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Original Contributions

PROPOSED BEDSIDE MANEUVER TO FACILITATE ACCURATE ANATOMIC ORIENTATION FOR CORRECT POSITIONING OF ECG PRECORDIAL LEADS V1 AND V2: A PILOT STUDY

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☐ **Abstract—Background: Misplacement of right precordial electrocardiogram (ECG) electrodes superiorly is a prevalent procedural error that may lead to false findings of T-wave inversion or QS complexes in V2—possibly triggering wasteful utilization of health care resources. Standard technique for proper placement of V1–V2 entails initial palpation for the sternal angle, pointing to the second intercostal space (ICS), followed by lead fixation at the fourth ICS. Study Objective: Because adherence to this approach may be limited by lack of a visual landmark for the second ICS, we assessed an alternative technique. Methods: The evaluated technique involved placement of the patient's hand up against the base of his/her neck ($H \rightarrow N$ maneuver) to help demarcate visually a specific point "X" on the chest. Results: Of 112 patients studied, "X" landed on the first rib in 2.7%, first ICS in 7.1%, second rib in 56.3%, second ICS in 33.0%, and third rib in 0.9%. Thus, in 89.3% (95% confidence interval 83.6–95.0%) of cases (93.3% of men, 84.6% of women; $p = 0.13$), the second ICS could be identified by $H \rightarrow N$ via the following simple rule: Utilize "X" if it overlies an ICS; or the immediately subjacent ICS if "X" overlies a rib. Conclusion: The $H \rightarrow N$ maneuver provides a primarily visual approach to identifying the second ICS and, thereby, the fourth ICS for affixing V1–V2. If the present initial experience is confirmed, $H \rightarrow N$ might merit consideration as an educational tool to promote anatomically correct placement of these precordial leads, a prerequisite to diminishing the incidence of ECG procedure-related "septal ischemia/infarction."** © 2012 Elsevier Inc.

☐ **Keywords—electrocardiography; diagnostic errors; acute coronary syndromes; myocardial infarction; emergency department**

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INTRODUCTION

Over 100 years after its introduction, the electrocardiogram (ECG) remains an invaluable and relatively inexpensive diagnostic modality for rapidly detecting a broad spectrum of cardiac disorders, including various life-threatening conditions such as acute coronary syndrome (1,2). Accurate interpretation of the 12-lead ECG presupposes proper electrode placement. Yet, despite standardization of their locations since the late 1930s, precordial leads V1 through V6 are still often subject to erroneous and inconsistent placement on the chest (1,3–12). Such lapses in procedural adherence can lead not only to altered R-wave amplitude, but also false ECG diagnoses, most significantly "ischemia" (T-wave inversion, or ST-segment shifts) and "infarction" (Q waves or QS complexes), and additionally, "Brugada syndrome" (5,8,13–23). These misdiagnoses are far from trivial in that they can prolong evaluation time in the emergency department (ED) (and, thereby, contribute to the crowding

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problem); cause postponement of previously scheduled surgical procedures; lead to unnecessary non-invasive (and perhaps even invasive) diagnostic cardiac tests; prompt treatments that are potentially risky (e.g., intravenous antithrombotic or antiplatelet therapy) or expensive; and possibly raise a red flag if the patient applies for employment or life insurance (22,24).

Right precordial electrodes V1 and V2—which are supposed to be placed parasternally at the fourth intercostal space (ICS)—are particularly prone to being malpositioned superiorly (i.e., in a cranial direction) on the chest, possibly causing registration of T-wave inversions or QS complexes (6,12,15–22). Although such waveforms are part of the physiologic adult ECG morphologic spectrum in V1, their appearance in V2 (or in both V1 and V2) is usually considered abnormal, suggesting ischemia or infarction localized, by common convention, to the interventricular septum (albeit an anatomic oversimplification) (20,25–35). Superiorly misplaced right precordial leads also may display altered P-wave morphology (17,20,22,36).

Textbooks diagramming the anatomically precise positions for V1 and V2 commonly depict the loci for these electrodes in relation to an underlying rib cage, as generically illustrated in Figure 1A (37–46). In a real live patient, however, one encounters a torso typically devoid of any visual markers for ribs or interspaces (Figure 1B). Although not widely described in standard texts, the traditional technique for overcoming this perceptual gap entails searching by palpation for the horizontal bony ridge between the manubrium and body of the sternum, that is, the sternal angle (of Louis), serving as anatomic landmark for the second ICS (Figure 1A), from which one can then count downward to the fourth ICS to affix leads V1 and V2 (36,46–49). It is acknowledged that execution of this technique can be challenging (10,49). Not surprisingly, therefore, the default approach is simply to position the V1 and V2 electrodes at chest wall sites that "look right," regardless of whether that is actually the case (5).

Our working hypothesis was that a major impediment to widespread adoption of the conventional technique for identifying the second (and, thereby, the fourth) ICS is the method's requirement of a palpation search for the sternal angle owing to relative invisibility of the latter structure. As such, it would be desirable to have the option of an anatomically reliable alternate technique that circumvents the practical challenge of the sternal angle-based method, with the hope of also reducing the tendency of ECG operators to default to an intuitive—but often erroneous—lead positioning approach. Accordingly, one of us (M.H.L.) devised a bedside maneuver specifically offering visual guidance to encourage localization of the second ICS as a first step to anatomically proper placement of precordial leads V1 and V2. The present communication reports the results of a pilot study assessing the anatomic accuracy of this novel technique, a prerequisite for its consideration as a supplemental ECG procedural learning tool.

MATERIALS AND METHODS

Study Design and Setting

This was a single-center, prospective cohort study, performed in a community setting, at a satellite center of an academic health system, under approval of the Institutional Review Board of the University of Michigan School of Medicine.

Patient Selection

Outpatients undergoing an ECG as part of a cardiac stress-testing procedure were considered for enrollment in the study. Of 132 consecutive patients screened for participation in the trial, 4 individuals were eliminated after application of the exclusion criteria (left infraclavicular pacemaker or implantable cardioverter-defibrillator pulse generator [n = 3], dementia [n = 1], pectus excavatum or carinatum [n = 0], or upper limb amputation [n = 0]). The remaining 128 patients were approached for enrollment, and 112 (88%) agreed to participate, forming the cohort for this report.

Data Collection

Just before performance of the baseline ECG, signed informed consent was obtained and the study protocol implemented. For each patient we recorded: age, sex, ethnicity (in 111/112 cases, as identified from the demographics section of the electronic medical record), and self-reported weight (in pounds) and height (in inches). The patient was placed in a supine position on an examination bed, the head of which was partially elevated; lighting in the room was dimmed. The sternal angle was semi-quantitatively graded by the senior investigator (an academic cardiologist for 28 years, and Director of our health system's Electrocardiography Laboratory), as follows: *Grade I* – not visible and barely palpable; *Grade II* – not visible, but definitely palpable; and *Grade III* – visible as well as palpable.

Guided by palpation of the sternal angle, the second ICS ("gold standard" anatomic site) was identified manually by the senior investigator and demarcated using an invisible ink marker. Then, without having observed this landmarking process, a second investigator (A.M.K.) performed the alternate (test) method, utilizing what we have termed the "hand-to-neck" maneuver (or, $H \rightarrow N$) to point