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

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1 **Abstract**

2 **Objective**

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

5 **Design**

6 Retrospective study.

7 **Setting**

8 University teaching hospital.

9 **Animals**

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

12 **Interventions**

13 None.

14 **Measurements and main results**

15 All pericardial catheters were placed within 5 hours of presentation, usually
16 within 1 hour (median 72.5 minutes, range 45-300 minutes, mode 60 minutes).

17 Ten of 18 cases were sedated with butorphanol, and 4 with additional midazolam.

18 Four had pericardial catheters positioned for single drainage only and were
19 immediately removed. The other 14 pericardial catheters remained in situ for a
20 median of 18 hours (range 2-88 hours). Ten of the remaining 14 cases were re-

21 drained after pericardial catheter placement. The main adverse events reported
22 were new arrhythmias in 6/18 cases, with 4 of these 6 patients being

23 administered anti-arrhythmic therapy. No infectious or functional complications

24 were reported. Ten patients were discharged, 1 died and 7 were euthanised.

25 **Conclusions**

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

35

36 **Abbreviations**

37 PE, Pericardial effusion.

38

39 **Keywords**

40 Tamponade, treatment, extended catheter drainage.

41

42 **Introduction**

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

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

61 Pericardial catheter placement and 'extended pericardial catheter
62 drainage' is well documented in human medicine, being the standard of care for
63 management and repeated drainage of pericardial effusions, and has been shown
64 to prevent further fluid accumulation in both malignant and idiopathic
65 effusions.^{7,8} Extended pericardial catheter drainage refers to the process of
66 continued, elective drainage of pericardial effusion by indwelling catheter every
67 4-6 hours until the effusion is minimal in volume (25-30ml/day). This is usually
68 for approximately 4 days. In human pericardial catheter placement, the incidences
69 of major complications, such as myocardial or coronary artery laceration, and
70 severe arrhythmias (usually vasovagal bradycardia) are both less than 2%.⁷
71 Although over the needle central venous catheters have been recommended for
72 single drainage previously,⁹ there have been no studies reporting or investigating
73 extended pericardial catheter drainage in veterinary medicine. The equipment
74 required for pericardial catheter placement and extended drainage is readily
75 available but there is no evidence indicating a clear advantage or disadvantage of
76 its use or information regarding its safety.

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

80

81 **Materials and methods**

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

92

93 **Statistical methods**

94 All continuous data was assessed for normality using a Shapiro-Wilk Test
95 and descriptive data calculated as appropriate using commercially available
96 software.^a

97

98 **Results**

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

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

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

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

129 Three dogs had needle pericardiocentesis prior to re-effusion and
130 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.

156 These were nearly exclusively ventricular arrhythmias. Ventricular premature
157 complexes and accelerated idioventricular rhythms predominated, with
158 ventricular tachycardia reported in 3 of these dogs and second degree
159 atrioventricular block in one dog. Two of the 4 dogs with ventricular
160 arrhythmias documented pre-procedurally required lidocaine bolus treatment
161 (2mg/kg) prior to the procedure, followed by continuous rate infusions (50-
162 80mcg/kg/min). Four of the 6 dogs with new arrhythmic events were treated
163 with lidocaine boluses, with 2 requiring adjunctive continuous rate infusions.
164 Two dogs with arrhythmias noted pre-catheter placement and 2 dogs with
165 arrhythmias noted during or after placement were not treated with anti-
166 arrhythmic therapy.

167 Six cases received post procedural analgesia (butorphanol 0.1 mg/kg or
168 methadone^s 0.1mg/kg) which was presumed to have been administered for
169 perceived or anticipated discomfort due to the pericardial catheter.

170 Overall, 40 pericardial drainage events were performed using the
171 pericardial catheters. Four dogs had pericardial catheters positioned for
172 immediate drainage only which were subsequently removed (in one of these no
173 fluid was retrieved, but it relieved the effusion and was immediately removed).
174 The other pericardial catheters remained in situ for a median of 18 hours (Range
175 2-88). Ten of the 14 dogs with catheters kept in situ after first drainage had
176 repeat pericardial effusion drainage via the catheter, 7 of these due to a
177 perceived clinical deterioration such as tachycardia or worsening arrhythmias,
178 and 3 electively on a routine basis. Among the 7 cases re-drained out of apparent
179 necessity, there were 12 re-drainage events.

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

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

188

189 **Discussion**

190 This retrospective study describes the use of pericardial catheters in dogs
191 with pericardial effusion, demonstrating an alternative to needle
192 pericardiocentesis in this disease process, either in the first instance or in cases
193 requiring repeated drainage. Caution should clearly be exercised before
194 considering this procedure in the first instance without more rigorous
195 demonstration of safety or benefit, however. The population described in this
196 study is consistent with previous retrospective studies of canine pericardial
197 effusion, with Golden Retrievers, German Shepherd Dogs and males apparently
198 over-represented.⁴ There were high numbers of presumed neoplastic aetiologies
199 (66% of the population), with 31-68% reported previously.^{4,10}

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

318

319 **Footnotes**

320 ^a IBM SPSS Statistics, Version 22, New York, USA

321 ^b 14ga x 20cm (8in) Catheter fenestrated up to 8cm mark, MILA International Inc.

322 Medical Instrumentation for Animals, Kentucky, USA

323 ^c Colorline Surgifix, elastic tubular netting, FRA production, Dusino San Michele,

324 Italy

325 ^d Alvegesic vet. 10mg/ml, Dechra, Shrewsbury, UK

326 ^e Hypnovel 10mg/2ml, Roche Products Limited, Welwyn, UK

327 ^f 2% Lidocaine, Braun Melsungen, Melsungen, Germany

328 ^g Comfortan 10mg/ml, Dechra, Shrewsbury, UK

329

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373 **Figure Legends**

374 Figure 1. Pericardial catheter placement.

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

376 throughout.

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

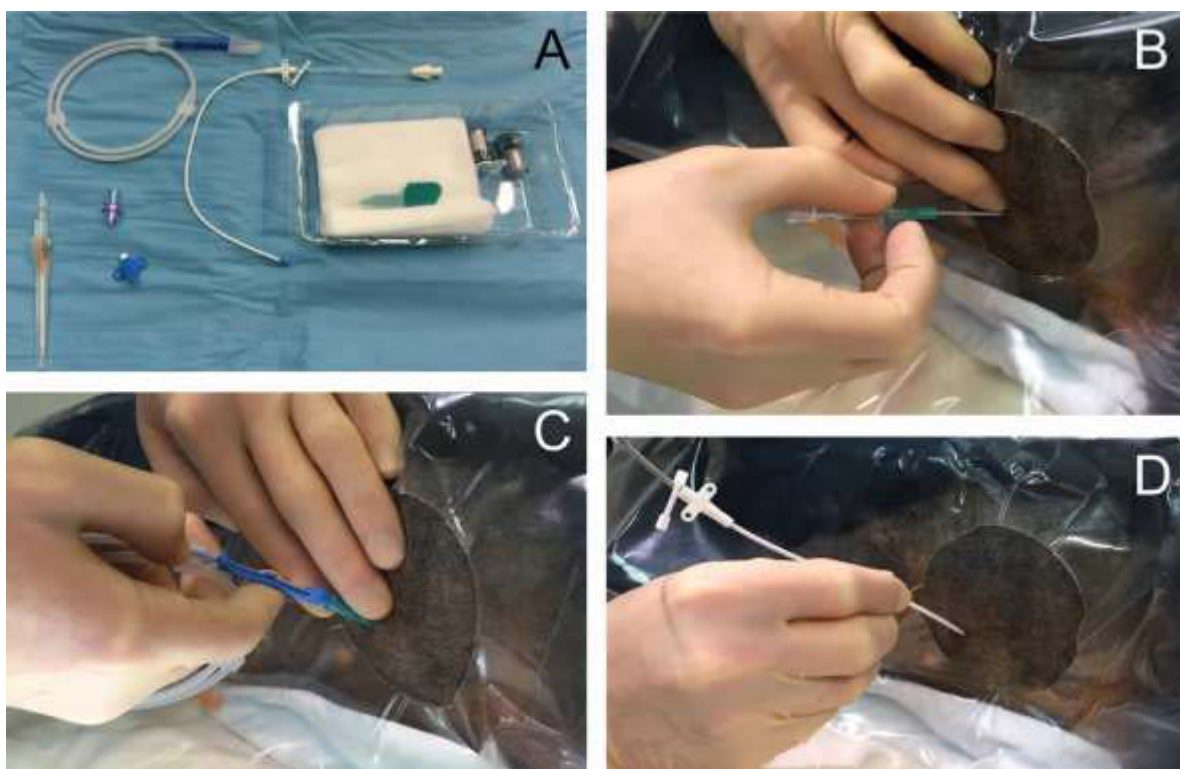
378 clamps and bungs.

379 B. IV cannula secures access into the pericardial space.

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

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

382 surface.



383

384