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Research Article

Evaluation of the QT Interval to QRS Duration Ratio as a Non-Invasive Arrhythmia Marker in Psoriatic Arthritis Patients Without Cardiovascular Comorbidities

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Abstract

Purpose: *Psoriatic arthritis (PsA) is associated with increased cardiovascular (CV) events. Conduction disturbances and arrhythmias are reported, yet electrophysiological mechanisms are unclear. The index of cardio-electrophysiological balance (iCEB=QT/QRS) and its corrected form (iCEBc=QTc/QRS) are new ECG markers of ventricular depolarization-repolarization balance. This study examined whether iCEB or iCEBc differ in PsA patients without CV comorbidities.*

Methods: *In this retrospective case-control study, 24 PsA patients and 24 age- and sex-matched healthy controls were evaluated. Individuals with cardiovascular or metabolic disease, electrolyte or thyroid abnormalities, or cardiac medication use were excluded. Standard 12-lead ECGs were reviewed. QTc was calculated with Bazett's formula. Group comparisons used the Mann-Whitney U test; correlations used Spearman's coefficient.*

Results: *The PsA and control groups were comparable regarding age, sex distribution, biochemical findings, and baseline ECG parameters (all $p>0.05$). No significant differences were observed in iCEB (4.20 vs 4.05, $p=0.284$) or iCEBc (4.51 vs 4.32, $p=0.307$). Within the PsA group, iCEB and iCEBc were not associated with age, duration of disease, sex, smoking status, LDL-cholesterol, or CRP ($p>0.05$).*

Conclusion: *In PsA patients without cardiovascular comorbidity, iCEB and iCEBc values were similar to those of healthy individuals, indicating preserved depolarization-repolarization balance. These results suggest that PsA alone may not increase arrhythmic risk through iCEB-related mechanisms. Larger prospective studies are required to determine whether iCEB becomes altered in patients with higher inflammatory activity or established cardiac involvement.*

Key words*: Arrhythmia, Inflammation, Psoriatic arthritis*

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Introduction

Beyond its classic manifestations in the joints and entheses, psoriatic arthritis (PsA) is now understood as a systemic inflammatory condition that carries a substantial burden of cardiovascular (CV) disease. A growing body of evidence indicates that patients with PsA face a higher risk of CV morbidity and mortality, a risk that persists even after accounting for conventional risk factors. This is largely attributed to the chronic inflammatory state in PsA, which promotes endothelial dysfunction and accelerates the development of atherosclerosis (1).

Cardiac electrical abnormalities and repolarization disturbances in psoriatic disease have emerged as significant comorbidities alongside atherosclerotic conditions. Population studies demonstrate increased arrhythmia risk among psoriasis and PsA patients, suggesting that disease-related inflammation may contribute to these cardiac complications (2). Case-control electrocardiographic research further demonstrated that patients with PsA may exhibit subclinical conduction abnormalities and altered repolarization parameters compared with healthy individuals (3). Additionally, spondyloarthritis cohorts, which share similar inflammatory pathways with PsA, show an increased prevalence of atrioventricular and bundle branch blocks, supporting the relationship between systemic inflammation and conduction impairment (4).

A relatively new electrocardiographic marker, the index of cardio-electrophysiological balance (iCEB), offers a non-invasive means to assess the relationship between ventricular depolarization and repolarization. This ratio is a surrogate for the cardiac wavelength-a fundamental concept in arrhythmogenesis (5). Experimental data demonstrate that increased iCEB values are associated with susceptibility to torsade de pointes and long QT-related ventricular arrhythmias, whereas reduced values are linked to reentrant ventricular tachyarrhythmias (6). Because iCEB is derived from a standard 12-lead ECG without additional testing, it offers practical clinical utility for arrhythmic risk stratification (5, 6).

Systemic inflammation is known to promote arrhythmogenesis. Pro-inflammatory cytokines can lengthen ventricular repolarization, lead to QT interval prolongation, and precipitate torsade de pointes, even when no structural cardiac abnormality exists (7). These electrophysiological alterations mediated by inflammation have been documented in autoimmune rheumatic conditions such as

rheumatoid arthritis (RA) and during episodes of systemic inflammatory exacerbation (8). Given that PsA is a systemic inflammatory disorder in which conduction abnormalities and arrhythmias can occur, assessing iCEB may provide novel information regarding electrophysiologic status in this patient group.

However, despite the known arrhythmic burden in PsA, no prior study has assessed iCEB in PsA patients. Evaluating iCEB in this population may help identify subtle electrophysiological alterations before overt CV disease develops. The purpose of this study was to compare iCEB and iCEBc values in PsA patients without CV comorbidities versus healthy individuals to assess whether PsA affects cardiac electrophysiological balance.

Methods

The present investigation employed a retrospective, cross-sectional case-control design and was performed at (censored) Training and Research Hospital, encompassing the period from January 1, 2020 through July 1, 2025. The study protocol received ethical clearance from the Non-Interventional Clinical Research Ethics Committee (reference number: 2025/6-5, date of approval: 24.06.2025).

Psoriatic arthritis patients were identified consecutively from Cardiology outpatient clinics, to which they had been referred by their rheumatologists for resting ECG evaluation; their ECG recordings and clinical data were subsequently retrieved from the hospital's digital archive. A total of 45 individuals with an established diagnosis of PsA were screened. Only patients whose resting 12-lead ECG recordings were available in the hospital's digital archive at the time of the visit were considered for eligibility. Eighteen patients were excluded due to predefined criteria that might influence electrophysiologic measurements: ischemic heart disease (n=3), documented arrhythmia (n=3), hypertension (n=5), diabetes mellitus (n=3), chronic kidney disease (n=1), thyroid dysfunction (n=1), electrolyte imbalance (n=1), and the use of cardiac or antihypertensive medications (n=2). One additional patient was excluded due to acute infection, and another due to anemia. Eligible participants were between 18-65 years of age, fulfilled the CASPAR (9) criteria for PsA, and were clinically stable without flare or treatment modification in the prior 3 months. Twenty-four patients diagnosed with PsA who met all specified inclusion criteria were enrolled in the study.

An equivalent number of healthy individuals (n=24), matched according to age and sex and free from CV, metabolic, or inflammatory disorders, comprised the control group.

Clinical and laboratory assessment

A comprehensive array of demographic and clinical variables was systematically recorded and documented for all study participants enrolled in both the patient and control groups. These variables included chronological age, biological sex, body mass index (BMI) calculations, systolic and diastolic BP measurements, current smoking status and history, and the documented duration of disease manifestation in affected patients. Following an overnight fast, venous blood specimens were obtained. The biochemical evaluation encompassed multiple parameters including serum glucose concentrations, creatinine levels, electrolyte measurements (specifically sodium and potassium concentrations), a complete lipid fraction analysis (comprising total cholesterol, low-density lipoprotein cholesterol [LDL-C], high-density lipoprotein cholesterol [HDL-C], and triglyceride measurements), as well as high-sensitivity C-reactive protein (hs-CRP) quantification as a marker of systemic inflammation. All hematologic parameters were systematically determined and quantified utilizing a standardized automated laboratory hematology analytical platform to ensure precision and reproducibility of measurements.

Electrocardiographic analysis

Standard 12-lead electrocardiography was performed on all participants following a 10-minute rest period in the supine position, utilizing standardized recording parameters of 25 mm/s paper speed and 10 mm/mV calibration. Digital conversion of all ECG recordings was conducted, followed by independent analysis employing EP Calipers software version 2.5.2. The intraclass correlation coefficient (ICC) was utilized to evaluate interobserver reliability, revealing excellent concordance between observers' measurements. Parameters assessed included heart rate (HR), PR interval, QRS complex duration, QT interval, and heart rate-corrected QT interval (QTc), with QTc determination performed using Bazett's formula ($QTc=QT/\sqrt{RR}$). The iCEB was computed as the ratio of QT to QRS duration, while its rate-corrected counterpart (iCEBc) was derived as QTc/QRS. These electrocardiographic indices characterize the temporal relationship between ventricular depolarization and repolarization phases and serve as surrogate markers for assessing arrhythmogenic potential.

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics version 27.0 (IBM Corp., Armonk, NY, USA). Normality of distribution was evaluated using the Shapiro-Wilk test. Non-normally distributed continuous variables were expressed as median and interquartile range (IQR), whereas categorical variables were reported as frequencies and percentages. Between-group comparisons were conducted using the Mann-Whitney U test for continuous data and the chi-square test for categorical data. Spearman's rank correlation coefficient was used to assess associations between iCEB/iCEBc and clinical or laboratory parameters. Statistical significance was set at $p<0.05$ (two-tailed).

*An a priori sample size calculation was conducted with G*Power 3.1. Based on the effect size derived from the iCEB difference reported by Uçar et al. (10) (Cohen's $d=1.01$), and assuming $\alpha=0.05$ and $1-\beta=0.80$ for a two-group comparison, the minimum required sample size was 16 participants per group. With 24 participants in each group, the current study was adequately powered to detect an effect of similar magnitude.

Results

The study included 24 PsA patients and 24 healthy individuals matched for age and sex. Median age did not differ significantly between groups (52 [46-57] vs 51 [46-58] years, $p=0.718$), and the proportion of female participants was comparable (75% vs 50%, $p=0.074$). No significant differences were observed regarding systolic or diastolic BP, BMI, or smoking status (all $p>0.05$). In addition, biochemical results including glucose, creatinine, electrolyte levels, lipid profile, hs-CRP, and hematologic indices were comparable (Table 1).

Electrocardiographic findings are presented in Table 2. Heart rate, PR interval, QRS duration, and QT/QTc values were comparable between the PsA group and healthy controls, with no statistically significant differences (all $p>0.05$). Similarly, iCEB and iCEBc values were comparable between the groups. The median iCEB was 4.20 (3.80-4.60) among PsA patients and 4.05 (3.73-4.26) among controls ($p=0.284$). Median iCEBc values were 4.51 (4.11-5.08) and 4.32 (4.00-4.86), respectively ($p=0.307$).

Table 1. Baseline characteristics and laboratory findings of PsA and control group.

	PsA group (n=24)	Control group (n=24)	p-value
Age (years)	52 (46-57)	51 (46-58)	0.718
Female, n (%)	18 (75)	12 (50)	0.074
Systolic BP (mmHg)	120 (117-129)	126 (120-135)	0.162
Diastolic BP (mmHg)	76 (73-82)	77 (70-82)	0.572
BMI (kg/m²)	27.8 (24.6-30.4)	26.9 (23.1-30.5)	0.610
Smoking	8 (33.3)	7 (29.2)	0.755
Glucose (mg/dL)	97 (88-102)	96 (90-102)	0.918
Creatinine (mg/dL)	0.8 (0.7-0.8)	0.7 (0.6-0.8)	0.262
Sodium (mmol/L)	140 (138-142)	139 (138-141)	0.415
Potassium (mmol/L)	4.3 (4.2-4.6)	4.2 (4.1-4.7)	0.739
LDL cholesterol (mg/dL)	137 (105-169)	118 (108-170)	0.984
Total cholesterol (mg/dL)	228 (179-259)	196 (180-245)	0.642
HDL cholesterol (mg/dL)	57 (47-70)	49 (41-64)	0.186
Triglycerides (mg/dL)	120 (89-165)	120 (81-154)	0.837
CRP (mg/dL)	1.8 (0.1-3.3)	1.3 (0.1-1.9)	0.323
WBC (×10⁹/L)	6.4 (5.6-7.4)	6.7 (5.9-7.7)	0.375
Hemoglobin (g/dL)	13.3 (12.1-14.0)	13.9 (13.1-15.5)	0.094
Platelets (×10⁹/L)	200 (181-238)	220 (169-267)	0.741
Lymphocytes (×10⁹/L)	2.0 (1.6-2.4)	1.9 (1.7-2.3)	0.975
Neutrophils (×10⁹/L)	3.5 (2.8-4.4)	4.0 (3.1-4.8)	0.420

**Continuous variables are expressed as median (IQR); categorical variables as n (%).*

Abbreviations: BMI: Body mass index; BP:Blood pressure; LDL: Low-density lipoprotein; HDL: High-density lipoprotein; WBC: White blood cells; Hb: Hemoglobin; PsA: Psoriatic arthritis.

Table 2. Comparison of ECG parameters between PsA and control groups

	PsA group (n=24)	Control group (n=24)	p-value
HR (bpm)	80 (71-90)	77 (70-85)	0.570
PR interval (ms)	149 (144-162)	157 (140-167)	0.599
QRS (ms)	91 (82-99)	94 (86-99)	0.414
QT (ms)	373 (352-383)	369 (357-391)	0.992
QTc (ms)	412 (398-427)	400 (392-413)	0.204
iCEB	4.20 (3.80-4.60)	4.05 (3.73-4.26)	0.284
iCEBc	4.51 (4.11-5.08)	4.32 (4.00-4.86)	0.307

Abbreviations: HR: Heart rate; PR: PR interval; QRS: QRS duration; QT: QT interval, QTc: Corrected QT interval (Bazett's formula); iCEB: Index of cardioelectrophysiological balance (QT/QRS); iCEBc: Corrected index of cardioelectrophysiological balance (QTc/QRS)

Within the PsA group, iCEB and iCEBc values showed no significant correlation with age, disease duration, sex, smoking status, LDL-cholesterol, or CRP levels (all $p>0.05$) (Table 3).

Table 3. Correlation analysis between iCEB/iCEBc and clinical variables in PsA patients.

Variable	iCEB (Spearman r)	p-value	iCEBc (Spearman r)	p-value
Age (years)	-0.063	0.672	0.018	0.905
Disease duration (years)	0.120	0.778	0.036	0.933
Sex	-0.140	0.343	-0.177	0.229
Smoking status	0.118	0.423	0.107	0.469
LDL-C (mg/dL)	0.283	0.052	0.252	0.084
CRP (mg/dL)	0.067	0.744	0.258	0.202

*Data are Spearman correlation coefficients (r). Categorical variables were coded dichotomously for analysis.

Abbreviations: LDL-C: low-density lipoprotein cholesterol; CRP: C-reactive protein; iCEB: index of cardioelectrophysiological balance; iCEBc: corrected index of cardioelectrophysiological balance.

Discussion

The principal finding of our study is that there was no significant difference in iCEB or iCEBc values between PsA patients and controls. Furthermore, iCEB/iCEBc did not correlate significantly with disease duration or CRP concentrations within the PsA cohort.

The absence of a significant alteration in iCEB in our PsA cohort appears to contrast with the established literature documenting an increased burden of arrhythmias and conduction disturbances in psoriatic disease. A large nationwide cohort study demonstrated a significantly increased risk of various arrhythmias, including ventricular arrhythmias and heart blocks, in patients with psoriasis and PsA, with the highest risk observed in the PsA subgroup (2). Furthermore, specific conduction abnormalities, such as a statistically significant prolongation of the PR interval, have been previously reported in PsA patients compared to controls, suggesting subtle involvement of the conduction system (3). Our findings, which showed similar PR, QRS, QT, and QTc intervals between groups, align with this prior work in that we did not find gross conduction defects, but extend it by suggesting that the global balance between depolarization and

repolarization, as captured by iCEB, may remain intact in a carefully selected population.

Our results diverge from those reported in RA, another chronic inflammatory arthritis. Uçar et al. (10) documented elevated iCEB and iCEBc values in RA patients, which correlated with inflammatory markers, implying an inflammation-driven proarrhythmic state predisposing to Torsades de Pointes. Several considerations may explain this contrast with our null findings in PsA. First, the pathophysiological and genetic underpinnings of PsA and RA, while both inflammatory, are distinct and may affect the myocardium differently. Second, our study specifically excluded patients with any CV comorbidities or traditional risk factors to isolate the effect of PsA itself. The electrophysiological substrate necessary to alter iCEB may only emerge in PsA patients who have additional risk profiles. These could include individuals with more advanced disease, a greater lifetime burden of inflammation, or the presence of undiagnosed atherosclerotic disease.

This concept is supported by case reports where extreme QTc prolongation and TdP occurred in patients with active chronic inflammatory arthritis, including PsA, but always in the context of multiple synergistic risk factors such as electrolyte imbalances, heart failure, or the use of QT-prolonging drugs (8). In our stable, treatment-naïve (for cardiac conditions) cohort without such aggravating factors, the inflammatory drive may have been insufficient to cause a detectable shift in iCEB. The lack of correlation between iCEB and CRP in our PsA group supports this interpretation.

The iCEB biomarker itself is grounded in solid electrophysiological principles, serving as a non-invasive surrogate for the cardiac wavelength (λ=effective refractory period × conduction velocity) (5). Its utility has been validated in both drug studies and hereditary arrhythmia syndromes. For instance, Robyns et al. (6) demonstrated that iCEB increases with sotalol (a TdP-risk drug) and decreases with flecainide (a non-TdP VT/VF-risk drug), and is significantly altered in Long QT and Brugada syndromes. Our study confirms that iCEB can be feasibly measured in a PsA population, but its value as a sensitive risk stratification tool in otherwise low-risk PsA patients may be limited.

With regard to additional conduction disturbances, Park et al. (4) conducted a systematic review on spondyloarthritis (including PsA) and observed that while the incidence of low-grade AV block and bundle branch block remained comparable to controls, the risk of high-grade AV block and subsequent pacemaker implantation

was elevated approximately two-fold. This indicates that significant conduction system disease does occur in spondyloarthritis, but it may affect a smaller subset of patients, potentially those with more severe or long-standing disease, which our cross-sectional study was not powered to detect.

Limitations

Our findings should be interpreted in light of several limitations. Most importantly, the sample size of 24 patients per group is relatively modest and represents the primary constraint of this work; despite adequate statistical power for the primary outcome, the study may have been underpowered to detect subtle differences or clinically relevant correlations, and our results must therefore be regarded as preliminary and hypothesis-generating rather than definitive. The single-center, retrospective, and cross-sectional design further limits causal inference and external validity. Although the sample is comparable to other initial studies in the field (3, 11), this limitation warrants acknowledgment. The use of Bazett's formula for heart rate correction, while common, can over-correct at high heart rates. We also lacked data on disease activity indices (e.g., DAPSA) and more sensitive inflammatory biomarkers like IL-6, which has been directly implicated in QTc prolongation (8). The absence of DAPSA scores is a structural limitation inherent to the retrospective design: these indices were not routinely recorded in the cardiology outpatient setting from which records were retrieved, rather than an oversight. Furthermore, our strict exclusion criteria, while strengthening internal validity, resulted in a modest imbalance in the proportion of female participants between groups (75% vs 50%, p=0.074), which may limit direct comparability, and broadly limit the generalizability of our findings to the wider PsA population, which often presents with concomitant cardiovascular risk factors.

Conclusion

Our findings indicate that cardio-electrophysiological balance, measured by iCEB, is preserved in PsA patients carefully selected for the absence of overt cardiovascular comorbidities. This suggests that systemic inflammation in PsA does not necessarily produce the type of global electrophysiological disruption captured by iCEB, which differs from patterns seen in RA. The heightened arrhythmia risk reported in population-based studies may stem from factors not present in our cohort: uncontrolled or chronic inflammation, traditional CV risk factors, or localized conduction system scarring rather than generalized changes in ventricular electrical activity. Large-scale prospective studies with detailed disease activity assessment,

sophisticated cardiac imaging, and long-term monitoring are required to determine which PsA patients face genuine risk for serious arrhythmias and would benefit from enhanced surveillance and preventive measures.

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Author contributions (CRediT):

NK: Formal analysis, Writing - original draft, Supervision

YH: Data curation, Methodology, Formal analysis, Writing - original draft.

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