ORIGINAL RESEARCH

# Paramedic Identification of Electrocardiograph J-Point and ST-Segments

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**Abbreviations:**
BEH = Bachelor of Emergency Health
DAPS = Diploma of Ambulance and Paramedic Studies
ECG = electrocardiograph
STEMI = ST-segment elevation myocardial injury

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## Abstract

**Introduction:** Correct identification of the J-Point and ST-segment on an electrocardiograph (ECG) is an important clinical skill for paramedics working in acute healthcare settings. The skill of ECG analysis and interpretation is known to be challenging to learn and often is a difficult concept to teach.

**Objectives:** The objective of the study was to determine if undergraduate paramedic students could accurately identify ECG ST-segment elevation and J-Point location.

**Methods:** A convenience sample of undergraduate paramedic students (n = 148) was provided with four enlarged ECGs (ECG1–4) that illustrated different levels, patterns, and characteristics of ST-segment elevation. Participants were asked to identify whether ST-elevation was present, and if so, height in millimeters (mm) and the correct location of the J-Point.

**Results:** There were significant variations in students' accuracy with both J-Point and ST-segment determination. Eleven (10%) students correctly identified the ST-segment being present in all ECGs. Also, ECG 2 reflected 6 mm of ST-elevation; however, only one student correctly identified this. Overall the students were 0.55 mm (95% CI = 0.29–0.81 mm, range = -6.5–5.8 mm) from the J-point on the horizontal and -0.18 mm (95% CI = -0.31–0.04 mm, range = -2.8–2.3 mm) on the vertical axis.

**Conclusions:** Undergraduate paramedic students recognize ST-segment elevation. However, inaccuracies occurred with measurements of ST-segment and precise location of J-Points. Errors in ECG analysis may reflect weaknesses in teaching this skill. Consideration should be given to the design of an educational program that can reliably improve performance of this skill.

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## Introduction

Correct identification of the J-Point and ST-segment on the electrocardiograph (ECG) is an important clinical skill for paramedics working in acute healthcare settings. This skill is important in clinical practice, especially where paramedics are responsible for the initiation of thrombolytic therapy, expediting moving the patient to the cardiac catherization laboratory, or are required to diagnose wide-complex versus narrow-complex tachydysrhythmias to determine appropriate intervention for a life-threatening dysrhythmia. The skill of ECG analysis and interpretation is known to be challenging to learn and is a difficult concept to teach.

Given the changing nature of prehospital management of the acute coronary syndromes (ACS), which in some cases now includes the administration of prehospital thrombolytic agents, accurate and reliable interpretation of ECG ischemic injury patterns is critical. Similarly, correct estimation of the J-Point location and subsequent interpretation of narrow-complex versus wide-complex tachydysrhythmias also is important, particularly with the prehospital administration of drugs such as calcium channel blockers.

Previous studies involving experienced and inexperienced medical personnel have demonstrated inconsistent clinical interpretation when attempting to

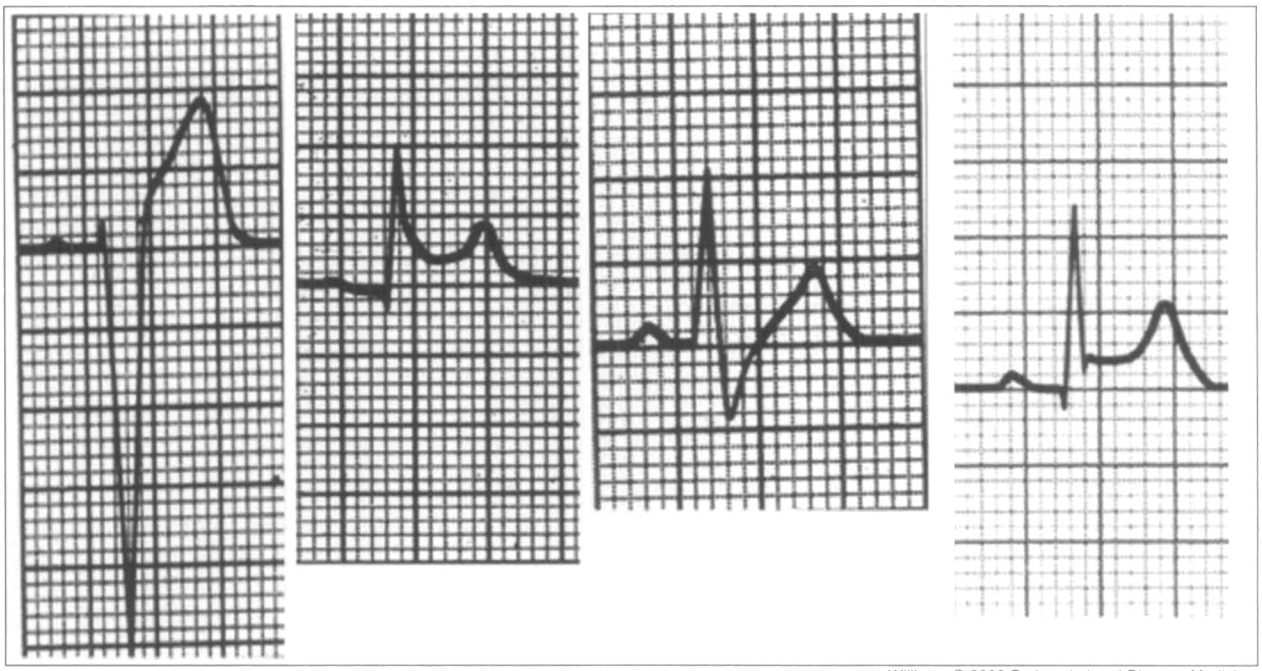



**Figure 1**—Electrocardiographs 1–4

identify specific ECG morphologies. The literature relating to paramedic performance of this skill is limited, with only 11 studies identified.[1–11] No published studies have been conducted on paramedic undergraduate students. To the knowledge of the authors, no formal integration of previous medical research in this area has been included in undergraduate paramedic educational objectives.

The objective of the study was to determine if undergraduate paramedic students could accurately estimate ECG ST-segment elevation and J-Point location. The results from this study should help to better inform the educational design of programs that teach ECG interpretation.

## Methods

This study was a prospective, single-blinded, observational study that used a convenience sample of (n = 148) students over two university semesters in 2006. The data collection form contained four enlarged ECGs (Figure 1) all of which illustrated different levels, patterns, and characteristics of ST segment elevation. Participants were asked the following questions: (1) Is ST-segment elevation present?; (2) If so, how many mm exist?; and (3) Identify with a mark (x) where the J-Point is located.

The population consisted of paramedic students attending undergraduate university-level paramedic courses. There were two groups of students: (1) those taking their course prior to employment (pre-registration), Bachelor of Emergency Health (BEH); and (2) those employed by an ambulance service (post-registration), Diploma of Ambulance and Paramedic Studies (DAPS), and were taking their course using on-the-job and off-the-job training mode. All participants were in training between 15 and 24 months; however, the DAPS program provides more of an integration of between ECG theory and practice due to greater clinical experience and exposure than the does BEH program.

The BEH is a paramedic pre-employment (pre-registration) degree offered over three years and has reduced on-the-job experience or exposure. Besides level of qualification, the fundamental differences between the DAPS and BEH are the teaching and methods. The BEH uses a contemporary and more student-centered approach with students receiving greater education in general cardiology and electrocardiography and students are expected to correctly interpret >30 ECGs compared to approximately six ECGs in the DAPS program.

Participation in the study was voluntary, ethics approval for the study was granted by the Standing Committee on Ethics in Research Involving Humans. Participants provided additional information including their age group, course, and year of study.

The J-Point estimates made by participants were measured in relation to the correct position of the J-Point as determined by expert consensus. The position of the student's mark was recorded by reference to a Cartesian coordinate system, giving a coordinate on an x and y axis (Figure 2).

Statistical processing was conducted using SPSS (Version 15.0, SPSS Inc., Chicago, IL). The results were considered statistically significant when $p < 0.05$, and all confidence intervals (CI) are 95%.

Descriptive statistics (means and medians) were used to summarize the data. Students' *t*-test, Mann-Whitney U-test, and a one-way ANOVA test were used to establish differences between the BEH and DAPS groups.

## Results

A total of 148 students participated in the study, but not every student completed all of the components of the data collection form. The majority were in the 24–44 year age group (71%), with most students from the DAPS course (n = 82,

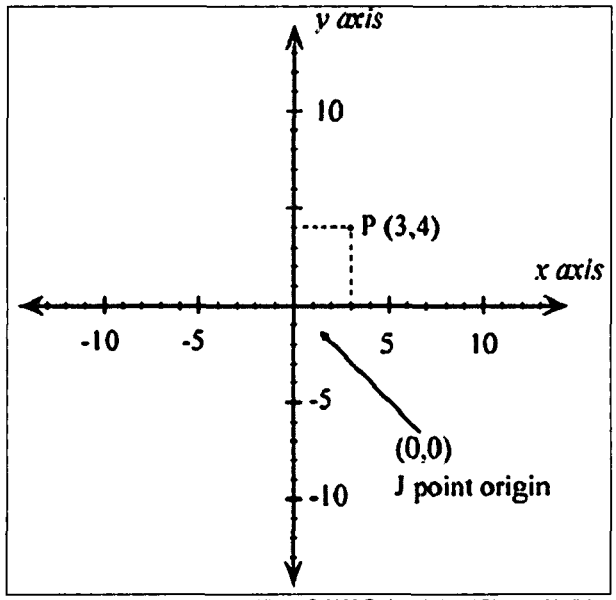




Figure 2—Cartesian coordinate system

55%). The remaining students (n = 66, 45%) were third year students enrolled in the BEH course.

For ECG 1, 52 students (38%) correctly identified that there was ST-segment elevation with 16 students (12%) correctly identifying that there was 2 mm of elevation. The mean ST elevation estimation was 3.4 mm (95% CI = 3.0–3.8 mm, median = 3.0 mm, range = 0–9 mm). Fifty-six (40%) students correctly identified the location of the J-Point. Students were 0.6 mm (95% CI = -0.5–0.38 mm, range = -19.0–9.0 mm) from the J-Point on the horizontal and -0.2mm (95% CI = -0.32–0.28 mm, range =-4.0–9.0 mm) on the vertical axis.

For ECG 2, 111 students (76%) correctly identified that there was ST-elevation, but only one student correctly identified that there was 6 mm of elevation. The mean ST-elevation estimation was 1.96 mm (95% CI = 1.7–2.2 mm, median = 2.0 mm, range = 0–8 mm). Thirty-three (25%) students correctly identified the location of the J-Point. Students were 1.6 mm (95% CI = 1.2–1.9 mm, range = -6.0–11.0 mm) from the J-Point on the horizontal and -0.7 mm (95% CI = -1.93– -0.48 mm, range = -5.0–5.0 mm) on the vertical axis.

For ECG 3, 108 students (74%) correctly identified that there was no ST elevation. The mean of the ST-elevation identification was 0.43 mm (95% CI = 0.21–0.65 mm, median = 0 mm, range = 0–7 mm). A total of 106 (80%) students correctly identified the location of the J-Point. Students were -0.4 mm (95% CI = -0.28–0.19 mm, range = -6.0–8.0 mm) from the J-Point on the horizontal and -0.5 mm (95% CI = -0.19–0.08 mm, range = -5.0–4.0 mm) on the vertical axis.

For ECG 4, 116 students (80%) correctly identified that there was ST-elevation, with 12 students (9%) correctly identifying that there was 1 mm of elevation. The mean ST-elevation estimation was 1.77 mm (95% CI = 1.59–1.94 mm, median = 2.0 mm, range = 0–8 mm). Eighty-five (65%) students correctly identified the location of the J-Point. Students were 0.85 mm (95% CI = 0.48–1.2 mm, range = -4.0–11.0 mm) from the J-point on the horizontal and -0.08 mm (95% CI = -0.09–0.1 mm, range = -2.0–2.0 mm) on the vertical axis.

Eleven (10%) students correctly identified the ST-segment being present in each of the four ECGs. Thirteen (11%) students did not correctly identify ST-segment elevation in any of the ECGs. Only 13 (11%) of students correctly identified the J-Point in all ECGs, 10 (8.5%) did not correctly recognize any of the J-Points.

Overall, the students were an average of 0.55 mm (95% CI = 0.29–0.81 mm, range = -6.5–5.8 mm) from the J-Point on the horizontal and -0.18 mm (95% CI = -0.31– -0.04 mm, range = -2.8–2.3 mm) on the vertical axis. When comparing all results by the different courses (BEH and DAPS), only ECG 1 demonstrated a significant difference in mean results (BEH = 4.3 mm; DAPS = 2.8 mm, 95% CI = 0.74–2.36, $p$ <0.0001). There were no other statistically significant differences in the results for the other three ECGs (Table 1).

## Discussion

This study demonstrates that undergraduate paramedic students found it difficult to accurately identify ST-segment elevation. Given the actual height of the ST-segment elevation and location of the J-Point, general inaccuracies in estimation were highlighted. Age, clinical experience, and educational qualifications had no significant influence on estimation accuracy. These findings should help to modify teaching and learning approaches used to impart this skill. Electrocardiogram interpretation errors by paramedics have been described in published studies.[1–11] In a retrospective study by Sejersten *et al*, paramedics incorrectly diagnosed ST-segment elevation myocardial injury (STEMI) in more than half of the cases studied.[11] Madsen *et al* found that paramedics misinterpreted tachydysrhythmias in (41%) of cases.[7] It is important to note that these studies assessed qualified paramedic staff, whereas this study targeted undergraduate paramedic students. This suggests that even after lengthy education, training, clinical exposure, and practical integration, significant interpretation errors still exist.

Other previously published studies on paramedic misinterpretation of ECGs show ranges of 10–40% of the participants.[1–3,6,8–10] One explanation could be that paramedic training in these cases failed to develop the required level of performance, or that educational quality is not maintained throughout continuing education programs.[4] Evidence shows that mastery of this skill is important for enabling paramedics to correctly identify the location of the J-Point and thus the height of ST-segment elevation. Greater emphasis on teaching this skill should be linked to a longitudinal study to quantify the outcome.

The frequently incorrect identification of J-Point location in this study may compromise the student's ability to discriminate between wide-complex and narrow-complex tachydysrhythmias, particularly those involving ventricular tachycardia (VT) or supraventricular rhythms with aberrancy. A further study of this aspect of ECG analysis may be warranted, particularly as one in five tachydysrhythmias were diagnosed incorrectly by paramedics in the study by Goebel *et al*.[4]

In the previous studies that reported paramedic's misinterpretation of dysrhythmias,[1–10] none have addressed the issue of undergraduate education by examining the para-

| | ECG 1 n (%) | ECG 2 n (%) | ECG 3 n (%) | ECG 4 n (%) |
|---|---|---|---|---|
| Correctly identified ST-elevation | 52 (38) | 111 (76) | 108 (74) | 116 (80) |
| Correctly identified level of elevation | 16 (12) | 1 (1) | NA | 12 (9) |
| Correctly identified location of J-Point | 56 (40) | 33 (25) | 106 (80) | 85 (65) |



**Table 1**—Results from the electrocardiograph analysis NA = no ST elevation; Did not provide: mean estimated ST-segment elevation, actual ST-segment elevation, distance between actual and estimated J-Point location for the horizontal and vertical axis

medics' education and training of electrocardiography and electrophysiology. In addition, none of the paramedic-oriented studies addressed why misinterpretation had occurred, for example, identification of the J-Point or other reasons. Despite the small sample size, the results from this study indicate that a major contributing factor for this misinterpretation could be the level of education and the mode of learning environment. Therefore, a study that addresses levels of education and training in electrocardiography is warranted.

The use of prehospital 12-lead ECGs to assist in the diagnosis of STEMI has been recommended by the International Liaison Committee on Resuscitation (ILCOR) in its last consensus review of resuscitation. The Committee's science consensus identified several high-level, prehospital studies that concluded that paramedics are capable of identifying a STEMI in a patient with chest pain. The Committee also recommended the use of prehospital thrombolytics by paramedics to treat patients with a STEMI.[12]

The study has several limitations. The use of single ECG complexes may have lost authenticity by not using a continuous rhythm strip, and the enlarged ECGs may have provided an advantage that assisted the student's analysis. This study also was limited by the targeting of participants with inadequate clinical experience; therefore, these results cannot be generalized to include the broader paramedic workforce.

## Conclusions

Undergraduate paramedic students in this program are able to recognize ST-segment elevation; however, inaccuracies in measurements of elevation of ST-segments and the precise location of J-Points were noted. Consideration should be given to developing alternative and enhanced teaching strategies that reliably can improve knowledge, understanding, and ultimately clinical performance. This modification to ECG teaching and learning should lead to safer and more accurate patient care.


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