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CASE REPORT

The Efficiency of 7.2% Hypertonic Saline Solution on Echocardiographic Parameters in a Dog with Systemic Inflammatory Response Syndrome

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ABSTRACT

We were aimed with this case report that evaluate the efficiency of 7.2% hypertonic saline infusion on echocardiographic parameters in a 5-months-old male Kangal Shepherd crossbreed dog with the systemic inflammatory response syndrome (SIRS). For this propose on initial referral to the clinic, SIRS was defined with clinical and laboratory finding. Hypertonic saline (7.2%) was administered at intravenously of 4 ml.kg-1 (1.6 ml.kg-1.min-1) for fluid replacement. Echocardiography was performed at before (t=0 min), and after (t=5, t=15 min) fluid infusion. An increase in systolic function, cardiac contractility and left ventricular preload in the dog were determineted with the administration of 7.2% hypertonic saline. Considering this case, systolic dysfunction was improved by infusion of 4 ml.kg-1 7.2% hypertonic saline solution.

Key Words: Hypertonic Saline Solution, Left Ventricular Function, M-Mode Echocardiography, Systemic Inflammatory Response Syndrome

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Sistemik Yangısal Yanıt Sendromlu Bir Köpekte %7.2'lik Hipertonik Salin Solüsyonunun Ekokardiyografik Parametreler Üzerine Etkisi

ÖZ

Biz bu olgu sunumuyla sistemik inflamatuar yanıt sendromu (SIRS) gelişmiş 5 aylık, erkek, Kangal Çoban melezi bir köpekte %7.2 hipertonik salin infüzyonunun ekokardiyografik parametreler üzerine etkisinin değerlendirilmesi amaçladık. Bu kapsamda olgu kliniğe ilk başvurduğunda SIRS klinik ve laboratuvar bulguları ile tanımlandı. Sıvı replasmanı için %7.2 hipertonik salin, 4 ml.kg-1 dozda (1.6 ml.kg-1.dk-1) intravenöz yolla uygulandı. Ekokardiyografi sıvı infüzyonundan önce (t=0. dk), ve sonra (t=5., t=15. dk) gerçekleştirildi. Köpekte %7.2'lik hipertonik salin uygulaması sonrasında sistolik fonksiyonda, kardiyak kontraktilitede ve sol ventrikül ön yükünde artış belirlendi. Bu olgu dikkate alındığında 4 ml.kg-1 %7.2 hipertonik salin solüsyonu infüzyonun sistolik disfonksiyonu düzenlediği belirlendi.

Anahtar Kelimeler: Hipertonik Salin Solüsyon, Sol Ventrikül Fonksiyonu, M-Mod Ekokardiyografi, Sistemik Inflamatuar Yanıt Sendromu

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INTRODUCTION

Systemic inflammatory response syndrome (SIRS) is a clinical symptom complex of noninfectious (pancreatitis, trauma, neoplasia and immune-mediated diseases) or infectious origin which is initiated by series of inflammatory events (Bone et al. 1992, Rau et al. 2007, Torrente et al. 2015). Even if SIRS exist, excessive amount of cytokine is released followed by activation of the coagulation system throughly increasing microvascular permeability in relation with progressive endothelial dysfunction (Dircks et al. 2012, Bauer and Moritz 2013). All aforemented could contribute to secondary multiple organ dysfunction and death (Bone et al. 1992, Shapiro et al. 2010). Furthermore, it was demonstrated that vast majority of researches claimed that myocardial dysfunction might be existing during SIRS (Nelson and Thompson 2006, Gommeren et al. 2012, Hamacher et al. 2015). In patients with sepsis and SIRS, impaired perfusion, nutrition and along with metabolism, could lead to a general increase in microvascular permeability which can cause hypovolemia and tissue edema as a result of transcapillary leakage (Hinshaw 1996, Fink 2001).

The diagnosis of SIRS was made in regard to criteria previously stated (Bone et al. 1992, Okano et al. 2002). Left ventricular systolic function, related ejection fraction (EF) and fractional shortening (FS) have been evaluated by echocardiography in dogs with SIRS prone to myocardial dysfunction (Nelson and Thompson 2006, Gommeren et al. 2012).

Hypovolemic shock has been successfully managed with 7.2% hypertonic saline solution (HSs) (Velasco et al. 1980, Lopes et al. 1981, Us et al. 2001). It has a beneficial hemodynamic effect with various mechanism, that consequently elevates microvascular blood flow, on initial treatment of severe hypovolemia and shock (Baue et al. 1967, Drobin and Hahn 2002, Suzuki et al. 2005). Although the cardiovascular effect of 7.2% HSs has been investigated in normovolemic (Suzuki et al. 2006) and anesthetized dogs (Suzuki et al. 2008), we were unawere of finding documented reports of cardiac acceleration effect of HSs infusion in hypovolemic dogs with SIRS.

Thus, the aim of this case report was to determine the efficiency of 7.2% HSs infusion on echocardiographic parameters in a dog with SIRS.

Case Report

Case Presentation and Hypertonic Saline Infusion

A 5-months-old male Kangal Shepherd crossbreed dog presented as an critical case and priority triage referral to Aydın Adnan Menderes University, Small Animal Hospital. History of the dog was included acute diarrhea and vomiting for 3 months, two weeks after antihelminthic therapy of tremors begins and which was followed by anorexia, vomiting, diarrhea and constipation were evident. Muscle weakness with weight loss, comatose mentation, RR of 60 bpm, a HR of 165 bpm, and 34.5 °C body temperature, prolonged capillary refill time (3 s) were obtained in physical examination. There was a poor and insensible femoral pulse. For supportive care, 4 ml.kg-1 7.2% HSs intravenouslly was infused at a flow rate of 1.6 ml.kg-1.min-1. Echocardiography was performed at before (t=0 min), and after (t=5, t=15 min) fluid infusion.

Echocardiography

In order to perform the echocardiographic examination, the right 4-6 intercostal space of the dog was shaved and alcohol was administered first. Echocardiographic evaluation was performed using a 3.5-4 MHz convex probe and ultrasound gel on the echocardiography table with the device (Mindray M5 Color Doppler, distirubuted by Hasvet, Antalya, Turkey) available as a facility in our faculty. In echocardiographic evaluation, right parasternal short axis view; left ventricul (LV) were observed at the level of the chordae tendinea, and related parameters were measured with using the M-mod and Teicholz method (Figure 1). Left atrium-Aorta (LA/Ao) measurements were performed at the base of the heart (Figure 2). Echocardiographic images were obtained at before (t=0 min), and after (t=5, t=15 min) 7.2% HSs infusion and these are shown in Table 1.

Table 1. Echocardiographic measurements at 0, 5 and 15 minutes of administration of hypertonic solution.

Measurements[1]	t=0	t=5	t=15
IVSd	**0.62 cm**	**0.62 cm**	**0.7 cm**
LVIDd	**1.86 cm**	**2.37 cm**	**2.43 cm**
LVPWd	**0.85 cm**	**0.45 cm**	**0.45 cm**
IVSs	**0.85 cm**	**1.02 cm**	**0.85 cm**
LVIDs	**0.96 cm**	**1.07 cm**	**1.19 cm**
LVPWs	**1.07 cm**	**0.85 cm**	**0.9 cm**
EDV	**10.62 ml**	**19.65 ml**	**20.75 ml**
ESV	**1.84 ml**	**2.49 ml**	**3.25 ml**
SV	**8.78 ml**	**17.08 ml**	**17.50 ml**
EF%	**82.7**	**87.3**	**84.3**
FS%	**48.5**	**54.8**	**51.2**
LA/Ao	**0.77**	**0.86 cm**	**0.99 cm**
LA	**1.36 cm**	**1.50 cm**	**1.63 cm**
Ao	**1.76 cm**	**1.71 cm**	**1.64 cm**
HR	**165**	**103**	**99**
CO	**1448,7 ml**	**1759,24**	**1732,5**

IVSd= Interventricular septum diastolic, LVIDd= Left ventricular internal diameter, LVPWd= Left ventricular posterior wall diastolic, IVSs= Interventricular septum systolic, LVIDs= Left ventricular internal diameter systolic, LVPWs= Left ventricular posterior Wall systolic, EDV= End diastolic volume, ESV= End systolic volume, SV= Stroke volume, EF%= Left ventricular ejection fraction, FS% = Left ventricular fractional shortening, LA/Ao= Left atrium/aortic root, LA= Left atrium, Ao= Aortic root, HR= Heart rate, CO= Cardiac output.CO

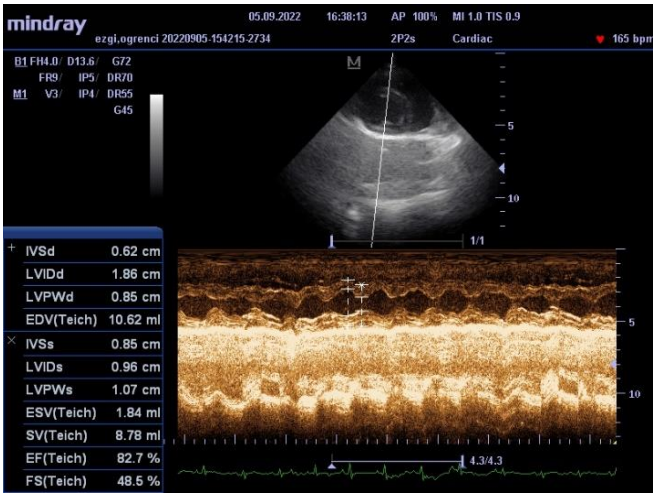

Figure1. LV measurements at the corda tendinea level in the right parasternal short axis.

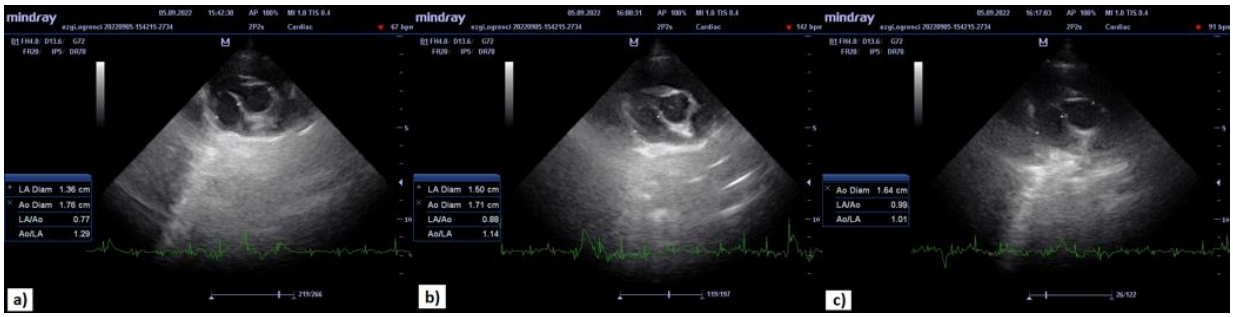

Figure2. Right parasternal axis-heart base image LA/Ao measurements at t=0 (a), t=5 (b), t=15 (c) min after the initiation of 7.2% hypertonic saline solution infusion.

DISCUSSION

In this case report we aimed to evaluate the efficiency of 7.2% HSs infusion on echocardiographic parameters in dog with SIRS. We determinated that systolic dysfunction was improved by infusion of 4 ml.kg-1 7.2% HSs.

There are a few studies related to echocardiographic evaluation following 7.2% HSs in animals. These studies stated that HSs infusions had no effect on systolic function however they performed on normovolemic animals (Cosntable et al. 1994, Ogino et al. 1998, Suzuki et al. 2006). Echocardiography is a crucial non-invasive assessment tool for the diagnosis and follow-up of the shocked patient. It is enable to evaluate intravascular volume that is difficultly determined by only clinical examination in patient with circulatory failure (McLean 2016).

Regarding previous study performed by Sirieix et al. (1999), investigated postoperative role of hypertonic solution on volume resuscitation in patient with mitral valve disorders, the researchers found that EF values increased after the HSs. It was reported that EF slightly increased after infusion of HSs in the normovolemic dogs (Suzuki et al. 2006). Magalhães et al. (2019), also showed left ventricular systolic dysfunction and myocardial injury were improved in brain death rats with HSs. Considering our results as EF increased from 82.7% (before infusion) to 87.3% (at 5 min) and thereafter were stable as 84.3% (at 15 min after completion of infusion), the amelioration of EF might be associated with effect on left ventricular preload/afterload and increasing myocardial contractility (Goertz et al. 1995, Sirieix et al. 1999).

Stroke volume (SV) and end-diastolic volume (EDV) regularly increased from at the time 5 and 15 min to 17.08 ml, 19.65 ml and 17.50 ml, 20.75 ml respectively, compared with prior to infusion (8.78 ml, 10,62 respectively). Furthermore LVIDd and LVIDs regularly increased from 1.86 to 2.43 and 0.96 to 1.19 cm at timeline 0. and 15. th minutes. According to Tavanaeimanesh et al. (2015), SV, end-diastolic volume (EDV) and LVIDd/s peaked at 40 min and relevant alteration were no more presented markedly in contrast to basal volume through 1.5 hours following infusion.

According to Campbell and Kittleson (2007), the La/Ao ratio is important for correct assessment of LA by eliminating racial body size differences. Furthermore these researchers showed a decrease in the LA/Ao ratio and LA value due to hypovolemia in cats, and an increase in the LA/Ao ratio and LA value after the hypovolemia was ameliorated with fluid infusion. In a human study (Agarwal et al. 2011) in which hypovolemia was induced by ultrafiltration, the LA diameter was initially measured as 2.1 cm in which was calculated as 0.14 and 0.15 cm lesser than the baseline values at 4 and 8 weeks, respectively. In several studies, LA diameter in human patients were increased after rapid intravenous fluid management (Di Donato et al. 1982, Duvekot et al. 1994) In our study, we determined that there was a gradual increase in LA/Ao ratio from 0.77 to 0.99 and LA value from 1.36 to 1.63 after HSs infusion. The reason for the elevation in LA diameter and LA/Ao ratio could be caused by the response to high LV diastolic filling pressure from myocardial failure (Fox et al. 1995, Rush et al. 2002). Heart rate and over volume loading may impact on LA diameter (DeMaria et al. 1979, Di Donato et al. 1982).

Experimentally induced hypovolemic shock in dogs has been resuscitated successfully with small volume of 7.2% HSs (Velasco et al. 1980, Lopes et al. 1981, Us et al. 2001). Hypertonic saline (7.2%) solution's beneficial hemodynamic effects are temporarily reducing systemic and pulmonary

vascular resistance (Suzuki et al. 2005), rapid increase of plasma volume with shifting body fluid from the intracellular space (Baue et al. 1967, Drobin and Hahn 2002), eliciting a vagal-mediated reflex by simulation of pulmonary osmoreceptors (Lopes et al. 1981, Velasco et al. 2004), and increasing cardiac contractility (Velasco et al. 1980). Additionally, a positive inotropic effect was determined with infusion (Kien and Kramer 1989, Muir and Sally 1989, Kien et al. 1991, Mouren et al. 1995). It caused cellular fluid loss via the osmotic effect, so elevating the calcium level (Wildenthal et al. 1975). Positive inotropic effect of 7.2% HSs may be related to increase cardiac contractility due to elevated intracellular calcium level. Nevertheless, considering in vitro investigation, a rapid elevation of extracellular sodium concentration causes a negative inotropic effect on cardiac contractility, lasting up to 10 minutes (Brown et al. 1990, Ben-Haim et al. 1992, Waagstein et al. 1999). A significant positive effect was not identified on some reports, so improvement of cardiac contractility is still considered uncertain (Suzuki et al. 2006).

In conclusion, we determined an increase in systolic function, cardiac contractility and left ventricular preload with the administration of 7.2% HSs in a dog with SIRS.

Conflict of Interest: The authors declared that there are no actual, potential or perceived conflicts of interest for this article.

Authors Contribution Rate: The authors declared that they contributed equally to the article.

Ethical Approval: This study is not subject to HADYEK's permission in accordance with Article 8 (k) of the "Regulation on Working Procedures and Principles of Animal Experiments Ethics Committees".

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