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# Inherited Malignant Ventricular Tachyarrhythmia in a German Shepherd

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**Abstract :** A 9-month-old neutered male German Shepherd dog was referred with the primary complaint of episodic collapse. Apparent abnormal findings were not observed in physical examination, routine biochemistry, and diagnostic imaging studies. In the 12-lead surface ECG after collapse, the dog showed frequent ventricular premature contractions (VPCs) with *torsade de pointes*. The frequency of VPCs was reduced after lidocaine infusion. Based on the history, findings in event recordings of the ECG and lidocaine response test, the dog was diagnosed as inherited malignant ventricular tachyarrhythmia. Although the dog was initially responded to oral sotalol therapy, the dog was died suddenly. This report described the first case of malignant ventricular tachyarrhythmia of German Sheperd in Korea.

***Key words*** **:** German Shepherd dog, arrhythmia, malignant ventricular tachyarrhythmias.

## Introduction

Malignant ventricular tachyarrhythmia in German Shepherds is an inherited cardiac conduction defect characterized by a sudden death during sleep in the early morning or during rest shortly after exercise (5,6). Although the exact inheritance mode has not been clearly identified, a sex-linked or autosomal dominant inheritance was suggested (6). Young dogs (age ranged from 4-45 months, but frequently in 6-7 months) are more vulnerable to sudden cardiac death. Most affected dogs have no obvious clinical signs, cardiographical abnormalities and unremarkable postmortem findings. Death is mainly due to malignant ventricular tachyarrhythmia (MVT) progressing to ventricular fibrillation (VF). According to current studies, mechanism(s) of the arrhythmia in this dog breed are; i) induction of triggered activity by perturbations in the autonomic nervous system and by lacking and heterogeneous innervation (11,12), ii) developmental arrest in tissues involved in conduction, iii) abnormal ventricular repolarization due to structural derangement associated ion-channel. The abnormal ventricular repolarization noticed in this dog breed is similar to human long-QT syndrome (LQTS), Brugada syndrome, and the short-coupled *torsade de pointes* (7,9). Furthermore, perturbations in the autonomic nervous system caused to sudden death in this dog can be similarly noticed in sudden infant death syndrome (SIDS) by cardiac cause (2). However, a recent study found spatial heterogeneity in expression and catecholamine responsiveness of potassium ion channel causes to heterogeneous left ventricular repolarization in this dog breed, contributing the incidence of ventricular arrhythmias (1). Several genetic etiologies were also proposed, based on human studies (3). Similar ventricular arrhythmias were also observed in Boxers and pigs (2).

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## Case

A nine-month-old castrated male German Shepherd dog (weighing 25 kg) was referred to Heart Clinic at Veterinary Teaching Hospital in Kangwon National University with the primary complaint of episodic collapse. The owner stated that the first episodes were noticed 3 weeks ago and had increased in frequency. Most of the episodes had started while the dog was asleep on the bed or resting after exercise. While the dog was collapsed, the dog did not lose consciousness and did not urinate or defecate. The episodes last less than 1 min and he regained normal mentation immediately afterward. No particular past medical history was observed. The dog was fully vaccinated and regularly dewormed. Two other dogs in the same litter died suddenly in the early of life. According to local practitioner who examined both dogs, no apparent cause of death was identified in necropsy. No particular findings of the referred dog were seen in the physical examination. Normal pulsation was detected in both femoral arteries. No abnormalities were also observed in hematology and blood chemistry. In urinalysis, mild proteinuria and bilirubinuria in urine dipstick test (SG10, Ames, USA) were noticed but were within normal range for a male dog. Heart rate was 119 beats per minute (bpm), but it was decreased to 60 bpm, when the dog was collapsed. Immediately after recovery from collapse, the heart rate was steeply increased to 150 bpm, suggesting that the dog has at least normal compensation of heart against the

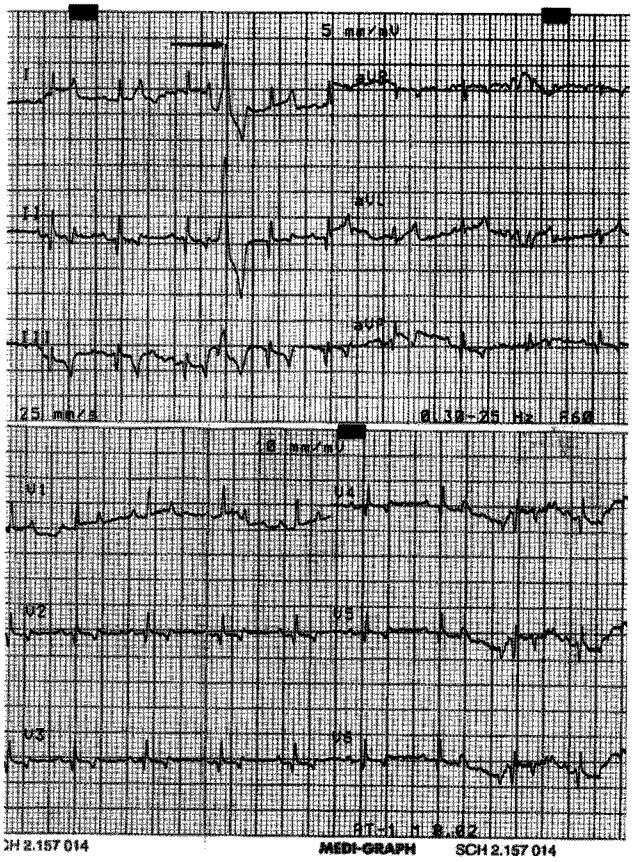


**Fig 1.** The 12-lead ECG recording taken at the day of presentation. The ECG trace is showing a normal sinus rhythm with single ventricular premature contraction (VPC); (arrow). The QRS is 18° indicating left axis deviation. However, no signs of left atrial and ventricular enlargement were noticed.

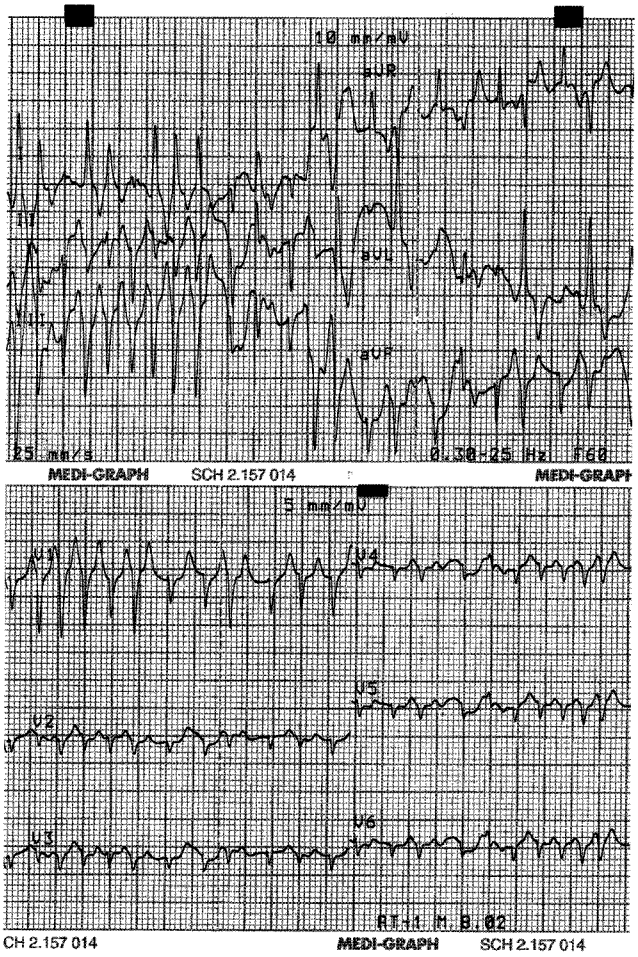


**Fig 2.** The 12-lead ECG recording taken during episode of malignant ventricular tachyarrhythmias. The ECG trace is showing *torsade de pointes* (polymorphic malignant ventricular tachyarrhythmias).

sudden arrhythmia. In cardiac auscultation, point of maximum intensity (PMI) was left apex as normal. No murmurs were auscultated in both thoracic walls.

A single ventricular premature contraction (VPC) with left QRS axis deviation was observed in a 12-lead surface electrocardiogram (Fig 1). However, no obvious signs of left side cardiac enlargement were observed in chest radiography and sonocardiogram. In the surface ECG and event recordings taken immediately after the episode, the runs of malignant ventricular tachyarrhythmia were observed (Figs 2 & 3). Total number of ventricular premature contractions (VPCs) was 670/hr in the first event recording (Table 1). In addition, there were runs of VPCs with irregular QRS morphologies, implying the ventricular arrhythmia was malignant. Lidocaine (2 mg/kg IV) response test was performed to recheck the ventricular tachyarrhythmia in this dog. The frequency of VPCs was reduced after injection. Based on medical history, ECG and lidocaine response test, the case was diagnosed as inherited malignant ventricular tachyarrhythmia induced inherited cardiac conduction defect, which often reported in this dog breed.

The dog was re-examined after 2 weeks of sotalol treatment (2.4 mg/kg, BID, PO for 2 weeks). The owner reported the dog had two episodes of collapse for last 2 weeks. The second event recording was performed. Heart rate was reduced from 105 bpm at presentation to 83 bpm after 2 week of treatment (Table 2). As shown in Table 1, the frequency of VPC was significantly reduced (10.3% to 3.7%). Furthermore the number of malignant VT (i.e. couplets or runs of VPC) was also markedly reduced. These findings were apparent evidence of clinical improvement. We increased the dose of sotalol to 90 mg (3.6 mg/kg BID, PO) for another 2 weeks, since the dog was tolerable to current dose of sotalol and did not show any adverse effects. In this time, the reduction of heart rate and the frequency of VPCs were minimal (Table 1 and 2). There were no apparent clinical improvements after increasing dose of sotalol. Therefore we decided to reduce the dose to 60 mg (2.4 mg/kg, BID, PO) again. The dog was died suddenly, 3 days after the visit. There were no remarkable necropsy findings.

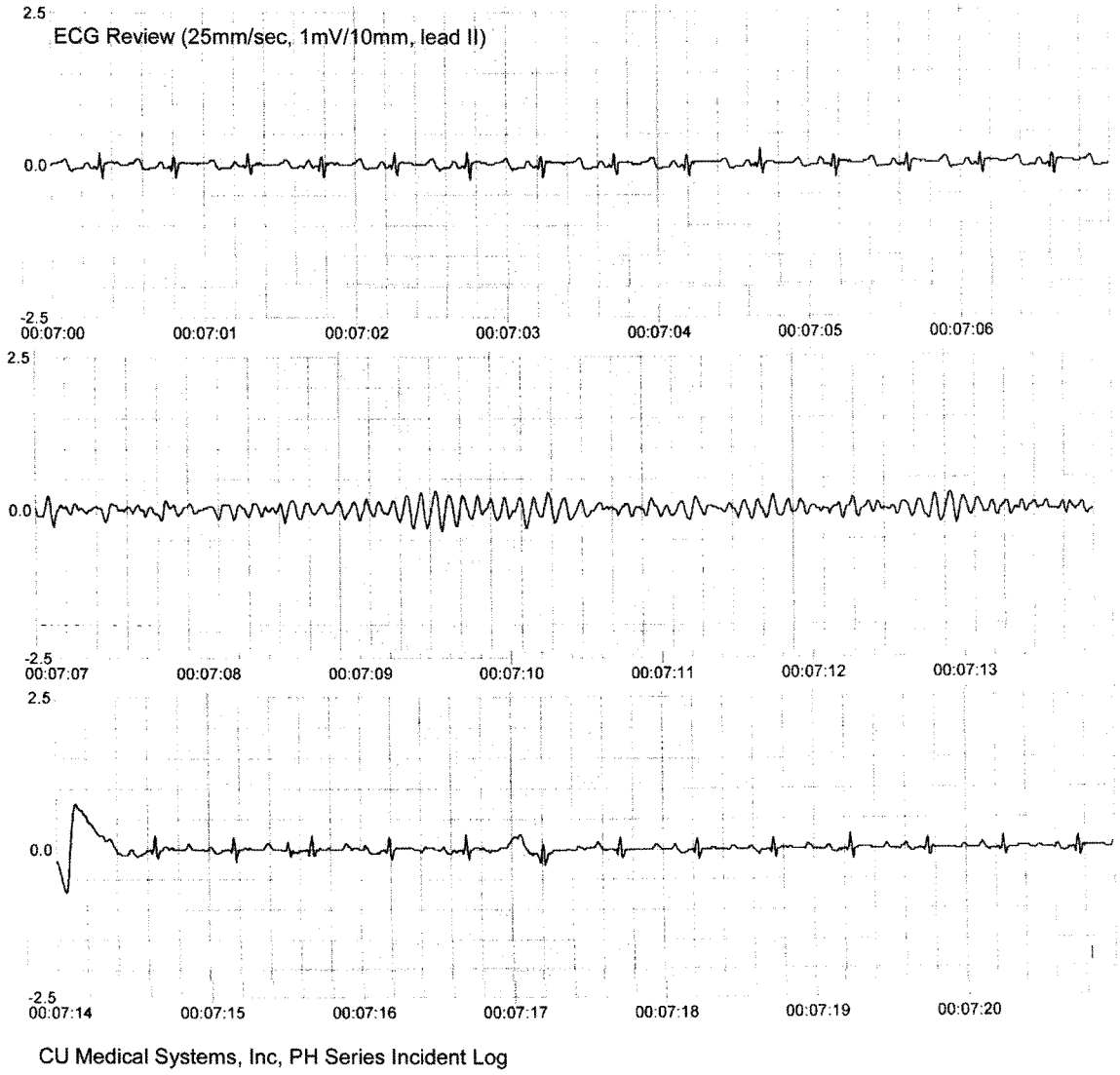


**Fig 3.** The 1-hr event recording taken at the day of presentation. The first and third trace is normal sinus rhythm. However the second trace is showing polymorphic runs of ventricular tachycardia (VT; ventricular fibrillation). The VPC lasted for 8 seconds and returned to normal sinus rhythm, immediately after VPC (See the third trace).

**Table 1.** Changes in frequency and morphology of QRS before and after medication in the 1-hr event recordings

| Event Recording | VPC Singles/Hr | VPC Couplets/Hr | VPC Runs/Hr | Total QRS | Total VPC | VPC% |
|---|---|---|---|---|---|---|
| Before Tx | 521 | 31 | 22 | 4937 | 670 | 13.6 |
| Reck1 | 118 | 7 | 3 | 4466 | 166 | 3.7 |
| Reck2 | 37 | 2 | 1 | 4388 | 57 | 1.3 |

Abbreviation: VT-ventricular tachyarrhythmias

**Table 2.** Changes in heart rate before and after medication in the 1-hr event recordings

| Event recording | Date of Recording | Duration of Recording (hr) | Drug | Dosage | Drug Duration | HR avg | HR min | HR max |
|---|---|---|---|---|---|---|---|---|
| Before Tx | 2005/05/07 | 1 | X | X | X | 105 | 75 | 134 |
| Reck 1 | 2005/05/21 | 1 | Sotalol | 60 mg BID | 2 wks | 83 | 56 | 113 |
| Reck 2 | 2005/06/04 | 1 | Sotalol | 90 mg BID | 2 wks | 81 | 49 | 101 |

Abbreviation: HR-Hear rate; avg-average; min-minimum; max-maximum Reck; recheck interval

## Discussion

VT can be occurred with primary myocardial diseases having myocardial damage that can produce reentry, abnormal automaticity, or triggered activity (8,10). VT can be also occurred with clinical states such as systemic disease, surgery and trauma, and in the presence of anesthetic agents such as thiobarbiturate (8,10). In general, occasional single VPCs are not required for treatment. The indication treatment for ventricular tachyarrhythmias are; i) more than 20 VPCs per min, ii) presence of doublets or triplets, iii) presence of multiformed VPCs, iv) presence of runs of VPCs and v) presence of so-called R on T phenomenon. Treatment for VT usually directs to; i) reduce the risk of sudden death, ii) decrease the frequency of a dangerous arrhythmia, and iii) improve or abolish related clinical signs (8). Class IB antiarrhythmic drugs and potassium ion channel blockers are choice of treatment for ventricular tachyarrhythmias in dogs (4,10). This case had strong ECG evidences indicating immediate treatment. Although the dog was initially responded to potassium channel blocker (sotalol) and marked clinical improvement on the heart rate and malignancy of VT were observed after initial treatment, medical therapy alone could not abolish the risk of sudden death. Implantable cardioverter defibrillator (ICD) could be an option for long-term management of malignant VT, although the cost of implantation would be an obstacle for this technology.

Primary cardiac conduction diseases are mainly genetic defects involved in impulse conduction processes (e.g., gap-junction genes, transcription factors) or repolarisation processes (e.g., ion-channel genes) (2). Acquired arrhythmias are mostly associated with myocardial disease, although conduction defects in the early stage of the disease process may be partly responsible for the development of myocardial fibrosis and dysfunction in some breed of dogs (3). In this case, two other dogs in the same litter died suddenly, 4 weeks and 5 months after birth, respectively. The family history of this case suggested genetic etiology. Since no genetic etiology related to cardiac conduction defects has been identified in dogs, a further study toward genetic investigation is warranted to reveal actual etiology for MVT in German shepherd dogs.

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# 져먼 셰퍼드종 개에서 발생한 유전성 악성 심실성 부정맥증

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**요 약** : 9살령 수컷 져먼 세퍼드종 개가 주기적인 실신 증상으로 내원하였다. 신체 검사, 혈액 생화학 검사 및 진단 영상학 검사에서 특별한 이상 소견은 관찰되지 않았다. 실신 직후 실시한 12-lead 심전도에서 환견은 심실조기박동을 동반한 악성 심실성 빈맥(*torsade de pointes*) 소견이 관찰되었다. Lidocaine 정맥주사 후 심실성 부정맥의 빈도수는 감소되었다. 병력과 심전도 검사(event recordings)를 토대로 본 증례를 져먼 세퍼드종의 유전성 심실성 부정맥증으로 진단하였다. 환견은 초기에 sotalol 구강투여로 증상이 개선되었지만 한달 후 특별한 증상 없이 급사하였다. 본 증례는 국내에서 최초로 보고된 유전성 악성 심실성 부정맥증이다.

**주요어** : 져먼 세퍼드, 부정맥, 악성 심실성 부정맥.