Chapter 5

Cardiac memory T wave frequency in the normal and diseased Dorper sheep heart.

Memory is a property common to a diverse range of tissues, such as the brain, the gastrointestinal tract and the immune system [1, 2], but is it possible for the heart to remember ? Indeed, this appears to be the case—cardiac memory has been demonstrated in the heart of the human, dog, cat and rabbit [3, 4, 5, 6].

Cardiac memory is an electrocardiographic phenomenon seen in the T wave, when T waves of normally conducted beats seem to "remember" the polarity of the QRS complexes of previous abnormally conducted beats [1, 3]. Only one event is remembered by the heart and that is a period (or periods) of altered ventricular activation [1, 3, 4, 6]. A variety of clinical scenarios are able to cause abnormal ventricular activation and these include: ventricular pacing, left bundle branch block, ventricular preexcitation and premature ventricular complexes [3, 4, 7, 8, 9, 10].

Rosenbaum and Blanco [3] , in their original description of cardiac memory, noted a specific sequence in cardiac memory. Periods of abnormal ventricular activation (leading to an altered sequence of ventricular depolarization) may induce a change in the T wave, which will be noted after return to a normal

sequence of ventricular activation. The T wave will retain the vector of the previous abnormal QRS complex—the polarity or direction of this T wave will be the same as that of the abnormal QRS complex(es).

Cardiac memory has never before been documented in the ovine heart. The objective of this study was therefore to examine the possibility that cardiac memory can be induced and documented in the hearts of normal Dorper wethers.

Materials and methods

The 10 clinically normal Dorper wethers that were used in chapter 3 were used in this study.

These 10 wethers were exposed to right ventricular PVC's for variable periods, as described in chapter 3 (table 5.1). The objective was to determine whether right ventricular PVC's are able to induce cardiac memory T waves. The second objective was to see if there is any difference in the frequency of cardiac memory T waves at the beginning and end of the study period.

Table 5.1. PVC load

Sheep number:	Number of PVC's counted:
1	55
2	221
3	80
4	575
5	150
6	371
7	1887
8	210
9	902
10	908

Results

A total of 5359 PVC's were counted and documented on a 12-lead surface electrocardiogram. In order to detect if there is any difference between the early and late occurrence of cardiac memory T waves the first and last 10 % of PVC's were evaluated in every wether. The T wave of the first normal beat after every PVC were evaluated in order to determine whether these T waves retained the vector of the previous PVC QRS complex (table 5.2). Only lead III of the 12-lead, surface electrocardiogram were used to assess for the presence

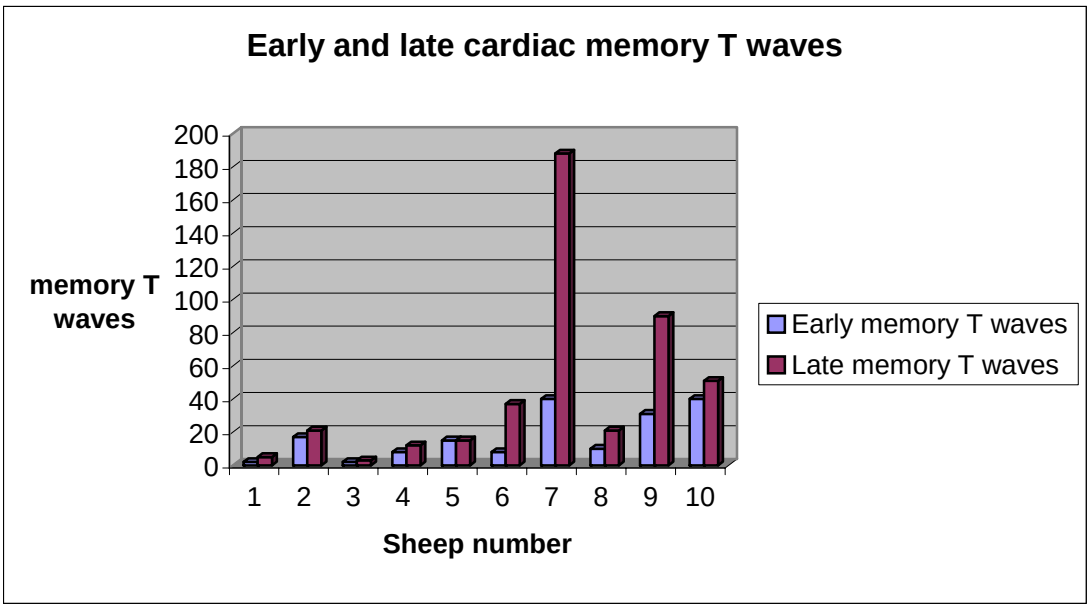
of cardiac memory T waves as a pilot study showed that this is the lead with the highest yield for cardiac memory T waves [11].

Table and graph 5.2. Early and late cardiac memory T waves

Sheep number:	Number of early memory T waves:	Number of late memory T waves:	Difference*:
1	2	5	3
2	17	21	4
3	2	3	1
4	8	12	4
5	15	15	0
6	8	37	29
7	40	188	148
8	10	21	11
9	31	90	59
10	40	51	11

* $p = 0.049$ (paired t-test).

OR = 10.38 (Odds ratio that an ovine heart that does not demonstrate cardiac memory T waves during the first 10 % of PVC's will do so during the last 10 % of PVC's.)



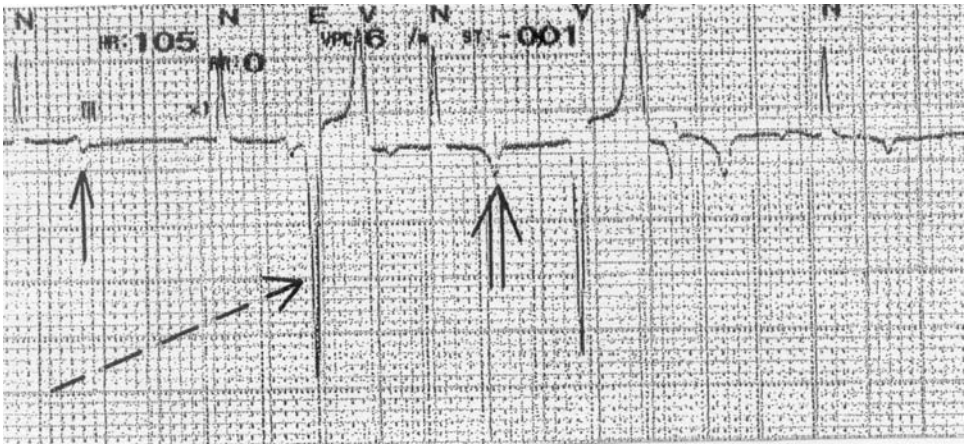


Figure 5.1. An example of cardiac memory T waves. The third and fifth beats in this tracing are PVC's (broken arrow). Note the bifid T waves before the first PVC (arrow). Note the inverted T waves after the PVC's (double arrow)—the T wave retains the vector of the QRS complex of the PVC—thus the term "cardiac memory".

Discussion

This is the first report of cardiac memory in sheep [11]. Cardiac memory T waves may appear after either short or long periods of altered ventricular activation [1, 4]. However, there is no consensus yet in the literature on the time period required to separate short- from long-term cardiac memory [4]. Rosenbaum and Blanco [3] in the first cardiac memory experiments needed 15 minutes of right ventricular pacing to demonstrate memory T waves in the human heart. Goyal and Syed [12] were able to induce cardiac memory after only 1 minute of right ventricular pacing in humans. This study demonstrates 2 concepts: First, the ovine heart is able to manifest cardiac memory T waves, and secondly the higher the load of altered ventricular activation (PVC's were used in this study) the more likely the manifestation of cardiac memory, as demonstrated by an odds ratio (OR) of 10.38 (the OR=10.38 that the amount of cardiac memory T waves will increase during the last 10% of PVC's as compared to during the first 10% of PVC's).

Currently, it is not known whether cardiac memory T waves can serve as an electrocardiographic warning for future myocardial pathology. In this study, it was shown that the true value of using cardiac memory T waves as an electrocardiographic surrogate for structural myocardial alteration in the Dorper sheep heart does not lie in an instantaneous electrocardiographic assessment, but in electrocardiographic follow-up in order to determine if there is an increase in the frequency of cardiac memory T waves. As shown in

this study an increase of at least 42 % in the frequency of cardiac memory T waves, following PVC`s is indicative of underlying structural myocardial changes in the Dorper sheep heart.

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