceration and perforation of the myocardium and coronary vessels, with the frequency of these complications reduced by echocardiographic guidance, and even more by fluoroscopic guidance.[7]

A retrospective study of dogs undergoing needle pericardiocentesis reported a 13% rate of arrhythmias requiring treatment,[6] which is not markedly different to the rate of arrhythmias requiring treatment (22%) in this study. Given the low frequency (4/18) of treatment of new ventricular arrhythmias in dogs with pericardial catheters positioned, it may be concluded that they were often of limited clinical significance as they did not require more than lidocaine bolus (4 cases) or continuous rate infusions (2 of these 4 cases). Future attempts ought to be made to ascertain whether such arrhythmias are catheter derived and hence avoidable. No dog underwent cardiopulmonary arrest secondary to the arrhythmias noted. If treatment of these is rarely required, it might seem reasonable to tolerate their presence so long as perfusion is not compromised, and to be vigilant of their potential progression as with any ventricular arrhythmia.

Two dogs (11%) were described as having ongoing bleeding. Both were considered cardiovascularly unstable on presentation and one had a right atrial

mass identified as the cause of the effusion. This dog had a pericardial catheter positioned in the first instance and it is impossible to conclude whether the catheter placement or right atrial mass was responsible for ongoing bleeding. The other died without a diagnosis being achieved, but the catheter was positioned due to immediate re-effusion post needle pericardiocentesis and hence the continued bleeding was either a function of the underlying disease or a previous pericardiocentesis. A coagulopathy was excluded. It is impossible to exclude pericardial catheter placement as a cause of ongoing bleeding in this case, but there was no suggestion of concerns for this in the clinical notes. Other explanations would include relieving the pericardial pressure and potentiating ongoing bleeding from an undiagnosed tumor. Adverse events other than arrhythmias described in a retrospective study of needle pericardiocentesis included ongoing bleeding in 3 of 85 cases (all of which had neoplasia as a cause of PE) and cardiopulmonary arrest in 4 of 85 cases.[6]

In the setting that repeat pericardiocentesis may be required with urgency, if there are no significant contraindications to maintaining a pericardial catheter in place, such as local pyoderma, then having one present carries obvious advantages. In people, extended pericardial catheter drainage is associated with a reduction in the recurrence of idiopathic and postoperative effusions by 44-77%.[12,13] They are associated with a lack of malignant pericardial effusion recurrence also.[14] The mechanism of this is postulated to be in fenestration of the pericardium by persistence of the catheter. In one study of pericardiocentesis in dogs, 29% of patients required repeated pericardiocentesis and based on the human literature, preventing recurrence of pericardial

effusions is a potentially unrecognized benefit of extended pericardial catheter drainage in veterinary medicine.[6]

In this study the length of time the pericardial catheter remained in situ appeared to be at the clinician's discretion. Four catheters were placed solely for immediate pericardiocentesis prior to removal, suggesting they were placed as the clinician preferred this technique to standard pericardiocentesis. No catheters were removed due to documented complications. Specific reasons for removal were not possible to determine and this is a limitation of the study, although they appeared to serve their purpose well and be removed pending discharge from the hospital or euthanasia. In human medicine where extended pericardial catheter drainage is utilized, they are drained every 4-6 hours or as necessary until fluid accumulation is less than 25-30 ml/day.[15]

Many of the indications for pericardiocentesis in human medicine arise after cardiothoracic surgery, or ventricle perforation during catheter assisted procedures such as pacemaker placement, valvuloplasty or pulmonary artery catheterization, with "primary" malignancy related effusions still predominating. It is possible that with increasing interventional radiology and cardiothoracic surgery procedures being performed in veterinary medicine, pericardial catheter drainage may be increasingly required post-procedurally and post-surgically.

This study is limited by its retrospective nature and also by the fairly small numbers of animals described. There was also no clear reasoning described in the records why pericardial catheters were placed rather than performance of needle pericardiocentesis, with 15 of 18 being used for first time drainage. It is therefore assumed that catheters were placed at the clinician's

discretion as no protocol, outlining clear indications, currently exists for their use at this teaching hospital but this cannot be definitively stated.

In conclusion, this study demonstrates that pericardial catheters can be placed to allow drainage of pericardial effusion, which can then be repeated if necessary. No adverse events were noted which could definitively be attributed to the catheter placement, but concurrent ventricular arrhythmias were seen. The advantage of placement of these catheters is that repeated drainage of effusion can be performed by a suitably qualified person (veterinarian or technician) alone, and that this can be performed without the stress and potential complications of repeated needle pericardiocentesis. It also introduces the concept of extended pericardial catheter drainage which may offer further advantages. Although not evaluated in this study, it is possible that procedural time is slightly longer than needle pericardiocentesis and likely that cost would be higher. Efficacy and safety of pericardial catheter use and extended pericardial catheter drainage would best be assessed with a prospective study.

Footnotes

[a] IBM SPSS Statistics, Version 22, New York, USA

[b] 14ga x 20cm (8in) Catheter fenestrated up to 8cm mark, MILA International Inc. Medical Instrumentation for Animals, Kentucky, USA

[c] Colorline Surgifix, elastic tubular netting, FRA production, Dusino San Michele, Italy

[d] Alvegesic vet. 10mg/ml, Dechra, Shrewsbury, UK

[e] Hypnovel 10mg/2ml, Roche Products Limited, Welwyn, UK

[f] 2% Lidocaine, Braun Melsungen, Melsungen, Germany

[g] Comfortan 10mg/ml, Dechra, Shrewsbury, UK

330 **References**

331 1. Ware WA. Pericardial diseases. In: Silverstein DC, Hopper K, editors. Small
332 Animal Critical Care Medicine. 2nd ed. St Louis: Elsevier, Saunders; 2015,
333 pp. 239-246
334 2. Dyce KM, Sack WO, Wensing CJG. Textbook of veterinary anatomy. 3rd ed.
335 Philadelphia: Elsevier, Saunders; 2002, pp. 219-220
336 3. Reineke EL, Burkett DE, Drobatz KJ. Left atrial rupture in dogs: 14 cases
337 (1990-2005) J Vet Emerg Crit Care 2008;18(2):158–164
338 4. Stafford Johnson M, Martin M, Binns S, Day MJ. A retrospective study of
339 clinical findings, treatment and outcome in 143 dogs with pericardial
340 effusion. J Small Anim Prac 2004;45:546–552
341 5. Petrus DJ, Henik RA. Pericardial effusion and cardiac tamponade
342 secondary to brodifacoum toxicosis in a dog. J Am Vet Med Assoc
343 1999;215(5):647–648
344 6. Humm K, Keenaghan-Clark EA, Boag AK. Adverse events associated with
345 pericardiocentesis in dogs: 85 cases (1999-2006). J Vet Emerg Crit Care
346 2009;19(4):352–356
347 7. Maisch B, Seferović P, Ristić A et al. Guidelines on the Diagnosis and
348 Management of Pericardial Diseases Executive Summary. Eur Heart J
349 2004;25:587–610
350 8. Sagristà-Sauleda J, Mercé A, Soler-Soler J. Diagnosis and management of
351 pericardial effusion. World J Cardiol 2011;3(5):35-143
352 9. Gidlewski J, Petrie JP. Therapeutic Pericardiocentesis in the Dog and Cat.
353 Clin Tech Small Anim Prac 2005;20(3):151–155

10. de Laforcade AM, Freeman LM, Rozanski EA, Rush JE. Biochemical analysis of pericardial fluid and whole blood in dogs with pericardial effusion. J Vet Int Med 2005;19:833-836
11. Valtolina C, Adamantos S. Evaluation of small-bore wire-guided chest drains for management of pleural space disease. J Small Anim Prac 2009;50:290-297
12. Tsang TS, Barnes ME, Gersh BJ et al. Outcomes of clinically significant idiopathic pericardial effusion requiring intervention. Am J Cardiol 2002;91(6):704–7
13. Tsang TS, Barnes ME, Hayes SN et al. Clinical and echocardiographic characteristics of significant pericardial effusions following cardiothoracic surgery and outcomes of echo-guided pericardiocentesis for management: Mayo Clinic Experience, 1979–1998. Chest 1999;116(2):322-31
14. Tsang TS, Seward JB, Barnes ME et al. Outcomes of primary and secondary treatment of pericardial effusion in patients with malignancy. Mayo Clinic Proceedings 2000;75(3):248-253
15. Tsang TS, Oh JK, Seward JB. Diagnosis and Management of Cardiac Tamponade in the Era of Echocardiography. Clin Cardiol 1999;22:446-452

Figure Legends

Figure 1. Pericardial catheter placement.

A MILA® chest tube was used in all cases. An aseptic technique is used throughout.

A. Kit includes large bore peripheral IV cannula for access, guide wire, chest tube, clamps and bungs.

B. IV cannula secures access into the pericardial space.

C. Guide wire is passed into the pericardial space through the cannula.

D. Tube is threaded into position by Seldinger technique and secured to skin surface.