

Differences in Negative T Waves Between Acute Pulmonary Embolism and Acute Coronary Syndrome



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BACKGROUND

Acute pulmonary embolism (APE) and acute coronary syndrome (ACS) often present with overlapping symptoms such as chest pain and dyspnea. On electrocardiogram (ECG), both conditions may show negative T waves (Neg T) in the precordial leads, which complicates early diagnosis. Accurate distinction is crucial because misclassification can delay proper treatment and contribute to preventable adverse outcomes.

In 2014, Kosuge et al. retrospectively studied 107 patients with APE and 248 with LAD-related ACS, all of whom had precordial Neg T on admission. They concluded that Neg T in both leads III and V1 and/or peak Neg T in V1–2 distinguished APE from ACS with high diagnostic accuracy, reporting sensitivity of 98%, specificity of 92%, positive predictive value (PPV) of 83%, and negative predictive value (NPV) of 99% (1). This “and/or” rule has since been widely cited and incorporated into ECG education as a simple bedside discriminator (2).

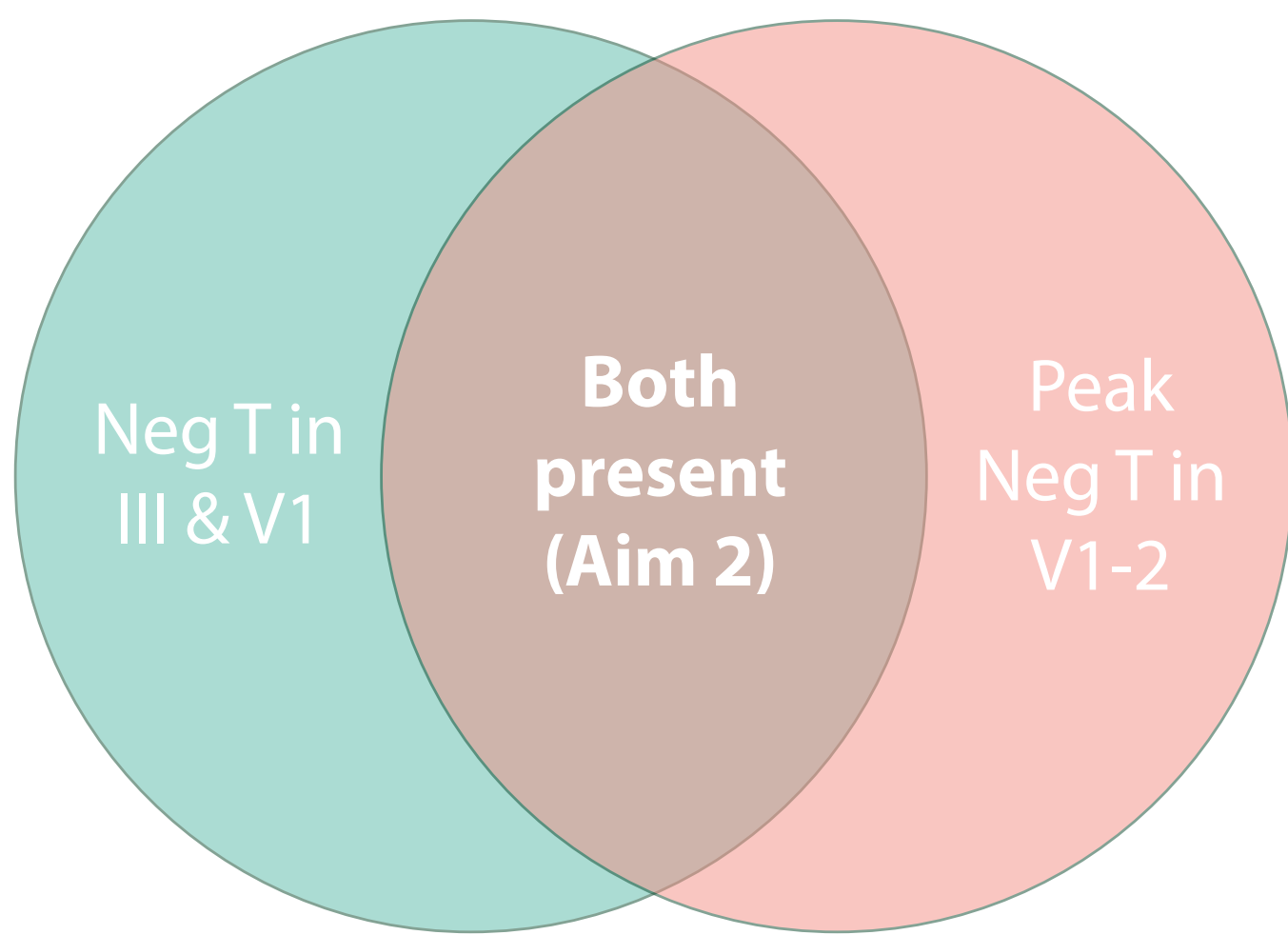
However, most APE patients in their cohort had both findings simultaneously, while isolated findings were less reliable. This observation suggests that the true diagnostic value may lie in the combined presence of both patterns rather than in either alone. Our project revisits this issue using the data reported in Table 3 and the critique from a subsequent editorial letter, with the aim of clarifying the performance of isolated versus combined findings.

AIMS

The aim of this project was to revisit the analysis of Kosuge et al. (2014) and clarify the diagnostic performance of isolated versus combined Neg T findings on ECG in distinguishing APE from ACS. Specifically, we sought to determine:

- Whether the presence of either Neg T in III and V1 or peak Neg T in V1–2 is diagnostically useful when present in isolation.
- Whether the co-occurrence of both findings simultaneously provides greater discriminatory value.

This objective arose from the observation that the original study’s high reported accuracy may have been driven by the combined presence of both findings, rather than the original conclusion that either alone was sufficient.



Key Question: *Do isolated Neg T findings truly discriminate, or is the co-occurrence the key signal?*

METHODS

We re-examined the data reported by Kosuge et al. (2014), which included 107 patients with APE and 248 patients with ACS caused by LAD disease. All patients presented with negative Neg T in the precordial leads V1–4. In their study, diagnostic performance was reported for three ECG criteria:

- Neg T in leads III and V1
- Peak Neg T in leads V1–2
- Neg T in III and V1 and/or peak Neg T in V1–2 (the combined “and/or” rule)

We extracted sensitivity, specificity, PPV, and NPV for these criteria as is presented in Table 3 of the original work, as seen below. Building on this work, we examined the distribution of patients who demonstrated either finding in isolation as well as those who demonstrated both findings simultaneously.

	Neg T in III and V1 and/or peak Neg T in V1-V2	Neg T in III and V1	Peak Neg T in V1-V2
Sensitivity (%)	98	87	87
Specificity (%)	92	96	96
PPV (%)	83	89	89
NPV (%)	99	94	94

Table 1. *Extracted data from the parent study by Kosuge et al. demonstrating sensitivities, specificities, PPVs, and NPVs for the three examined ECG patterns.*

RESULTS

Tables 2-3. *Frequencies of ECG patterns were back-calculated using the data reported in the original study in Table 1. 2x2 tables were reconstructed to visualize patient distribution within two assigned groups: Both ECG findings present (left) or only one of the two examined ECG patterns present (right).*

Both Neg T in III and V1 and Peak Neg T in V1-2 Present				Only Neg T in III and V1 or Peak Neg T in V1-V2			
	APE (+)	APE (-)	Total		APE (+)	APE (-)	Total
ECG pattern (+)	81	0	81	ECG pattern (+)	24	20	44
ECG pattern (-)	26	248	274	ECG pattern (-)	83	228	311
Total	107	248	355	Total	107	248	355

In the original study, when considered individually, the presence of Neg T in leads III and V1 demonstrated a sensitivity of 87%, specificity of 96%, PPV of 89%, NPV of 94%, and accuracy of 93%. Peak Neg T in leads V1–2 showed identical diagnostic performance, with sensitivity of 87%, specificity of 96%, PPV of 89%, NPV of 94%, and accuracy of 93%.

From re-analysis of the reported frequencies, the isolated presence of either finding without the other yielded a PPV of 55%, NPV of 71%, positive likelihood ratio (LR+) of 2.75, and negative likelihood ratio (LR–) of 0.85. The simultaneous presence of both findings was observed in 76% of patients with pulmonary embolism and 0% of patients with acute coronary syndrome.

DISCUSSION

The study by Kosuge et al. demonstrated that Neg T in leads III and V1 and peak Neg T in leads V1–2 could differentiate acute APE from ACS with high diagnostic accuracy. Their combined “and/or” rule achieved excellent sensitivity and negative predictive value, while each individual finding alone demonstrated strong specificity.

Our re-examination of these data indicates an important distinction in how these ECG findings should be applied clinically. The isolated presence of either Neg T in III and V1 or peak Neg T in V1–2 was associated with only modest predictive value and likelihood ratios, alongside the increased prevalance of ACS shown in both the examined and prior studies by the authors, indicate that either finding alone does not reliably discriminate between APE and ACS (1, 3). In contrast, the simultaneous presence of both findings was seen in the majority of APE patients and was not observed among ACS patients, making it a much more powerful discriminator. Although this pattern was reported in the original study, its significance may be better appreciated examined separately from the “and/or” rule.

These results suggest that isolated Neg T findings, while common, do not provide sufficient diagnostic certainty. Instead, the co-occurrence of both patterns offers greater specificity and should raise strong suspicion for APE. Clinically, this interpretation reinforces the importance of considering the overall distribution of T wave abnormalities rather than relying on a single isolated feature.

As far as limitations, this work is based on a retrospective, single-center study of patients selected for precordial Neg T, which may limit generalizability. Diagnostic metrics were descriptive rather than adjusted for confounders, and the sample size was modest. Prospective validation in broader populations is needed.

CONCLUSION AND CLINICAL TAKEAWAY

In patients with precordial Neg T, the simultaneous presence of Neg T in III and V1 with peak Neg T in V1–2 was seen in most PE cases and in 0% of ACS cases. Either finding alone was more frequent but had limited predictive value (PPV 55%, NPV 71%, LR+ 2.75, LR– 0.85). These results build on prior work by showing that the discriminatory value lies in co-occurrence rather than isolated findings.

Clinically, isolated Neg T patterns should be interpreted with caution, as they do not reliably separate PE from ACS. When both findings are present together, specificity is high and PE should be strongly suspected, warranting prompt diagnostic evaluation.

REFERENCES

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