

Increasing Electrocardiograph Speed does not Improve the Accuracy of Diagnosis of Narrow Complex Tachycardias

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Abstract

Background: The diagnostic dilemma of ECG rhythm diagnosis is very common for patients presenting in ED and Critical Care Units. A widely practiced method for diagnosing ECG rhythms of narrow-complex tachycardia is the use of double-speed (50mm/sec) ECGs in addition to the 25mm/sec speed ECG. Though widely practiced, accuracy of diagnosis by this method has not been evaluated adequately. **Method:** This single-center, single-blinded, comparative, questionnaire-based study was done amongst Emergency and Critical Care Physicians to assess whether adding a double speed ECG help in making a correct diagnosis of narrow-complex tachycardia. **Results:** The study did not show any significant improvement in diagnostic accuracy with use of 50mm/sec speed ECG. 26 ECGs were interpreted by 35 observers, each ECG set was diagnosed twice, once with 25mm speed only and once 25mm and 50mm speed together. Correct diagnosis was made in 534/910 (58.68%) in the standard group and 537/910 (59.01%) with the addition of the 50mm/s ECG. None of the narrow complex tachycardia revealed any improvement in diagnostic accuracy with the aid of double-speed ECG. Proportion of correct diagnosis by physicians of different years of experience with the help of double-speed ECG is not greater than that with standard speed ECG. The proportion of correct diagnosis by physicians with opinion that double-speed ECGs are helpful is also not better than physicians who do not find double-speed ECGs helpful. **Conclusion:** Though widely practiced in diagnosing narrow complex tachycardia, double speed ECG is not a very accurate tool. Perhaps physicians need more training and practice in interpreting double speed ECGs for more accurate information of rhythm analysis.

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Introduction

The clinical manifestations resulting from tachycardia are a common reason for presentation to Emergency Department. The narrow complex tachycardia comprises of Atrial fibrillation (AF), Atrial-flutter (AFI), Paroxysmal Supraventricular tachycardia (PSVT), AV nodal re-entrant Tachycardia (AVNRT), AV reciprocating tachycardia (AVRT), Multifocal atrial tachycardia (MAT) and Sinus tachycardia [1, 2, 6]. ECG remains the primary tool in arrhythmia analysis. However, the diagnosis of tachycardia is often difficult on standard ECG. In

rapid narrow complex tachycardia, the intervals may be too narrow to appreciate qualities such as irregularity and flutter waves. The arrhythmias are often more complicated due to presence of bundle branch blocks. The patients with narrow complex tachycardia are difficult to diagnose using the 12-lead ECG. Hence, technique for improving diagnosis by a simple, quick, noninvasive test such as the 50 mm/s ECG is therefore attractive and very commonly used. The only study to investigate the clinical utility of this strategy suggests that the addition of a 50 mm/s ECG to a standard 25 mm/s ECG improves diagnostic accuracy in narrow complex tachycardia [3]. The study also suggests that inappropriate use of

adenosine may be reduced by implementing this strategy, as interpreters are more likely to correctly diagnose difficult tracings [4, 5, 7, 8, 9]. However, more research is needed in this topic. This study was also aimed to determine if addition of a 50mm/s ECG aids in the correct diagnosis of narrow complex tachycardia when compared to standard speed (25 mm/s) ECG. We hypothesized that this addition improves the diagnostic accuracy of such tachycardia.

Methodology

The study was conducted as a single-blinded comparative trial at an academic Emergency Department at a corporate hospital amongst Emergency Physicians and Critical Care Physicians.

ECGs were selected from the patients who have attended the Hospital Emergency and had tachycardia on presentation. The ECGs were selected based on the difficulty of diagnosis. These ECGs were considered difficult based on the initial difficulty in interpretation or perceived difficulty by the authors. All ECGs were printed at 25 mm/s and 50 mm/s speeds simultaneously. The gold standard for each patient's diagnosis was based on the final diagnosis from the patient's medical record and a second opinion by a Senior Consultant Cardiologist.

Initially, thirty sets of ECGs (both 25 mm speed and 50 mm speed) were selected for the final questionnaire. Four ECGs were excluded due to a disagreement between the official diagnosis and the cardiologist's diagnosis. The finalized ECGs were marked by a code to prevent mixing-up between the two sets of same patient's ECG and also to "blind" the interpreters.

Thirty-five doctors, with different years of experience were asked to diagnose the ECGs. All the doctors who were asked to diagnose ECGs worked in Emergency Department or Critical-care, areas which require for a rapid interpretation of ECGs, sometimes even without any available past medical history. The observers were instructed that all hypothetical patients were hemodynamically stable but were masked to all other clinical information and asked to give the diagnosis based on the ECG interpretation only. The observers were initially given ECGs at 25 mm/s. Each observer was asked to diagnose the ECG rhythm (Sinus tachycardia, Atrial fibrillation/flutter, Supraventricular tachycardia, additional blocks etc). The questionnaire also asked about the participant's years of experience after graduation. After completion of the ECG observation with 25mm/sec the

observers were asked not to discuss the ECGs with other readers until completion of the study.

After a gap of 2-weeks, the same physicians were given the same ECGs at both the standard speed (25mm/s) and at rapid speed (50 mm/s) together. For the hypothetical patient population, the physicians were asked to interpret the rhythm based upon the ECGs. Also, opinion of the participants about usefulness of 50mm speed ECG in diagnosing narrow complex tachycardia was taken. The answers to this question are based on a Likert scale as following: *Not helpful, Helpful, Very Helpful, Essential*. Any correlation between diagnostic accuracy of doctors with years of experience was also searched by comparing diagnostic accuracy of doctors with different years of experience.

Diagnostic accuracy between the two groups was compared by using McNemar's Chi-squared test. All tests except exact binomial test are large sample tests. Comparisons between categorical variables are performed using McNemar's Chi-squared test and k-sample test for equality of proportions. In these tests, a P-value <0.05 are considered significant.

Results

Twenty-six ECGs were interpreted by thirty-five observers, yielding 910 observations in total (each ECG set was diagnosed twice, once with 25mm speed only and once 25mm and 50mm speed together).

The distribution of cardiac rhythms of the study was as follows:

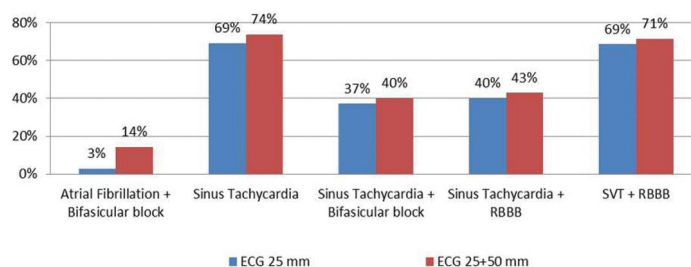
Rhythm	Quantity
Sinus tachycardia:	10
Sinus tachycardia with RBBB	1
Sinus tachycardia with bifascicular-block	1
Atrial flutter	2
Atrial fibrillation	5
Atrial fibrillation with bifascicular-block	1
Junctional rhythm	1
Supraventricular tachycardia	4
Supraventricular tachycardia with RBBB	1

Though widely believed to be useful in more accurate diagnosis of narrow-complex tachycardia, use of 50mm speed ECGs in addition to the standard ECG failed to show any significant improvement in interpretation of the various rhythms. Correct diagnosis was made in 534/910 in the standard group. With the addition of the 50mm/s ECG, correct diagnosis improved only to 537/910. Proportion of correct diagnosis with ECG 25mm and with ECG 25 mm + 50 mm speed is same with P-value 0.8538

ECG 25 mm (Mean ± Se)	ECG 25 + 50 mm (Mean ± Se)	McNemar's Chi-squared test P-value (two sided)
58.68% ± 1.63%	59.01% ± 1.63%	0.8538

Sl. No.	Disease category	Sample size	ECG 25 mm (Mean ± Se)	ECG 25+50 mm (Mean ± Se)	McNemar's test (one sided) P-value
1.	Atrial Fibrillation + Bifascicular block	35	2.86% ± 2.90%	14.29% ± 6.09%	0.0668
2.	Sinus Tachycardia	350	69.14% ± 2.48%	73.71% ± 2.36%	0.0549
3.	Sinus Tachycardia + Bifascicular block	35	37.14% ± 8.41%	40.00% ± 8.52%	0.5000
4.	Sinus Tachycardia + RBBB	35	40.00% ± 8.52%	42.86% ± 8.61%	0.5000
5.	SVT + RBBB	35	68.57% ± 8.08%	71.43% ± 7.86%	0.5000

Fig. 1: Proportion of correct diagnosis of different rhythms.

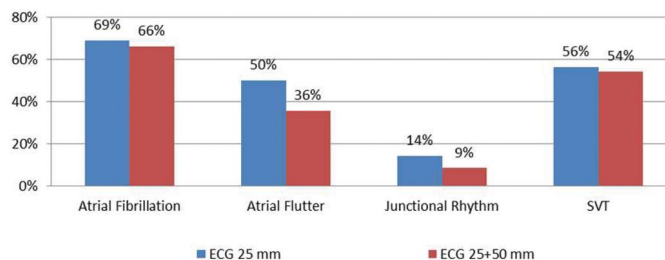


As evident in the graph, there is a marginal improvement in the diagnostic accuracy of the above rhythms; however the statistical analysis using McNemar's Chi-square test reveals that the

diagnostic accuracy is not significantly better using the 50mm speed ECG. The p-values of all the comparisons are non-significant with values 0.05 or more.

Sl. No.	Disease category	Sample size	ECG 25 mm (Mean ± Se)	ECG 25+50 mm (Mean ± Se)	McNemar's test (both sided) P-value	Exact Binomial test (one sided) P value
6.	Atrial Fibrillation	175	69.14% ± 3.51%	66.29% ± 3.59%	0.6025	0.7825
7.	Atrial Flutter	70	50.00% ± 6.06%	35.71% ± 5.81%	0.0550	0.9915
8.	Junctional Rhythm	35	14.29% ± 6.09%	8.57% ± 4.87%	0.6831	0.8906
9.	SVT	140	56.43% ± 4.22%	54.29% ± 4.24%	0.7656	0.7243

Fig. 2: Proportion of correct diagnosis with ECG 25+50 mm and ECG 25 mm.



It is clear from this table and graph that use of 50mm/sec speed ECG has not been helpful in these rhythm analyses. The use of double speed ECG has produced a less accurate diagnosis compared with those made by normal speed ECG only. Since there was a deterioration in performance, p-value using Exact Binomial test (one sided), was used for interpretation of results, and it clearly shows no

advantage in diagnostic accuracy using the 50mm speed ECG.

Proportions of correct diagnosis of respective diseases with ECG 25mm differ significantly amongst physicians (P value < 2.2e-16 < 0.0001, value of test statistic 112.7488) and the proportions of correct diagnosis of respective diseases with ECG 25+50 mm also differ significantly (P value < 2.2e-16 < 0.0001,

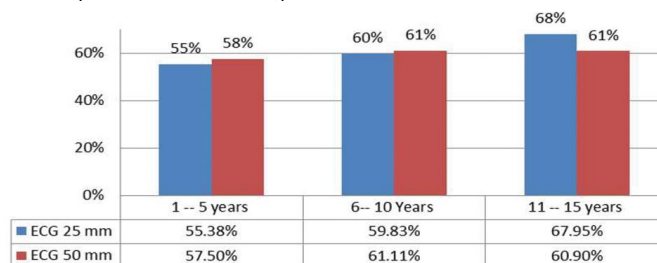
value of test statistic 129.1058). Test values correspond to 9-sample test for equality of proportions.

Proportion of correct diagnosis by Physicians of different years of experience

The ECG diagnostic accuracy of physicians with

different years of experience was also observed in the study to determine whether years of experience improves the interpretation skills of double speed ECGs. The observer physicians were divided into 3 groups according to years of experience: 1- 5 years; 6 -10 years and 11- 15 years.

Fig. 3: Correct Diagnosis by Physicians of Different Year of Experience with Ecg 25+50 Mm and Ecg 25 Mm



Proportion of correct diagnosis by physicians of groups 1- 5 & 6 -10 years of experience with ECG 25+50 mm is not significantly greater than that with

ECG 25 mm. Test values correspond to McNemar's Chi-square test (one sided).

Sl. No.	Years of experience of Physicians	Sample size	ECG 25 mm (Mean \pm Se)	ECG 25 + 50 mm (Mean \pm Se)	McNemar's test (one sided) P value
1	1 -- 5 Years	520	55.38% \pm 2.18%	57.50% \pm 2.17%	0.21815
2	6 -- 10 Years	234	59.83% \pm 3.22%	61.11% \pm 3.20%	0.3937

Though a slight improvement is noted in more experienced physicians; i.e., 11-15 years than the other groups in interpreting with the 25mm speed ECGs, there is no improvement, rather, deterioration in their

interpretation with the aid of 25+50mm speed ECGs (P-value 0.9638). Test value corresponds to Exact Binomial test (one sided).

Sl. No.	Years of experience of Physicians	Sample size	ECG 25 mm (Mean \pm Se)	ECG 25 + 50 mm (Mean \pm Se)	McNemar's test (both sided) P value	Exact Binomial test (one sided) P value
3	11 -- 15 Years	156	67.95% \pm 3.76%	60.90% \pm 3.93%	0.1360	0.9638

Proportions of correct diagnosis with ECG 25mm by physicians of different years of experience differ significantly (P value 0.01846, value of test statistic 7.9838) but the proportions with ECG 25+50 mm by physicians of different years of experience do not differ significantly (P value 0.5635, value of test statistic 1.147). Test values correspond to three sample test for equality of proportions (both sided). Thus, the study finds years of experience has no significant contribution over correct diagnosis of diseases with double-speed ECG though it's contribution is significant in correct diagnosis with ECG 25 mm only.

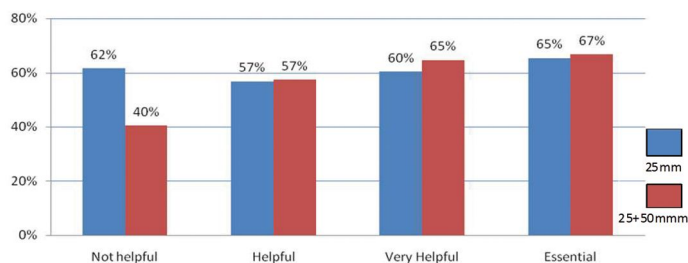
Proportion of correct diagnosis by Physicians of different opinions on utility of double-speed ECG

Proportion of correct diagnosis by physicians of the opinion 50mm "Not Helpful" with ECG 25+50

mm is less that with ECG 25 mm. Using Exact binomial test (one sided), the said proportion with ECG 25+50 mm is significantly less than that with ECG 25 mm (P value 0.01089). Though, proportion of correct diagnosis with ECG 25+50 mm by physicians of the other 3 groups is marginally better than diagnosis with 25mm speed ECG, McNemar's Chi-squared test P-values are >0.05 in all thus showing a non-significant improvement in all the groups.

Proportions of correct diagnosis with ECG 25+50 mm by physicians of different opinions on utility of ECG 50 mm differ significantly (P value 0.004777, value of test statistic 12.9362), though the proportions with ECG 25mm do not differ significantly (P value 0.4441, value of test statistic 2.677). Test values correspond to four sample test for equality of proportions (one sided).

Fig. 4: Proportions of correct diagnosis with ECG 25+50 mm and with ECG 25mm by physicians of different opinions



Discussion

Diagnoses of rhythm in high speed tachycardia are difficult and challenging. Some tachycardia occur secondary to fever, anxiety, pain etc. and responds to appropriate treatment of the pathologic insult. Some other tachycardia like Atrial fibrillation, SVT may indeed cause complaints like palpitations, light-headedness from poor perfusion and needs identification to be adequately managed. For diagnosis of rhythms, physicians rely chiefly on ECGs, at times a double speed ECG is used to aid in diagnosing very fast narrow-complex tachycardia. The study was aimed to evaluate the diagnostic accuracy using the double speed ECG.

Though commonly practiced as a diagnostic aid, accuracy of diagnosing the rhythm in narrow-complex tachycardia, using double speed ECGs is unsatisfactory and not above questionable merit. The physician are prone to give inaccurate diagnosis of rhythms when asked to make diagnosis with the aid of a static picture of rhythms by an ECG rhythm strip, specially without any knowledge about patients age, hemodynamic status, presenting complains etc. The accuracy of diagnosis is unaffected by the physicians experience or comfort level in interpreting ECGs. No specific narrow-complex rhythm can be said to be more accurately identifiable with the help of double-speed ECGs. At times, double speed ECGs may be more misleading than helpful in making diagnosis. Not all physicians are comfortable with the interpretation of double-speed ECG as they are used sparingly or by more qualified colleagues. The static picture as seen in ECG strip may give inadequate information of rhythm in fast paced tachycardia. Physicians also tend to consider the hemodynamic status and illness of patient when making a diagnosis, absence of such information too can mislead in making the correct diagnosis.

A weakness of the present study is that it was done on a single center with a limited sample size. A further weakness of the qualitative result was that we were

unable to expand upon the results as we did not collect any information on aids and difficulties faced by physicians on making their diagnosis of various rhythms by the ECG strips or what they might think to be more helpful in diagnosing narrow-complex tachycardia.

Therefore, more research needs to be directed to identify information and methods which may help in diagnosing difficult narrow-complex rhythms and increase diagnostic accuracy.

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Ethical approval

The study was approved by the Ethical Committee of Peerless Hospital & B K Roy Research Centre, Kolkata

Conflicts of interest

The authors declare that there is no conflict of interest.

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