Submitted: 11 August, 2022 Accepted: 18 November, 2022 Published: 08 May, 2023 DOI:10.22514/sv.2023.002

Open Access
Signa Vitae

ORIGINAL RESEARCH

A comparison of a precordial belt ECG and a gel-adhesive electrode in terms of ECG acquisition time and usability in emergency department patients

Ömerul Faruk Aydın[1], Sarper Yilmaz[2,*]

[1]Emergency Medicine Department of Yeni Yüzyıl University Faculty of Medicine Private Gaziosmanpaşa Hospital, 34245 Istanbul, Turkey
[2]Department of Emergency Medicine, University of Health Sciences, Kartal Dr. Lutfi Kirdar City Hospital, 34865 Istanbul, Turkey

***Correspondence**
sarperyilmaz08@gmail.com
(Sarper Yilmaz)

Abstract

An electrocardiogram (ECG) is a fast, valuable, and non-invasive test that has a wide range of uses in the diagnosis, examination, screening, and prognosis of many cardiac and non-cardiac morbidities. The study was designed as a prospective, single-blind randomized controlled, single center. The CONSORT (Consolidated Standards of Reporting Trials) statement is used. The patients were divided into two groups: Group Gel Adhesive Electrode (GAE) and Group precordial belt ECG (PBE), according to the ECG recording technique. The results between the two groups were compared. A total of 250 patients were included in the study. 127 patients were included in the Group GAE and 123 patients were included in the Group PBE. The mean ECG recording time of patients in the Group GAE was 86.83 $\pm$ 22.53 seconds, while it was 59.56 $\pm$ 15.08 seconds in the Group PBE. When the ECG recording time is evaluated, the mean of the patients in the Group PBE is shorter, and there is a statistically significant difference between the two groups ($p < 0.001$). When evaluated in terms of the need for repeat ECG acquisitions of the ECG (Group PBE: 9.75%, Group GAE: 14.96%), there is no statistically significant difference between the groups ($p = 0.251$). Causes of a repeat ECG were chest hair (Group GAE: 3.15%, Group PBE: 6.50%; $p = 0.215$), perspiration (Group GAE: 8.66%, Group PBE: 3.15%; $p = 0.108$), shaking (Group GAE: 15%, Group PBE: 0%; $p = 0.122$). Compared to the GAE, the precordial ECG Belt may be more advantageous in terms of examination time.

Keywords

Electrocardiogram; Precordial belt ECG; Gel adhesive electrode; Cardiac care

1. Introduction

Today, crowded patient admissions to Emergency Department (ED) have become a serious problem in providing adequate medical care. In addition, this chaotic condition negatively affects the quality of patient care and the productivity of health-care professionals [1]. Another negative consequence of this situation is increased mortality and morbidity due to delays in diagnosis, treatment, and hospital admission [2].

The increased ED visits and excessive admissions obligate hospital managements and health systems to take precautions and to make changes, such as speeding up test results, minimizing repetitive situations, focusing on faster conclusion of patient care and treatment processes, and establishing rapid decision mechanisms. Although it is not a laboratory test, these improvements are also pertinent for electrocardiography (ECG), which has an extremely important role in the diagnosis of diseases with high mortality. Different methods are being tried to shorten the recording time.

It has been shown that ECG recording time has effects on prognosis, especially in cardiac diseases with high mortality, such as ST segment elevation myocardial infarction (STEMI). In addition, the ten-minute time target determined in the guides for the door-to-ECG time remains up to date [3]. In many other diseases, as with patients presenting to ED with angina equivalents, serial ECG recordings may be required in the follow-up of a patient in ED in addition to the target of early ECG recording. There are many reasons such as gender, culture, inadequacy of hospital health personnel that affect the time to acquire ECGs in ED presentations of the patients [4]. Every factor, whether positive or negative, small, or large, that will affect this period may be clinically important.

The advantages of ECG can be seen as being cost-effective, giving rapid results in the diagnostic process, being simple and easy to use, being reproducible, being noninvasive and painless, and not disturbing the comfort of the patient [5]. In order to interpret the pathologies in the ECG properly, the ECG must be taken correctly. In this respect, it is important to place the leads in the appropriate areas, especially in repeated ECG recordings [6]. For a correct ECG recording the healthcare

worker (doctor or nurse) and the patient should act together and optimum conditions should be provided. The examiner should place the electrodes correctly, and act by considering many factors, such as the patient's physical characteristics and clinical condition.

Although there are few data available in the medical literature on the frequency and advancement of its use, one of the most frequently used ECG techniques in recent years is use of a precordial belt ECG. If we consider the precordial ECG Belt (PBE) in terms of its advantages; PBE's provide easy, fast, and reliable ECG recording. The belts consist of ECG electrodes embedded in a silicone-based flexible material. Since the electrodes are on the belt, there are no sticky or vacuum electrodes used as during classical ECG recordings. The belts are shaped according to the body through the flexible material from which they are produced and can be easily used for different body sizes. The shape of the belt, according to the body, allows the electrodes to be placed properly. Correct placement of the electrodes prevents false measurements. The belt is easier to clean than vacuum pumps and does not require maintenance. Less cable tangles offer ease of use. The hair on the chest of the patient does not need to be shaved. It is suitable for use with both women and men. All precordial ECG belts are compatible with all twelve-lead ECG devices. Electrodes are coated with Ag/AgCl (silver/silver chloride) to increase conductivity [7]. On the other hand, when gels used for GAE come into contact with the skin, local and systemic effects, such as allergic reactions, may occur regardless of composition or concentration [8]. In general, however, skin irritation problems from gel electrodes occur primarily with long-term use. In the examinations made with GAEs, which have lower comfort due to their adhesive feature, the performance quality decreases, especially if the adhesive properties decrease due to the person sweating [9].

ECG recording time is important for the management of patients with acute coronary syndrome (ACS), as well as for the management of other patients in the ED, ambulance, intensive care units and critical care units [3]. The ECG recording time is also of great importance in terms of correct results, correct interpretation, and correct diagnosis for cases where urgent decisions need to be made and for patients who need intervention based on this decision [10]. Therefore, in this study, the Gel-Adhesive Electrode (GAE) and precordial Belt ECG methods used in hospital ED were compared in terms of recording time.

2. Methods

2.1 Study design

The study was conducted as a prospective, single-blind randomized controlled, single-center study. All patients who were admitted to the ED between 07 April–07 May 2022, whose ECG was taken for any reason, who were over the age of 18, and whose written consent could be obtained from them or their legal guardians, were included in the study.

The study was conducted in the Emergency Medicine Department of Yeni Yüzyıl University Faculty of Medicine Private Gaziosmanpaşa Hospital, which is located in a province with a population of 491,000, and which has 18,000 annual emergency patient admissions.

Between 07 April 2022, and 07 May 2022, patients in whom an ECG is obtained in the ED were randomized according to the days on which each method would be used. Randomization was conducted using a computer aid (by '`randomizer.org`'). An allBrand™ twelve-lead ECG precordial Electrodes Belt was used for precordial belt ECG acquisition. Flow chart of study identification and inclusion is shown in Fig. 1. In this study, The CONSORT (Consolidated Standards of Reporting Trials) statement is used [11].

A single method was used for ECG recording on the specified days. Before the ECG recording, the patients were informed that the recording time would be recorded, and written consent was obtained. An ECG was performed by emergency nurses with at least two years experience. ECGs were interpreted by one general practitioner and one emergency medicine specialist with five years experience in the ED. ECGs were evaluated with the joint decision of these two groups. In the interim, a second experienced emergency medicine specialist was included in the evaluation.

The emergency nurse and the patient were not informed which method was the study group or the control group. Emergency nurses were coded with the first letters of their names and surnames, and ten volunteer emergency nurses, including AO, AS, ASZ, EY, HO, KNC, KC, OY, SNS, and UD, were included in the study.

A standard procedure has been developed in the hospital. The pairs of emergency nurses on duty were arranged and the ECG devices they would use were changed in each shift. Each nurse participating in the study; used both precordial belt and GAE ECG recordings (Fig. 2). The ECG devices that the shift workers will use are out of the knowledge of the nurses.

Median ECG recording time: after the patient goes into the ECG cabinet for the ECG recording, after the preparation for the ECG is made, after he declares to the emergency nurse in charge that he is ready; the time started after the patient's protocol number was entered into the ECG device by the emergency nurse in charge, and the time was automatically completed after the ECG printout.

The same ECG booth was used for the ECG recordings, and this was designated as the quietest place in the ED. The recordings were performed not on the standard stretchers used by the patients, but by creating a separate ECG recording area.

During the interpretation process, the physicians were not informed regarding the method of applying the ECGs. The ECGs taken were evaluated in two groups: 'appropriate' and 'technically mistaken'. As a criterion, ECGs in which no artifact was observed, or where all the leads could be interpreted even if there were artifacts, were evaluated as appropriate. Any ECGs that contained too much artifact and which could not be interpreted were evaluated as inappropriate and reworked. The examination time of the ECG, which was determined to be appropriate, was included in the study data regardless of the number of repetitions.

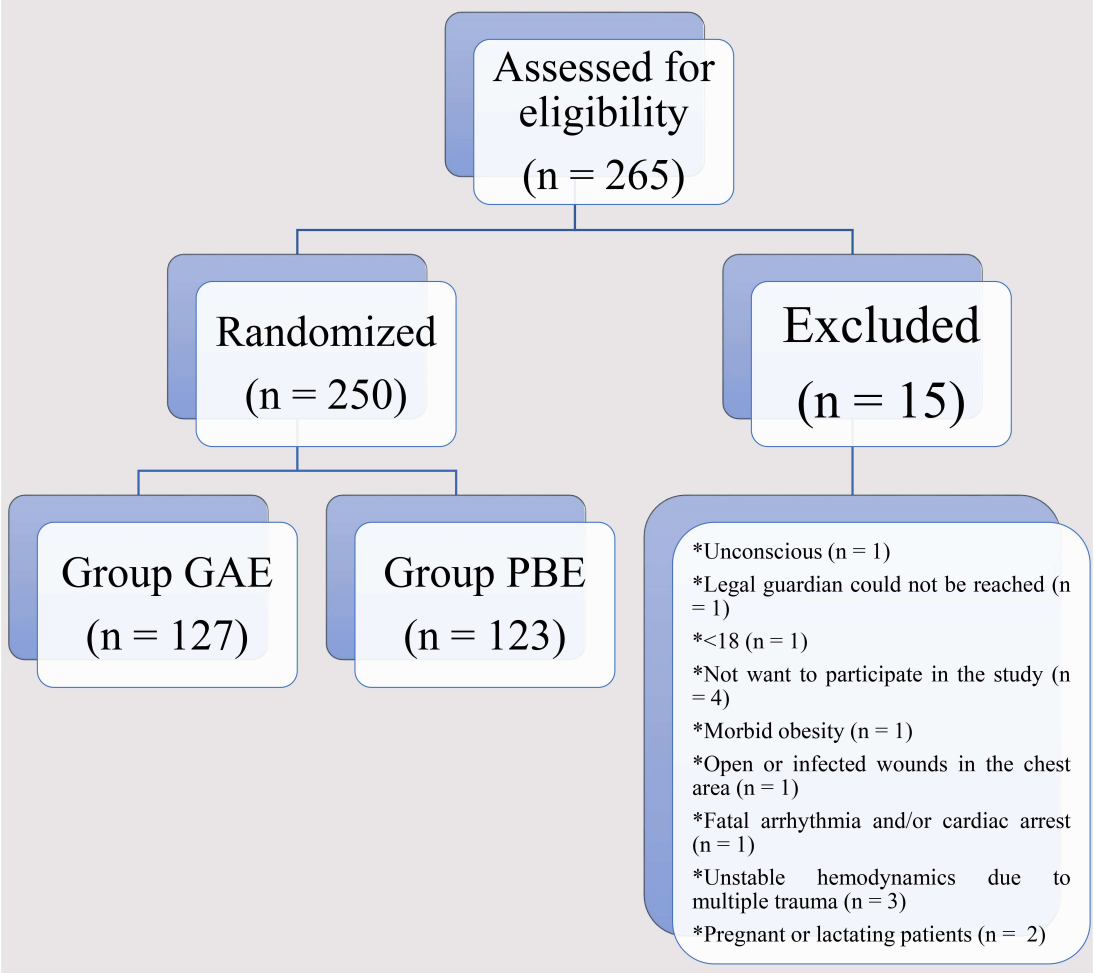

FIGURE 1. Flow chart of study identification and inclusion. Group GAE: Group Gel Adhesive Electrode; Group PBE: Group precordial belt electrocardiogram.

2.2 Exclusion criteria

In this study, none of the patients did not experience loss of follow-up, allocation, discontinuation and exclusion from analysis, but 15 patients were excluded from the analysis due to their current clinical and morphology.The following were not included in the study: unconscious patient (n = 1); patient whom legal guardian could not be reached (n = 1); patient under the age of eighteen (n = 1); patients who did not want to participate in the study (n = 4); patient who could not use a precordial ECG belt due to morbid obesity (n = 1); patient with open or infected wounds in the area to be belted in the chest area (n = 1); patient who had developed fatal arrhythmia and/or cardiac arrest during or just before the ECG acquisitions (n = 1); those who were unstable in terms of hemodynamics; those who were followed up due to multiple trauma; and those whose movement was restricted and unstable (n = 3); pregnant or lactating patients (n = 2) (Fig. 1).

2.3 Sample size

A pilot study was conducted to determine the required sample size. The pilot study indicated that our primary parameter (recording time of ECG) was around 73.70 ± 17.05 seconds in the group GAE (n = 20) and 66.95 ± 10.49 seconds in the Group PBE (n = 20). For the recording time of the ECG, a total sample size of 232 was calculated using G-Power version 3.1.9.2 (IBM Corp., Dusseldorf, Germany) with an alpha probability of 0.05 and a power of 0.95, and with effect size (0.476). Considering possible dropouts, we decided to include at least 250 patients in this study.

2.4 Statistical method

Statistical Package for Social Sciences (SPSS version 27, IBM Corp, Armonk, NY, USA) was used for statistical analysis. Continuous numerical data were given as mean ± standard deviation and median (interquartile range (IQR) 25th–75th), while categorical data were presented as frequency and percentage. The distribution of continuous data was confirmed with the Kolmogorov-Smirnof test and histogram. Categorical variables were planned to be analyzed using the chi-square test. It was planned to use Shapiro-Wilk analysis to control the normal distribution of quantitative variables, and to compare normally distributed quantitative variables with the *t*-test in independent groups and the Mann-Whitney U test for those who did not show normal distribution. $p < 0.05$ was considered statistically significant.

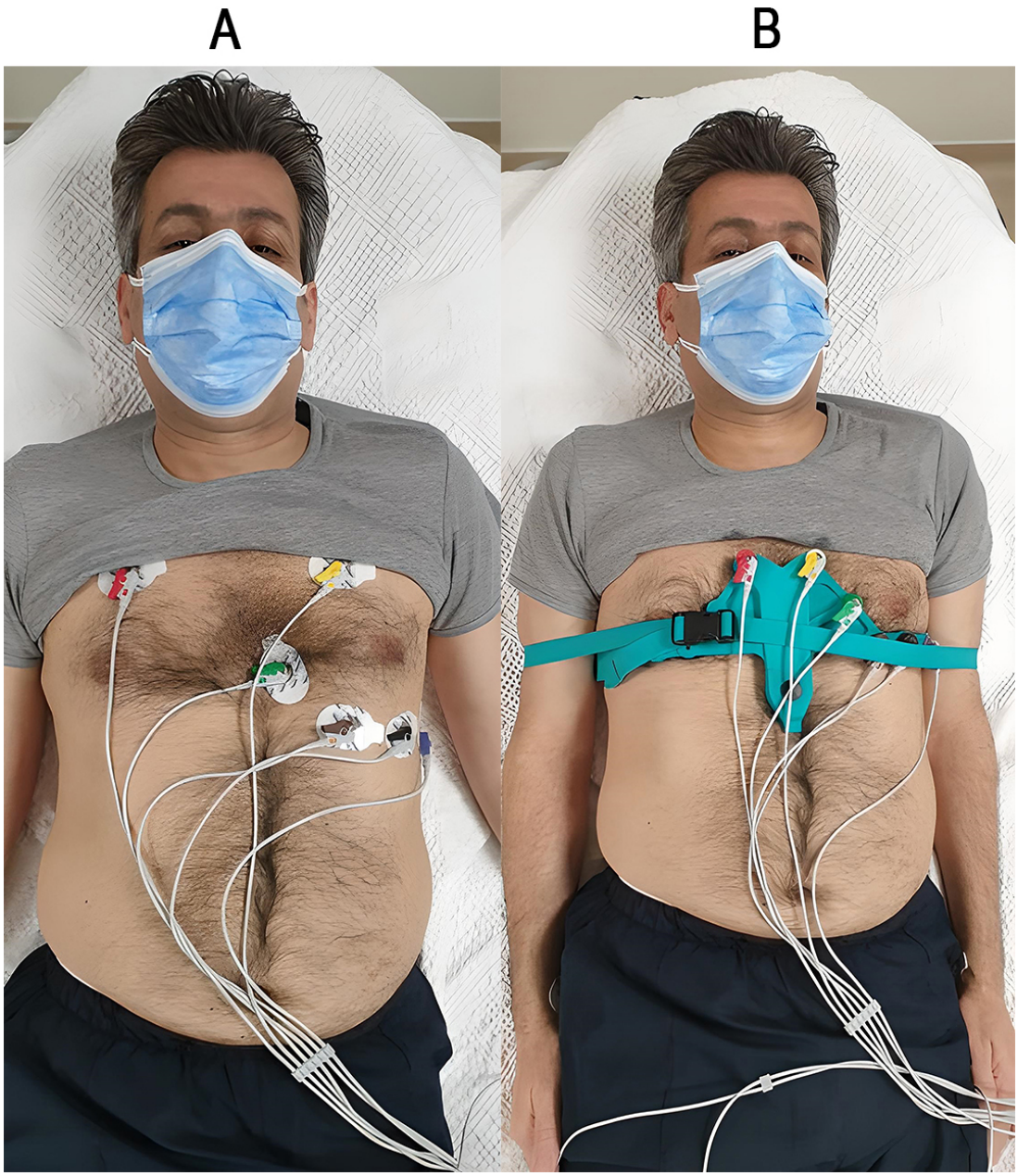

FIGURE 2. Recording of Gel Adhesive Electrode and Precordial ECG Belt. A. Gel Adhesive Electrode Recording. B. Precordial ECG Belt Recording.

3. Results

A total of 250 patients were included in the study. The patients were divided into two groups: the Group GAE and the Group PBE. In the Group GAE, 82 (64.57%) of 127 patients were male. In the Group PBE, 74 (60.16%) of 123 patients were male. There was no statistically significant difference between the two groups in terms of gender distribution ($p = 0.515^b$).

When the median-age of the two groups is evaluated, the median age of the patients included in the Group GAE was 51 (IQR 38–70) years. The patients in the Group PBE were 55 (IQR 43–70) years. There was no statistically significant difference between the median ages of the groups ($p = 0.489^a$).

The median weight, height and Body Mass Index (BMI) of the patients included in the two groups were evaluated, respectively: patients in the Group GAE were 70 (IQR 62–78) kg, 167 (IQR 159–174) cm, 25.47 (IQR 22.59–27.43); patients in the Group PBE were 72 (IQR 61–79) kg, 165 (IQR 158–172) cm, 25.83 (IQR 23.51–27.97). There was no statistically significant difference between the two groups when weight ($p = 0.568^a$), height ($p = 0.260^a$), and BMI ($p = 0.125^b$) were compared (Table 1).

Reasons for ECG recording were anaphylaxis, vertigo, palpitation, chest pain, epigastric pain, dyspnea, syncope. When the comparison of the reason for ECG recording, there was no statistically significant difference between the Group GAE and the Group PBE ($p = 0.692^b$). Nurses participating randomly assigned to their shift used PBE and GAE for patients.

When the type of ECG used by nurses for ECG recording of patients is compared (the Group GAE and the Group PBE), regardless of the reason for ECG recording, there was no statistical difference between the patients whose ECG was

recorded ($p = 0.654^b$) (Table 1).

The mean ECG recording time of the patients in the Group GAE was 86.83 ± 22.53 seconds, while the Group PBE's was 59.56 ± 15.08 seconds. When the ECG recording time is evaluated between the two groups, there is a statistically significant difference ($p < 0.001$), and the mean of the patients in the Group PBE is smaller.

When the need for repeat ECG acquisitions of the ECG was compared between the two groups, the ECG was taken again in nineteen (14.96%) patients in the Group GAE and twelve (9.76%) patients in the Group PBE. No significant statistical difference between the two groups ($p = 0.251^b$) was observed (Table 2).

When the reasons for re-examination of the patients were examined the following was found: four patients (3.15%) in the Group GAE, and eight patients (6.50%) in the Group PBE due to chest hair; eleven (8.66%) patients in the Group GAE, and four patients (3.25%) in the Group PBE due to perspiration; because of shaking, four (3.15%) patients in the Group GAE and no patients in the Group PBE were re-examined by ECG.

4. Discussion

Due to the crowding of EDs, patient management becomes more difficult every day. Less time-consuming techniques are needed to provide care for more patients in the same time frame. While examinations performed on patients affect the prognosis of these patients, on the other hand, a short time required for the test facilitates patient care in an ED. In this study, the ECG, one of the most important tests used in an ED, was evaluated. The use of a GAE ECG and a PBE in patients was compared in terms of time. The first and most important result is that a PBE can be taken in a shorter time compared to a GAE ECG. Shortening of this time could contribute positively to the targeted ten-minute gate-ECG time in STEMI [4].

The median difference between the two techniques is twenty-six seconds. Although this time difference may seem short, considering the time required for the patient to present to an ED, registration, triage, and meeting with the physician, we consider this is an important difference in achieving the ten-minute target, even in typical STEMI patients, and particularly in developing countries.

Today, although the ECG test is frequently used for diagnostic purposes, it is also requested for screening purposes in many cases, such as in athletes, people who intend to work in jobs that require effort, and in patients who will be started on drugs with pro-arrhythmic side effects.

In addition, it is recommended that patients who are admitted to health institutions due to Coronavirus Disease 2019 (COVID-19), which has been a serious health problem all over the world since 2019, should have an ECG test at the time of recording, and during the management and follow-up processes [12]. It may be advantageous to use PBE recordings for these patients, to shorten the time of contact with the patient carrying COVID-19.

Another result of the study is the need for repeat ECG acquisitions in the precordial belt ECG. Although there was no statistically significant difference between the two groups in terms of the need to repeat the procedure in the present, this rate is numerically lower in the belt group compared to the GAE. Studies with larger series would enable an evaluation of the need for re-examination.

When the literature is reviewed, studies on the precordial ECG belt are limited. In a study by Bell *et al*. [8] 'The belt's most obvious weakness was an inability to obtain a recording with a stable ECG baseline, triggering automated detection of baseline artifact or wander, and requiring a repeat recording' [7]. Although they obtained similar results, a different result was obtained in this study. The reason for this is that the study by Bell *et al*. [8] was conducted in 2001 and, particularly in recent years, the electrodes of precordial ECG belts have been coated with Ag/AgCl to increase conductivity [13]. This may enable different results. While both the shorter time and the need for repetitions contribute more to the ECG time allocated for the patient, the device, bed, and personnel used for the ECG reduce the time allocated for the ECG.

In a study conducted with nurses in the literature, it was found that 83.9% of nurses marked the area where the precordial unipolar leads are placed incorrectly [14]. In another study, it was found that 80% of the 210 nurses participating in the study misidentified the locations of the chest leads in the electrocardiography [15]. Incorrect electrode placement and interindividual differences in human anatomy can lead to misinterpretation of the ECG examination [16, 17].

Distortions in ECG traces increase with distance from the precordial lead specific to the selected electrode, the direction of displacement, and the ECG segment selected for calculations. This can cause difficulties in interpretation. For this reason, these problems may be experienced less frequently with the precordial belt since the electrode sites will not be placed one by one. When the literature is re-examined, the precordial belt ECG design has been found useful and recommended especially in women and people with abnormal breast configuration [18]. This study does not make the degree of ability for the healthcare worker to affect the electrode placement in relation to patient morphology. It cannot be both adaptable and not adaptable. Inability of the device in the present study to adapt to patient morphology accurately remains an important limitation, particularly for STEMI patients and for obese patients and patients with other morphological anomalies or wounds.

ECG repetition is less likely due to the missing and incorrect procedure of the person who took the precordial ECG belt. This is because the extraction procedure is easier, and the electrodes are partially fixed by placing them in a ready order. This is actually a significant advantage of the belt design and warrants more explicit description. Confusion in attaching which electrode position to which wire is a common and clinically important problem in ECG acquisition. This is actually a significant advantage of the belt design.

Rapid ECG recording not only contributes to the patient but also to the general patient management in the ED. Considering the most common reasons for referral to EDs today, ECG is a cost-effective tool in terms of evaluating comorbid diseases, deciding on the treatments to be started, diagnostic prognosis of the disease and differential diagnosis. In this way, this work-up may be routinely performed hundreds of times in an

TABLE 1. Comparison of patients' demographic and physical characteristics, reasons for ECG and nurses' preference for Group GAE and Group PBE.

	Group GAE	Group PBE	*p* Value
Age mean (SD)	51 (IQR 38–70)	55 (IQR 43–70)	0.489[a]
Gender (F/M)	45/82	49/74	0.510[b]
Weight	70 (IQR 62–78)	72 (IQR 61–79)	0.568[a]
Height	167 (IQR 159–174)	165 (IQR 158–172)	0.260[a]
BMI	25.47 (IQR 22.59–27.43)	25.83 (IQR 23.51–27.97)	0.125[b]
Reason for ECG			
Anaphylaxis	1	3	
Vertigo	3	6	
Palpitation	10	12	
Chest pain	58	50	0.692[b]
Epigastric pain	6	3	
Dyspnea	29	31	
Syncope	20	18	
Nurse			
AO	9	5	
AS	20	15	
ASZ	18	12	
EY	13	10	0.654[b]
HO	10	15	
KNC	9	12	
KC	14	14	
OY	10	14	
SNS	14	11	
UD	10	15	

Values are presented as median (interquartile range (IQR) 25^{th}–75^{th}, [a]: Mann-Whitney U test, [b]: Chi-square, Group GAE: Group Gel Adhesive Electrode; Group PBE: Group precordial belt ECG; ECG: electrocardiogram; BMI: Body Mass Index; SD: Standard deviation.

TABLE 2. Comparison of recording time, need for a repeat and causes of a repeat ECG.

	Group GAE	Group PBE	*p* Value
Recording time of the ECG	86.83 ± 22.53	59.56 ± 15.08	<0.001[a]
(seconds)	85 (IQR 72–95)	57 (IQR 51–65)	
Need for a repeat of the ECG	19/127 (14.96%)	12/123 (9.75%)	0.251[b]
Cause of a repeat ECG			
Chest hair	4 (3.15%)	8 (6.50%)	0.215[b]
Perspiration	11 (8.66%)	4 (3.15%)	0.108[b]
Shaking	4 (3.15%)	0 (0.00%)	0.122[c]

Values are presented as median (interquartile range (IQR) 25^{th}–75^{th}), [a]: Mann-Whitney U test, [b]: Chi-square, [c]: t-test, Group GAE: Group Gel Adhesive Electrode, Group PBE: Group precordial belt ECG, ECG: electrocardiogram.

easy and practical way for many patients in crowded EDs. Although the difference between the two patient groups as a result of this study may appear unimportant in terms of the contribution it provides for the "Door-to-ECG time determined as 10 minutes", there is a significant difference between the two groups in an ED with a large number of daily patient admissions. Even small gains between the methods developed for ECG are valuable.

5. Conclusions

In this study, it is shown that precordial ECG belts have certain advantages over gel adhesive ECGs. In addition, although there is no statistically significant difference between the two groups in terms of the reasons for re-examination of an ECG, it is noteworthy that there was no need for repeating in the belt group in situations related to movement, such as shaking, while such repeats were required with GAE. In experimental and comparative clinical studies to be conducted with a larger series, the difference may become statistically significant.

AVAILABILITY OF DATA AND MATERIALS

The data presented in this study are available on reasonable request from the corresponding author.

AUTHOR CONTRIBUTIONS

OFA—Conceptualization, methodology, software, data curation, writing-original draft preparation. SY—Visualization, investigation, supervision, software, validation, writing-reviewing and editing.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study was approved by the Yeni Yüzyıl University Faculty of Medicine Private Gaziosmanpaşa Hospital, Institutional Review Board with a waiver of informed consent owing to its prospective nature (IRB No: 07-04-2022-26). The first approval date was 04 April 2022.

ACKNOWLEDGMENT

We would like to thank the nurses of Emergency Medicine Department of Yeni Yüzyıl University Faculty of Medicine Private Gaziosmanpaşa Hospital for their support of our research.

FUNDING

This research received no external funding.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

[1] Di Somma S, Paladino L, Vaughan L, Lalle I, Magrini L, Magnanti M. Overcrowding in emergency department: an international issue. Internal and Emergency Medicine. 2015; 10: 171–175.

[2] Bernstein SL, Aronsky D, Duseja R, Epstein S, Handel D, Hwang U, *et al*. The effect of emergency department crowding on clinically oriented outcomes. Academic Emergency Medicine. 2009; 16: 1–10.

[3] Yiadom MYAB, Baugh CW, McWade CM, Liu X, Song KJ, Patterson BW, *et al*. Performance of emergency department screening criteria for an early ECG to identify ST-segment elevation myocardial infarction. Journal of the American Heart Association. 2017; 6: e003528.

[4] Keats A, Moran D, Rothwell S, Woodcock T, Williams T, Rawat N. A quality improvement project to reduce door-to-electrocardiogram time: a multicenter study. Journal of the Saudi Heart Association. 2018; 30: 180–187.

[5] AlGhatrif M, Lindsay J. A brief review: history to understand fundamentals of electrocardiography. Journal of Community Hospital Internal Medicine Perspectives. 2012; 2: 14383.

[6] Wagner GS, Macfarlane P, Wellens H, Josephson M, Gorgels A, Mirvis DM, *et al*. AHA/ACCF/HRS recommendations for the standardization and interpretation of the electrocardiogram. Circulation. 2009; 119: e262–e270.

[7] Meziane N, Webster JG, Attari M, Nimunkar AJ. Dry electrodes for electrocardiography. Physiological Measurement. 2013; 34: R47–R69.

[8] Bell SJ, Clifton J, Pease J, Greenfield JC, Leggett S, Maynard C, *et al*. The evaluation of a precordial ECG BELT: technologist satisfaction and accuracy of recording. Journal of Electrocardiology. 2001; 34: 155–159.

[9] Yang H, Ji S, Chaturvedi I, Xia H, Wang T, Chen G, *et al*. Adhesive biocomposite electrodes on sweaty skin for long-term continuous electrophysiological monitoring. ACS Materials Letters. 2020; 2: 478–484.

[10] Yiadom MYAB, Gong W, Patterson BW, Baugh CW, Mills AM, Gavin N, *et al*. Fallacy of median door-to-ECG time: hidden opportunities for STEMI screening improvement. Journal of the American Heart Association. 2022; 11: e024067.

[11] Schulz KF, Altman DG, Moher D; CONSORT Group. CONSORT 2010 statement: updated guidelines for reporting parallel group randomized trials. Annals of Internal Medicine. 2010; 152: 726–732.

[12] B Bergamaschi L, D'Angelo EC, Paolisso P, Toniolo S, Fabrizio M, Angeli F, *et al*. The value of ECG changes in risk stratification of COVID-19 patients. Annals of Noninvasive Electrocardiology. 2021; 26: e12815.

[13] S Rodrigues M, Fiedler P, Küchler N, P Domingues R, Lopes C, Borges J, *et al*. Dry electrodes for surface electromyography based on architectured titanium thin films. Materials. 2020; 13: 2135.

[14] Goz F, Baran G. Determination of nurses' evaluations and training needs regarding electrocardiography (ECG). Journal of Cumhuriyet University School of Nursing. 2000; 4: 1–6. (In Turkish)

[15] Doğan DH, Melek M. Determination of nurses' levels of recognizing ECG findings in emergency heart diseases and evaluating appropriate treatment approaches. Turkish Society of Cardiology Journal of Cardiovascular Nursing. 2012; 1–10. (In Turkish)

[16] Kania M, Rix H, Fereniec M, Zavala-Fernandez H, Janusek D, Mroczka T, *et al*. The effect of precordial lead displacement on ECG morphology. Medical & Biological Engineering & Computing. 2014; 52: 109–119.

[17] Bond RR, Finlay DD, Nugent CD, Breen C, Guldenring D, Daly MJ. The effects of electrode misplacement on clinicians' interpretation of the standard 12-lead electrocardiogram. European Journal of Internal Medicine. 2012; 23: 610–615.

[18] Mills H, Stein HI, Mandel WJ. The precordial ECG belt for obtaining rapid reproducible precordial leads. Journal of Electrocardiology. 1979; 12: 407–410.

How to cite this article: Ömerul Faruk Aydın, Sarper Yilmaz. A comparison of a precordial electrocardiogram (ECG) belt and a gel-adhesive electrode in terms of ECG acquisition time and usability in emergency department patients. Signa Vitae. 2023; 19(3): 152-158. doi: 10.22514/sv.2023.002.