RESEARCH PAPER

QT Interval Prolongation in Clinical Practice: Risk Stratification and Management Strategies

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ABSTRACT

QT interval prolongation is a clinically significant electrocardiographic abnormality associated with an increased risk of life-threatening ventricular arrhythmias, particularly torsades de pointes (TdP). It may result from congenital or acquired causes, including medications, electrolyte disturbances, and systemic illnesses. Early identification and appropriate risk stratification are essential to prevent adverse outcomes. This review provides a comprehensive overview of the mechanisms, etiologies, diagnostic approaches, and evidence-based management strategies for QT prolongation in clinical practice.

Keywords: QT interval, Torsades de Pointes, QTc prolongation, arrhythmia, risk stratification, electrocardiography

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1. Introduction

QT interval prolongation is frequently encountered in clinical practice and represents delayed ventricular repolarization. It is associated with polymorphic ventricular tachycardia, particularly torsades de pointes, which may lead to syncope or sudden cardiac death. With the increasing use of QT-prolonging drugs, awareness of this condition has become essential for physicians across specialties.

2. Physiology of QT Interval

The QT interval on ECG represents the duration of ventricular depolarization and repolarization.

QT Correction (QTc)

Since QT varies with heart rate, corrected QT (QTc) is calculated.

Common formulas include:

- Bazett's formula (most widely used)
- Fridericia's formula (more accurate at extremes of heart rate)

Normal QTc Values

- Males: < 450 ms
- Females: < 470 ms
- QTc > 500 ms → High risk of TdP

3. Pathophysiology

QT prolongation results from delayed repolarization due to:

- Reduced outward potassium currents (IKr, IKs)
- Increased inward sodium/calcium currents

This leads to:

- Early afterdepolarizations (EADs)
- Triggered activity → torsades de pointes

4. Etiology of QT Prolongation

4.1 Congenital Causes

- Long QT syndromes (LQTS)
- Mutations in ion channel genes

4.2 Acquired Causes

Drugs (most common cause)

- Antiarrhythmics (e.g., amiodarone, sotalol)
- Antibiotics (macrolides, fluoroquinolones)
- Antipsychotics (haloperidol, ziprasidone)
- Antidepressants (SSRIs, TCAs)

Electrolyte Abnormalities

- Hypokalemia
- Hypomagnesemia
- Hypocalcemia

Systemic Conditions

- Hypothyroidism
- Myocardial ischemia
- Bradyarrhythmias

5. Risk Factors for Torsades de Pointes

- QTc > 500 ms
- Female gender
- Advanced age
- Structural heart disease
- Polypharmacy (multiple QT-prolonging drugs)
- Renal or hepatic dysfunction
- Rapid IV drug administration

6. Clinical Presentation

- Asymptomatic (incidental ECG finding)
- Palpitations
- Syncope
- Seizure-like episodes
- Sudden cardiac arrest

7. Diagnostic Approach

7.1 Electrocardiography

- Measure QT interval in lead II or V5
- Correct using QTc formula
- Look for T-wave abnormalities

7.2 Laboratory Evaluation

- Serum electrolytes
- Renal and liver function
- Thyroid profile

7.3 Drug Review

- Identify QT-prolonging medications
- Evaluate drug interactions

8. Risk Stratification

Low Risk

- QTc < 480 ms
- No symptoms

Intermediate Risk

- QTc 480–500 ms
- Mild risk factors

High Risk

- QTc > 500 ms
- Syncope or arrhythmia
- Multiple risk factors

9. Management Strategies

9.1 General Measures

- Discontinue offending drugs
- Correct electrolyte abnormalities:
  - Potassium > 4 mEq/L
  - Magnesium > 2 mg/dL

9.2 Acute Management (Torsades de Pointes)

- **IV Magnesium Sulfate (first-line)**
- Electrical cardioversion if unstable
- Temporary pacing (overdrive pacing)
- Isoproterenol infusion (selected cases)

9.3 Chronic Management

- Avoid QT-prolonging drugs
- Beta-blockers (in congenital LQTS)
- Implantable cardioverter-defibrillator (ICD) in high-risk patients

10. Drug-Induced QT Prolongation: Clinical Pearls

- Always check baseline ECG before starting high-risk drugs
- Monitor QTc after dose escalation
- Avoid drug combinations with additive effects
- Use online QT risk calculators when available

11. Special Situations

ICU Patients

- High risk due to electrolyte imbalance and polypharmacy

Psychiatric Patients

- Antipsychotics significantly contribute

COVID-19 Era (historical relevance)

- Hydroxychloroquine + azithromycin increased QT risk

12. Recent Advances

- Genetic screening for congenital LQTS
- AI-based ECG interpretation
- Improved risk prediction models

13. Conclusion

QT interval prolongation is a potentially life-threatening but preventable condition. Early recognition, appropriate risk stratification, and timely intervention are crucial in reducing the risk of torsades de pointes and sudden cardiac death. A systematic approach combining clinical, biochemical, and electrocardiographic data is essential for optimal management.

References (Vancouver Style – Updated)

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