

Modified Bruce Protocol: Treadmill Testing for Cardiac Health

Purpose

The purpose of this investigation was three-fold: 1) for Dr. Carman to be come acquainted with the Hewlett-Packard 4755 AU Page Writer II EKG instrument in preparation to using it in class, 2) to obtain a treadmill test for teaching purposes for the second semester of Human Anatomy and Physiology and 3) to obtain a treadmill test for Dr. Carman's baseline health studies.

Materials

Standard EKG materials were readily available. Red Dot (3M) diaphoretic monitoring electrodes with soft cloth tape and solid gel were used (Figure, Below).



The EKG Instrument was donated to WNCC by Carson-Tahoe Hospital at the request of Haley Magney (one of Dr. Carman's former students). The technician was Dr. Carman's 9 year-old son, Tyler (Figure, Right).



The treadmill is a PreCOR M 9.21i treadmill that is adjustable for speed and elevation (maximum = 15%; Figure, Top Right). Facilities were at Dr. Carman's home. Room temperature was constant at 68° F (20° C).



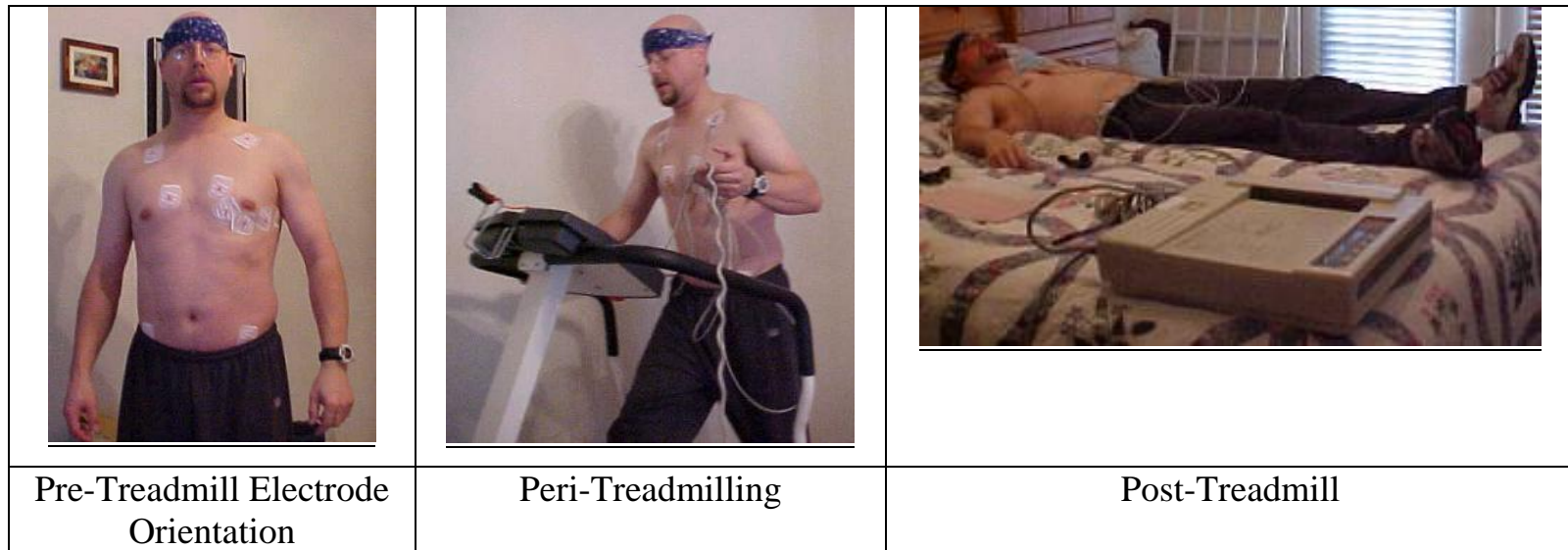
Subject

Dr. Carman is a 43 year old male in excellent health. He is about 5'10" tall and weighs 183 lbs. He is asymptomatic for chest pain, shortness of breath (SOB) or other cardiac symptomatology. His family history is positive for cardiovascular disease (primarily vasospastic) and cerebrovascular accidents. He does possess earlobe creases. He works out fairly regularly on the treadmill, lifts weights and hikes and bikes whenever possible. His last blood pressure was taken radially (electronically) at his dentist's (Andrew G. Getas, D.D.S., 883-8811) office, 01/08/2001, and measured 127/85 with a pulse of 76. The high BP is probably explained by having had only 40 minutes of sleep in that 48 hour period. He fasted overnight for a total of 17 hours prior to completing the exam.

Methods

The modified Bruce protocol was utilized with the following modifications: Stage 0 was added as a warm-up at 0% and 1.5 mph, per [Berman](#) [1]. Stages 4 and 5 had to be modified as follows: Stage 4 ran with 15% elevation instead of 16% as did Stage 5 rather than 18% due to the limitations of the treadmill. Blood pressures were not obtained.

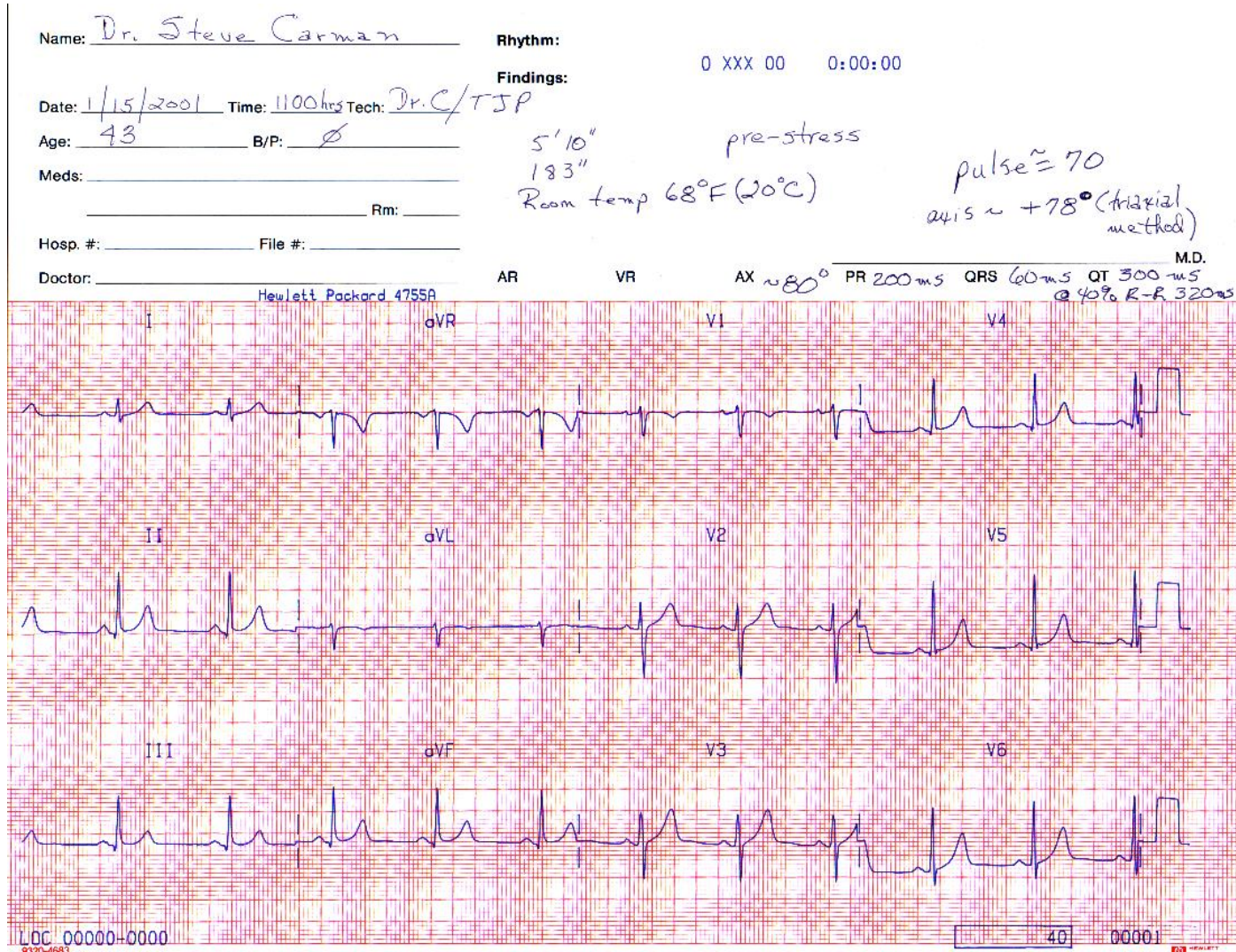
The electrodes were placed in standard positions to optimize electrical conductance and minimize electrical noise (Figures, Below). The skin was prepared with isopropyl alcohol and briefly "sanded" with the attached sand spots on the electrodes (Figure, Below). EKG's were obtained at the 3-4 minute time intervals (as opposed to the standard 3 minute intervals in the Bruce protocol) as the EKG instrument took 1 minute to obtain the 12-lead EKG. The elevation and speed were then adjusted.



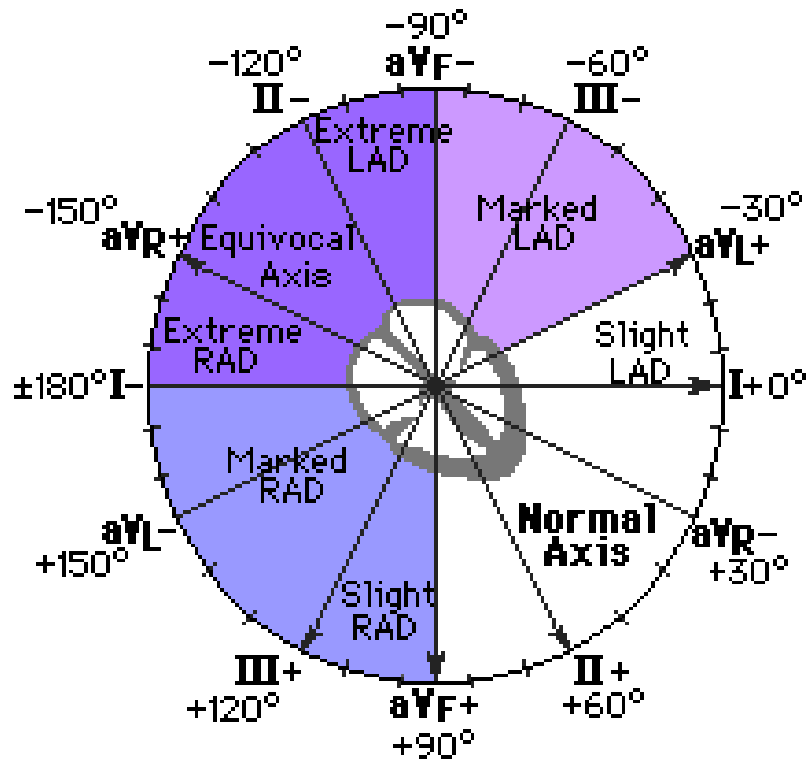
Results

Pre-Treadmill

The pre-stress test EKG was within normal limits (WNL):



EKG Axis performed by the triaxial method (as opposed to the hexaxial method; Figure, Left) is in the range of +80, i.e., WNL.



The table, below, summarizes and compares Dr. Carman's interval analysis with normal ranges:

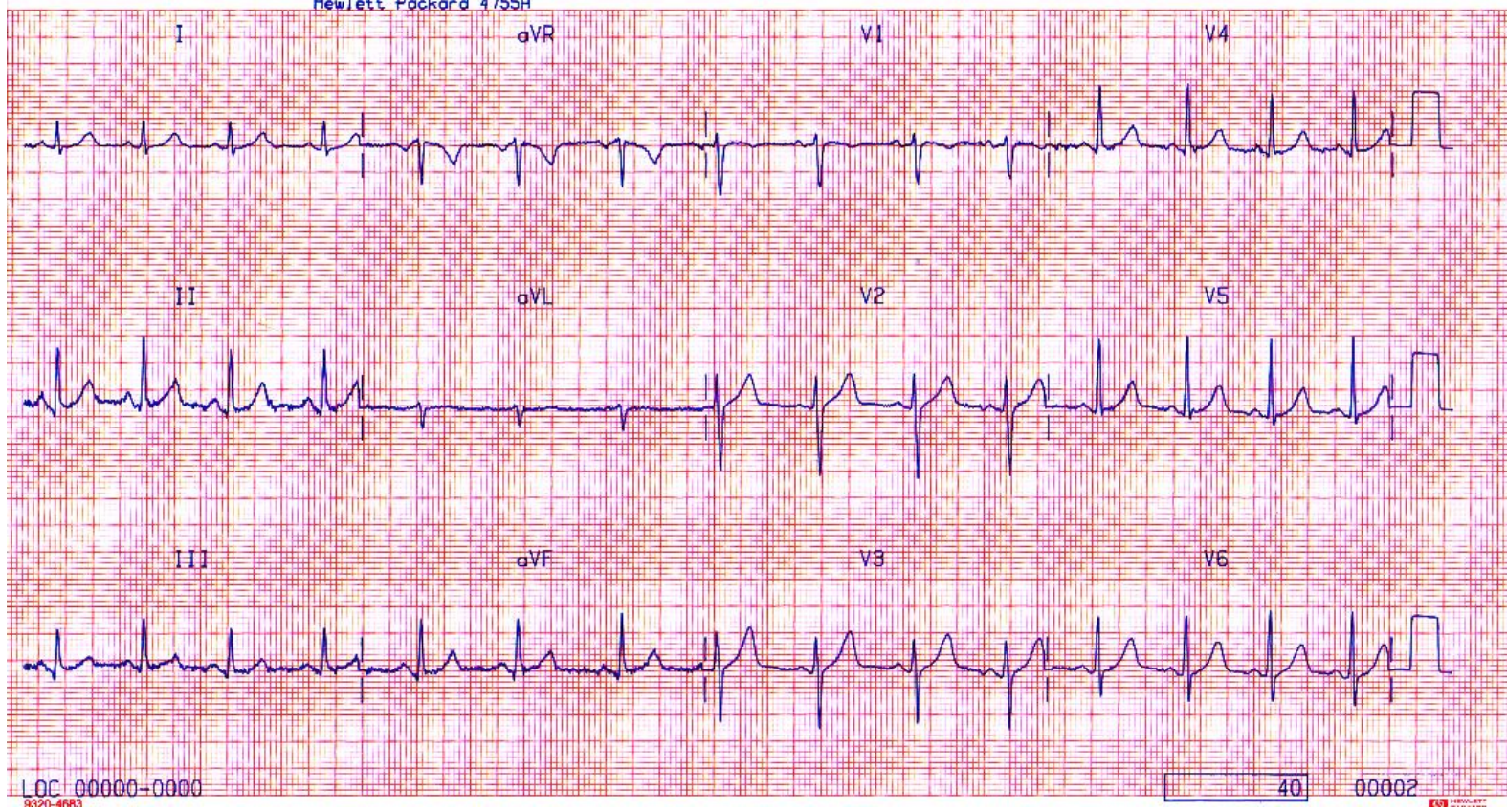
Normal Ranges	Dr. Carman's Values
PR interval: 120-200 msec	200 msec
QRS duration: 60-100 msec	60 msec
QT interval: 340-420 msec	300 msec
QT interval at 40% of R-R time: varies with rate	320 msec

Peri-Treadmill

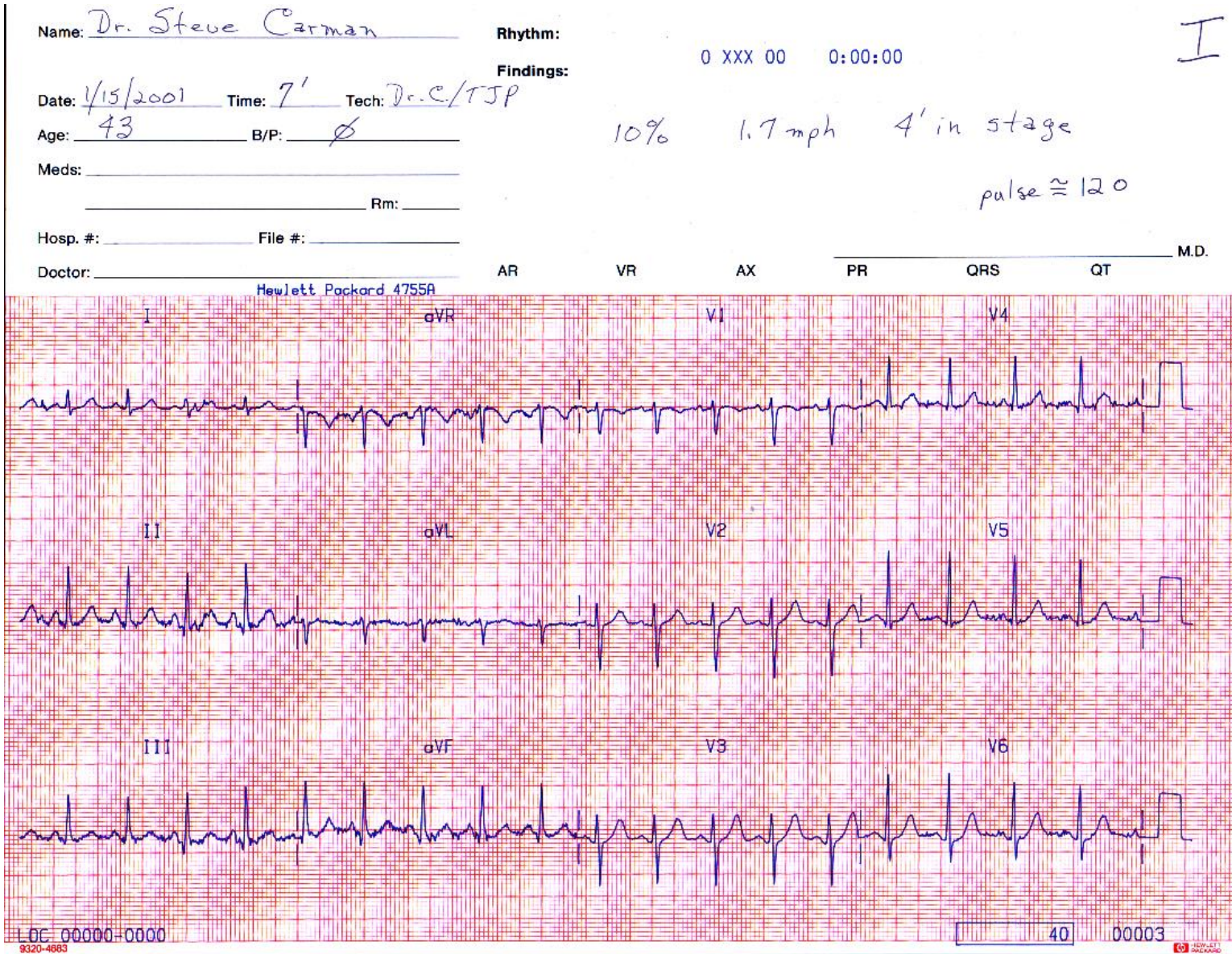
Dr. Carman oxidized approximately 300 kcal during this test. He walked 1.21 miles and went for the duration of the exercise, i.e., 24 minutes, without difficulty.

Stage 0: there were no obvious abnormalities identified in this EKG:

Name: Dr. Steve Carman Rhythm: 0 XXX 00 0:00:00 0 I
Date: 1/15/2001 Time: 3' Tech: Dr. C. / TJP Findings: 0% 1.5 mph 4' in stage
Age: 43 B/P: Ø pulse \approx 88
Meds: _____
Rm: _____
Hosp. #: _____ File #: _____
Doctor: _____ AR VR AX PR QRS QT M.D.



Stage I: there were no obvious abnormalities identified in this EKG:



Stage II: there were no obvious abnormalities identified in this EKG:

Name: Dr. Steve Carman

Rhythm:

0 XXX 00 0:00:00

II

Date: 1/15/2001 Time: 11' Tech: Dr. C./TSP

Findings:

Age: 43 B/P: _____

12% 2.5 mph 4' in stage
pulse \approx 135

Meds: _____

_____ Rm: _____

Hosp. #: _____ File #: _____

Doctor: _____

AR

VR

AX

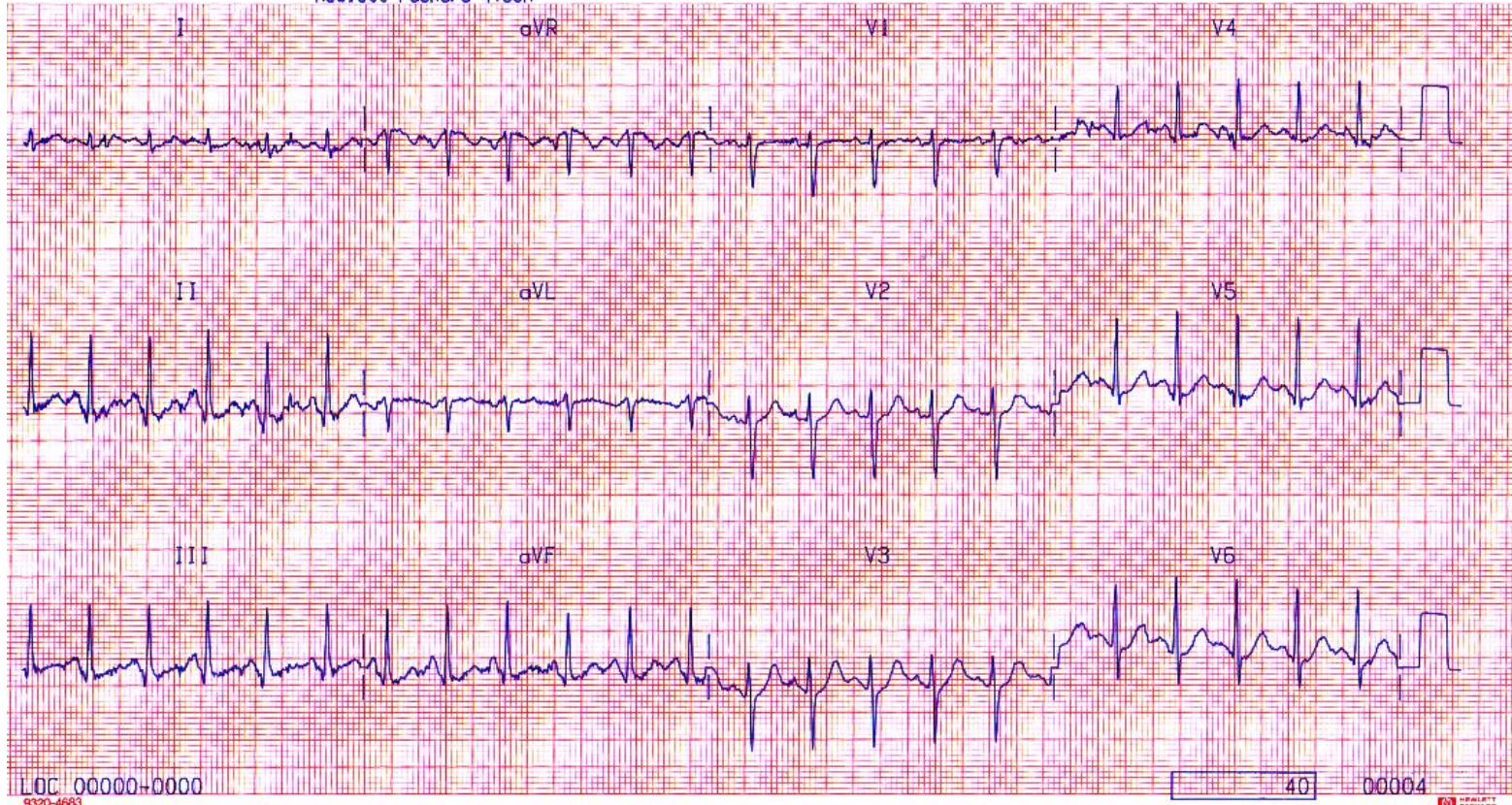
PR

QRS

QT

M.D.

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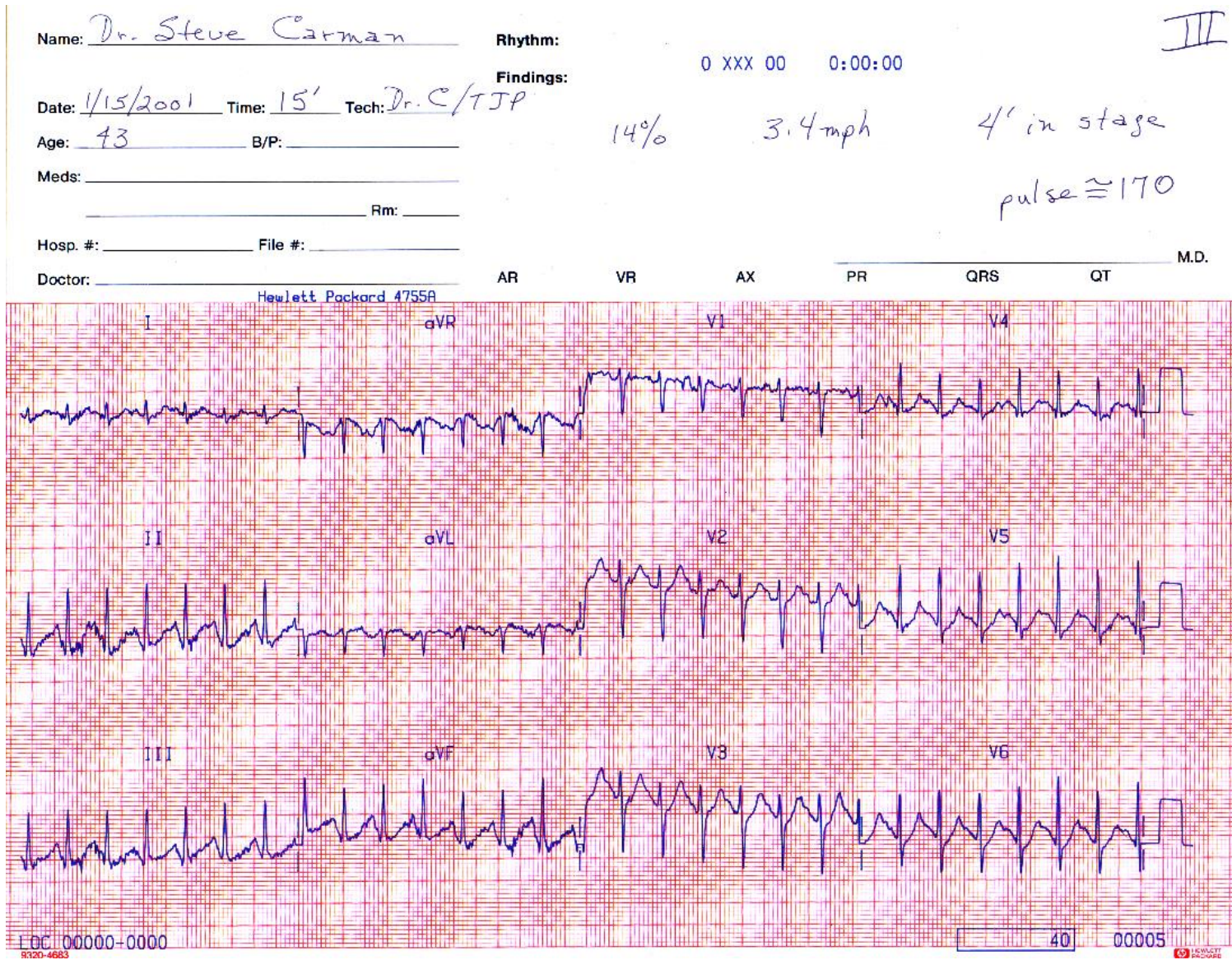


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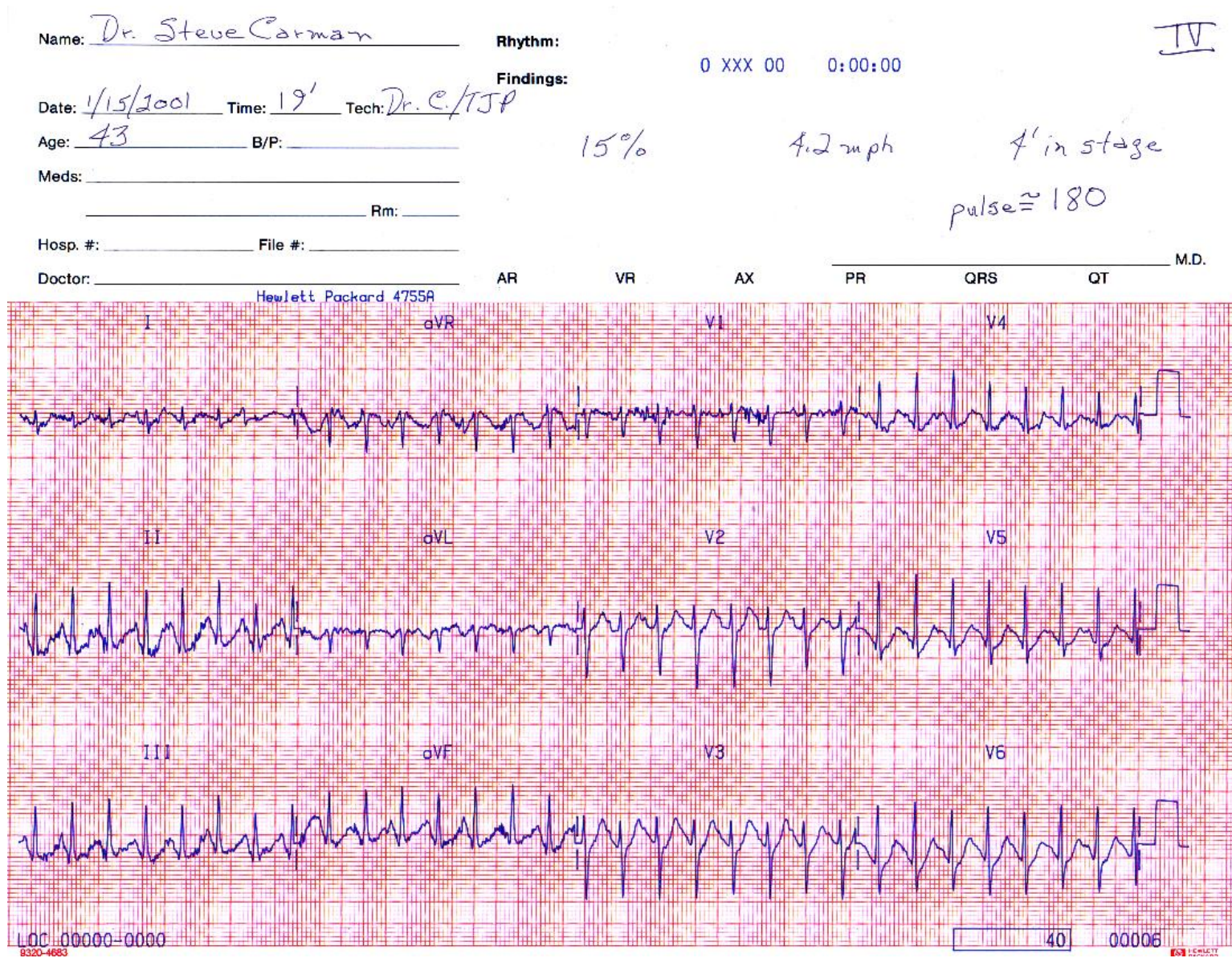
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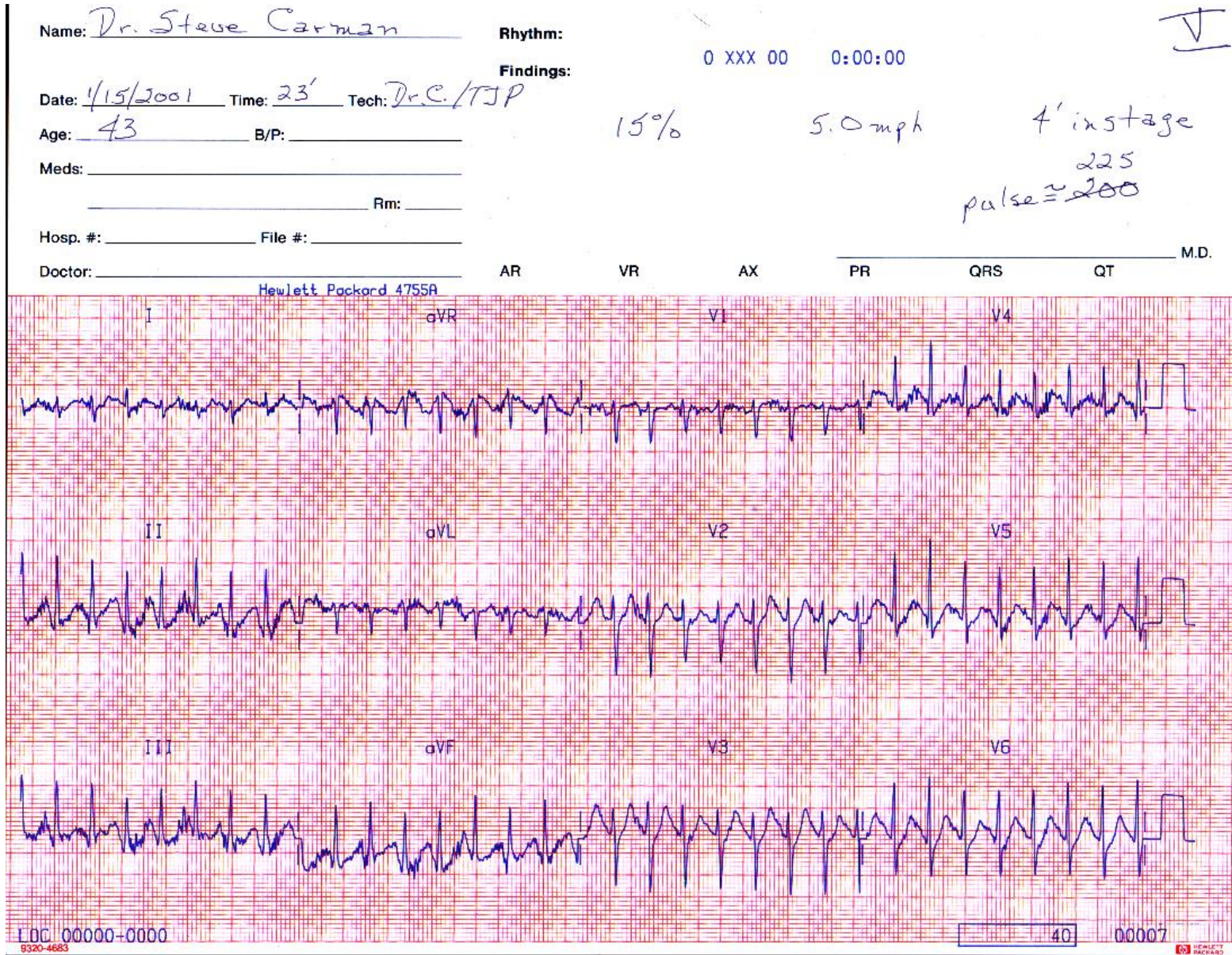
Stage III: one abnormality was noted in this EKG. Lead V6 appears to demonstrate what appears to be a minimal amount (< 2 mm) of ST segment depression:



Stage IV: ST segment depression, again, of a minimal amount (< 2 mm, again) seems to be demonstrated in leads V3, V5 and V6:

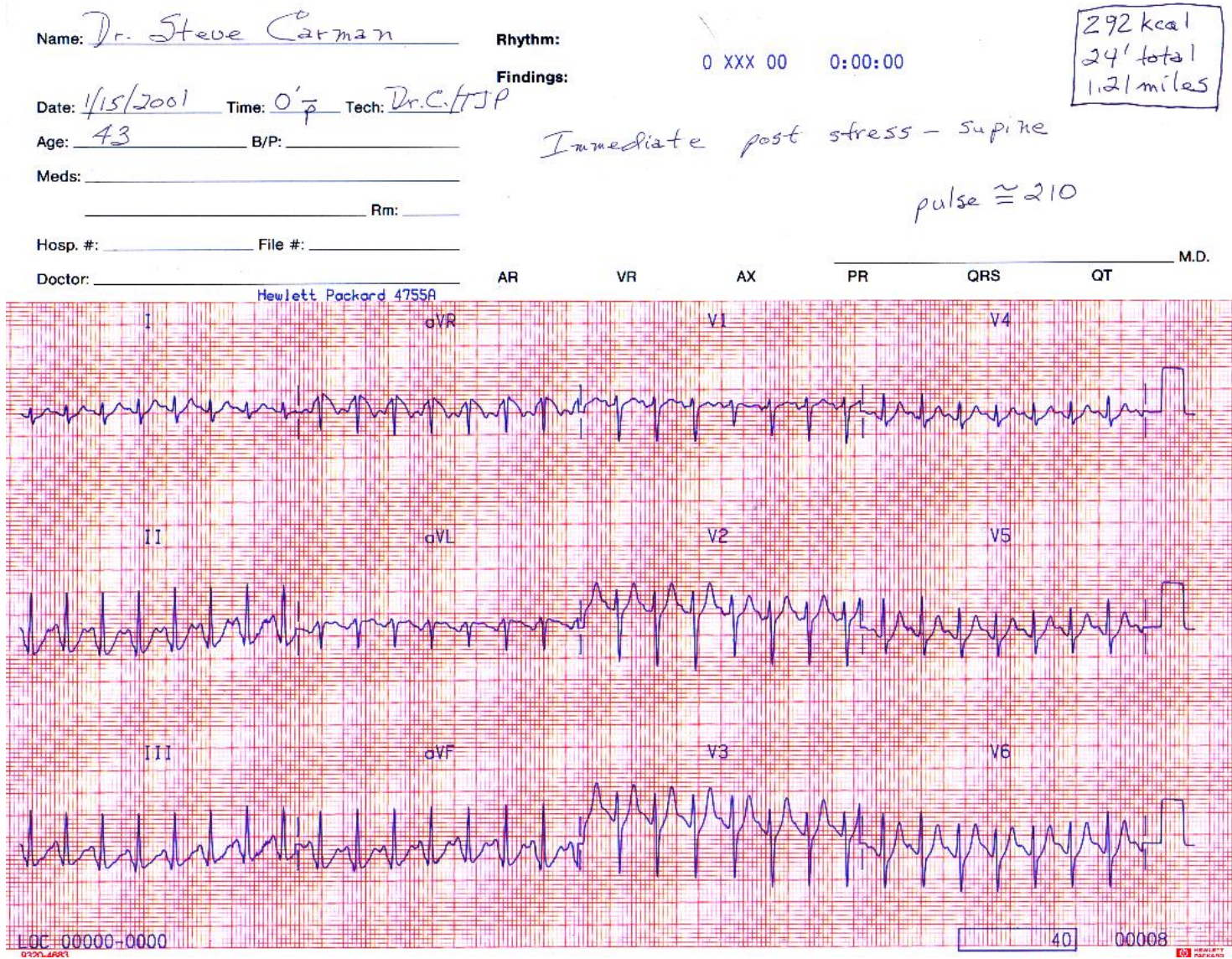


Stage V: ST depression of < 2 mm appears to be present, as well, in leads V3, V5 and V6:

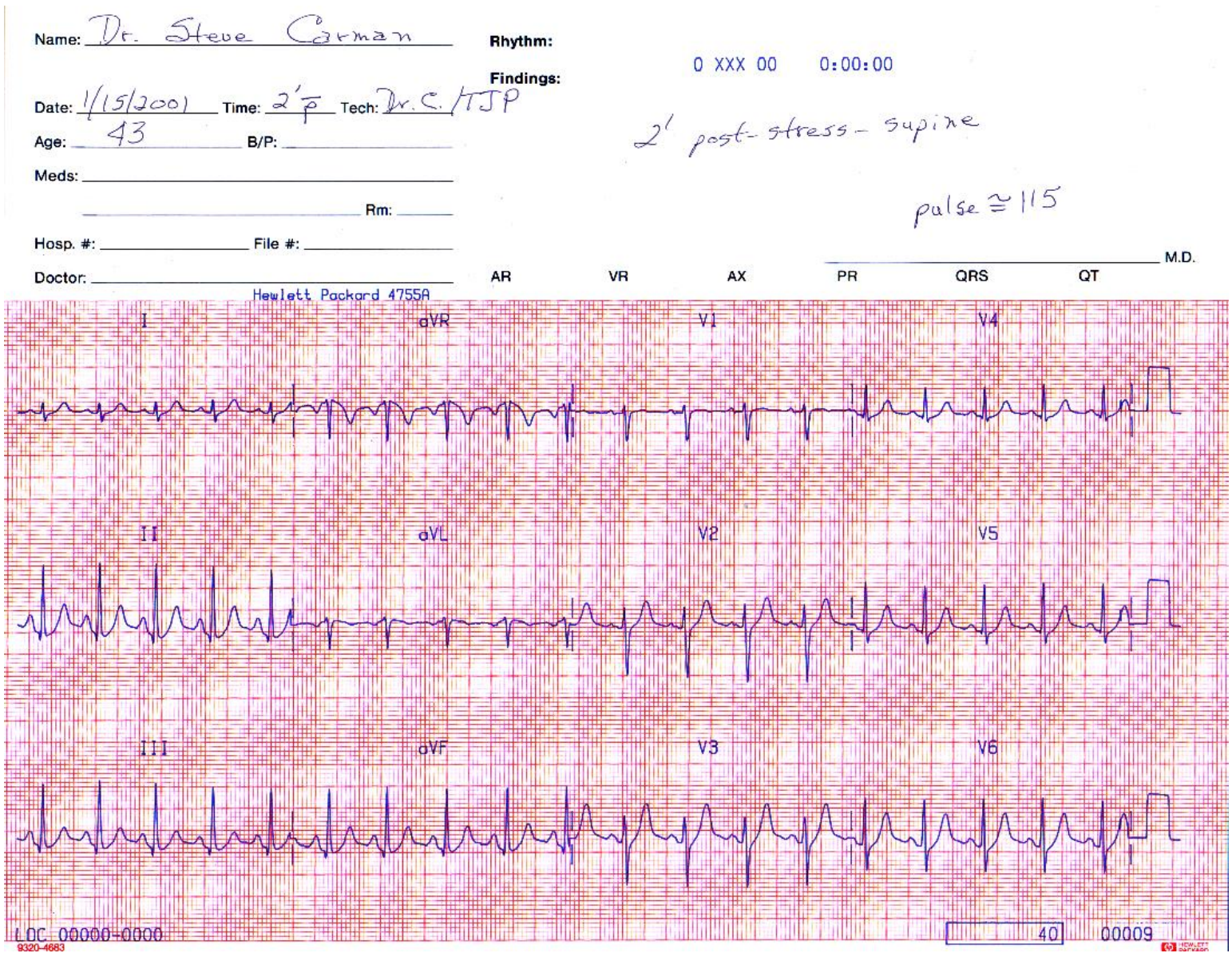


Post-Treadmill

The immediately post-treadmill EKG demonstrates approximately 1 mm ST segment depression in lead V3:



The EKG taken 2 minutes post-stress test demonstrates virtually no ST segment depression:



The EKG obtained 5 minutes post-treadmill demonstrates no ST segment depression:

Name: Dr. Steve Carman

Rhythm:

0 XXX 00 0:00:00

Date: 1/15/2001 Time: 5:17 p Tech: Dr. C/ASP

Findings:

Age: 43 B/P: _____

5' post-stress-supine

Meds: _____

pulse \approx 95

Rm: _____

Hosp. #: _____ File #: _____

Doctor: _____

AR

VR

AX

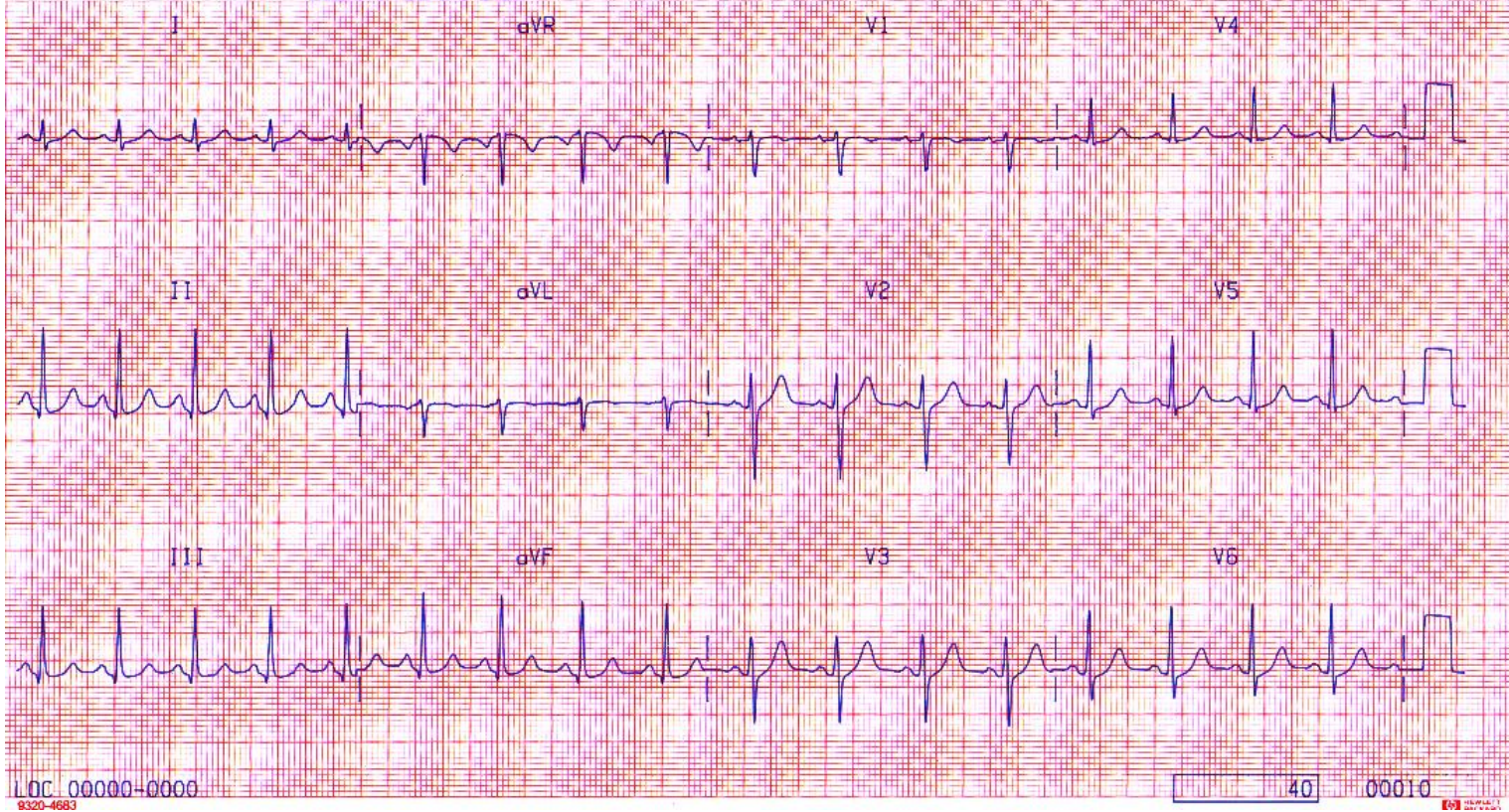
PR

QRS

QT

M.D.

Hewlett Packard 4755A

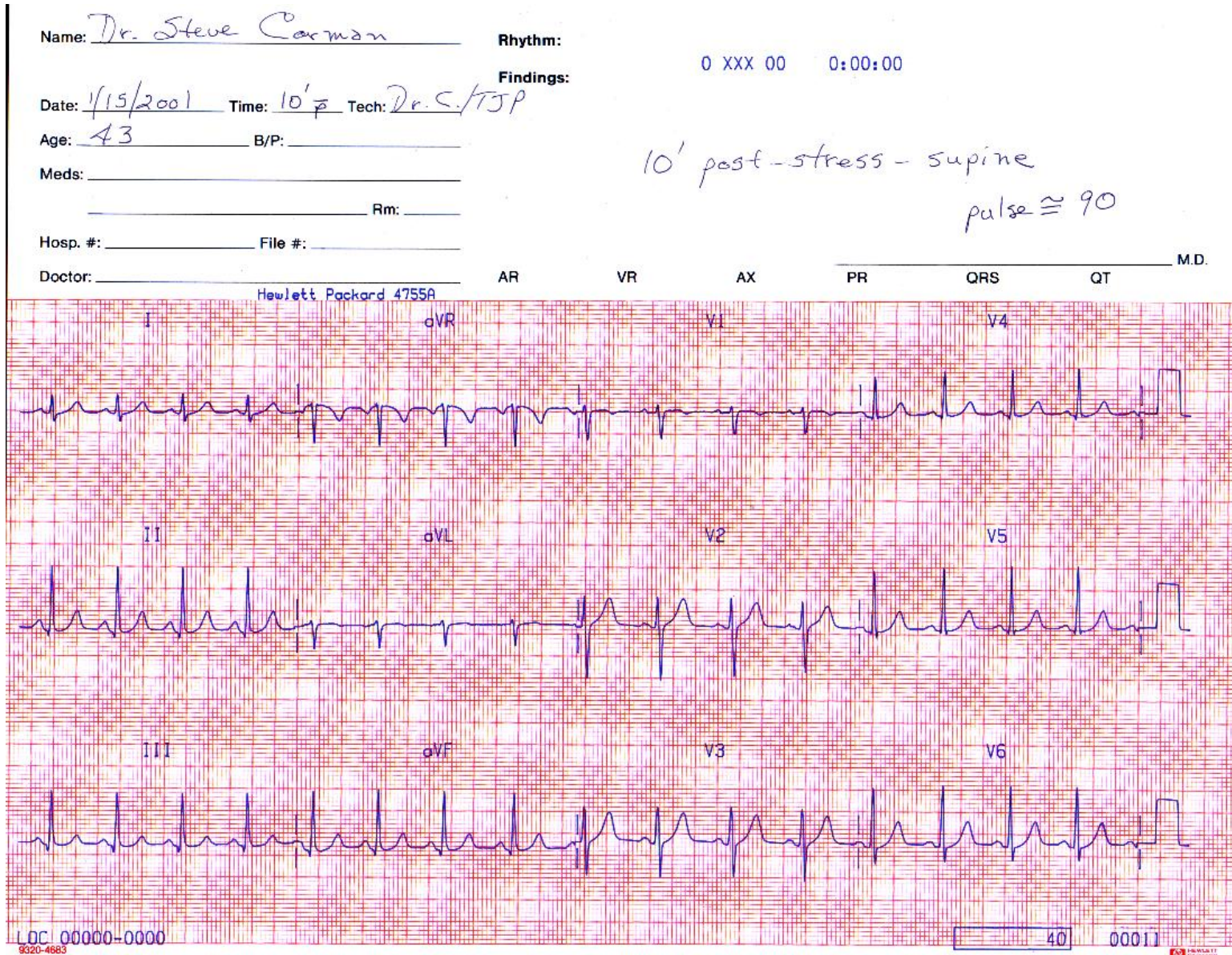


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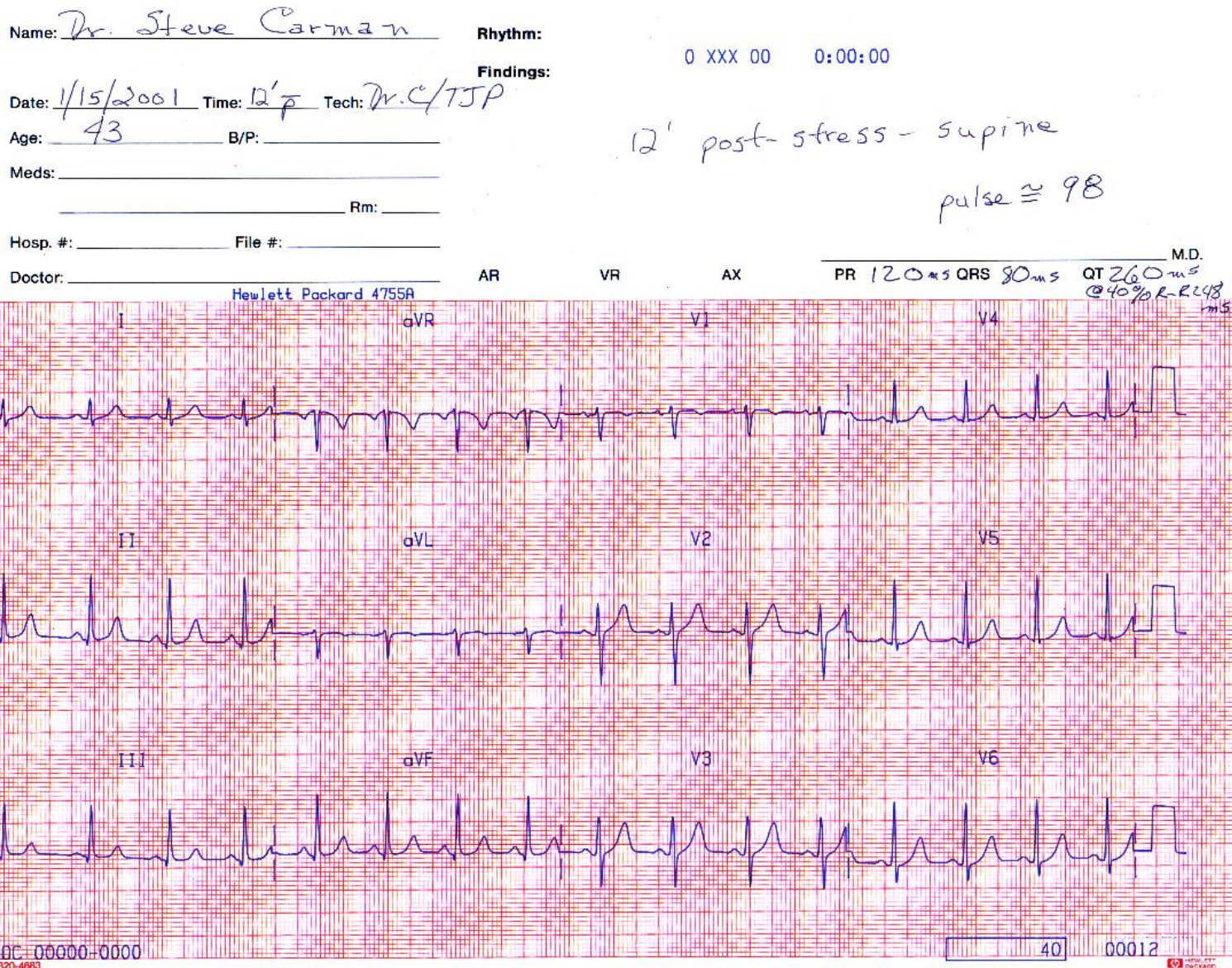
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The EKG obtained 10 minutes after the treadmill experience demonstrates normal sinus rhythm:



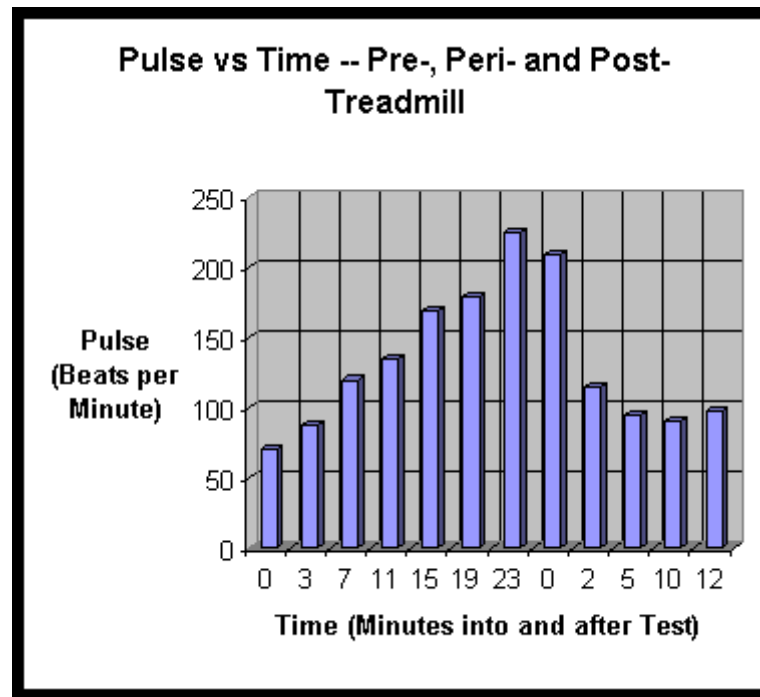
The only potential abnormality in the EKG obtained 12 minutes post-treadmill is the slightly elevated pulse rate:



The table, below, summarizes the interval analysis 12 minutes post-treadmill:

Normal Ranges	Dr. Carman's Values
PR interval: 120-200 msec	200 msec
QRS duration: 60-100 msec	80 msec
QT interval: 340-420 msec	260 msec
QT interval at 40% of R-R time: varies with rate	248 msec

The pulse rates were obtained per each EKG (and recorded on each EKG) and plotted:



The exam was stopped at 24 minutes due to having completed all stages of the test. No symptomatology consistent with any other reason to stop the stress test was observed or felt.

Discussion

Remember from lecture that the various leads from an EKG tell you something about specific parts of the heart, table, below:

II, III, aVF examine the inferior portion of the heart.
V1 and V2 examine the septum.
V3, V4, V5, V6 look at the anterior and lateral aspects of the heart.
I and aVL look at the superior/anterior and lateral aspects of the heart.
aVR examines the cavity of the heart and is, for all intents and purposes, of almost no value.

Remember, also, that specific coronary arteries feed specific regions of the heart. Given the fairly consistent demonstrations of minimal ST segment depression in the lateral leads, it would appear that the "incident" causing the depression is in or around the area of the circumflex artery. Whether the "incident" is partial occlusion, vasospasm or artifact is, of course, unclear. ST segment depression less than 2 mm in depth is considered to be "equivocal" results [2]. With no symptomatology to go along with it, it is probably of minimal significance. ST segment depression greater than 3 mm is considered a positive stress test and further testing would be performed. Whatever the incident is, it seems to be a temporary, reversible, event.

The ST segment depression, however, may also serve as a "wake up call". Dietary strategies may be undertaken and blood tests may be performed, e.g., lipid profiles to look at blood LDL, HDL, total cholesterol levels, ad nauseum, to determine how out of whack they are -- or not. If necessary, and if diet therapy does not work in conjunction with exercise, various lipid-lowering medications may be taken in an attempt to minimize the effects of atheromatous disease.

As regards the pulse rates at the end of this study, it is highly probable that the reason the last pulse went up was that Dr. Carman was dealing with a bored little boy and an obnoxious Dachshund. Neither of whom was thrilled at having to take so long to do an experiment.

Per Dr. Carman's memory, his axis seems to be dropping more down. This may be due to exercise and "leaning" up of the heart or due to a shift towards the right due to pulmonary conditions heretofore undiagnosed. Since he smoked mentholated cigarettes for 13 years and a pipe for 5 years before quitting ten years ago, it is possible that that is finally catching up to him. Pulmonary function testing in conjunction with routine chest x-ray may be of use in determining if this is a cause of the apparent axis shift.

Electrode placement was a sort of challenge. It's different putting electrodes on oneself without the benefit of bifocals that one uses to place them on a patient.

Conclusions

While the results of this treadmill test are equivocal, further studies appear to be indicated, e.g., as mentioned above. The EKG machine, while different from those used in the past by Dr. Carman, is very easy to use. That a 9 year-old can operate it with minimal instruction speaks fairly well for that.

References

- 1. Berman, W.I.: BUMC Proceedings 12:29-33, 1999.**
- 2. Cheitlin, M.D., Sokolow, M. and McIlroy: Clinical Cardiology, Sixth Edition. (Appleton and Lange: Norwalk, CT) © 1993.**