

Role of Electrocardiogram for Rapid Detection of Arrhythmia in End Stage Renal Disease Patient in Babylon Province

Ali Jasim M. AL-Sultani,

Department of Medicine, College of medicine, Babylon University.

Alialsultany81@yahoo.com

Hassanain Mohammed Saeed Abdul Amir,

Department of Medicine, College of medicine, Babylon University.

Ahlam Kadhim Abood AL-Hamdany,

College of medicine, Babylon University.

udayanabia@yahoo.com

Abstract

The cardiovascular diseases and their complications are the major causes of death of patients with chronic kidney disease and on dialysis. Aim : Role of non invasive rapid methods, like ECG, in predicting arrhythmias in end stage renal disease patients on hemodialysis. Methods: 60 patients (23 female, 37 male) with end stage renal disease on hemodialysis were enrolled in this cross sectional study with mean age (52 ± 5.5), A resting 12-lead surface ECG was recorded for each patient, measurement of the longest and shortest intervals QT interval and correction of these intervals by using Bazett's square root formula. QT-dispersion is measured by finding the difference between these intervals. The Tp-Te is measured in each precordial lead and is obtained from the difference between QT interval and QT_{peak} interval. The LVH is evaluated by Two-dimensional echocardiography. Measurement of QRS duration and PR interval were done. Results : Percentage and range of Abnormal values of these parameters includes: QTc interval 83.3 % (456-554 mSec) , QT-dispersion 67% (81-111mSec), TpTe 22.2%(110-120 mSec), PR interval 5% (0.22-0.24 Sec) with no abnormal QRS duration (0%) . Other findings : peaked T-wave (20%).70% of the patients had LVH. Patients were divided into those with LVH and those without LVH, maximal QT-dispersion is greater in the group with LVH than those without LVH (44%, 22% respectively), but statistically there is no significant difference. Conclusion : Electrocardiograms are low cost diagnostic tools for renal therapy centers, and nephrologists must consider QT interval, as measurement of QT and QTc dispersion is a simple bedside method to be used for analyzing ventricular repolarization during hemodialysis.

Key words : QT-interval, QT-dispersion.

الخلاصة

أمراض القلب والأوعية الدموية و مضاعفاتها هي الأسباب الرئيسية للوفاة في المرضى الذين يعانون من مرض الكلى المزمن و على غسيل الكلى. الهدف: دور الطرق السريعة، مثل تخطيط القلب لتشخيص عدم انتظام ضربات القلب للتنبؤ لمرضى الفشل الكلوي. اجراءات البحث: 60 مريضاً (23 أنثى، 37 ذكر) مع المرض الكلوي النهائي على غسيل الكلى مسجلين في هذه الدراسة المقطعية مع متوسط العمر (52 ± 5.5).

تم اجراء تخطيط القلب لكل مريض ، قياس أطول و أقصر فترات QT ثم تصحيح هذه الفواصل الزمنية باستخدام صيغة الجذر التربيعي Bazett . تم قياس Tp-Te والحصول عليها من الفرق بين فترة QT و QTpeak . تقييم تضخم البطين الأيسر عن طريق 2D Doppler . وقد أجري قياس مدة QRS و PR interval ايضا .

النتائج : نسبة القيم الغير طبيعية من هذه المعايير ما يلي QT interval: 83.3 % (456-554 mSec) ، QT dispersion 67% (81-111 mSec) ، TpTe 22.2 % (110-120 mSec) و PR interval 5% (0.22-0.24) ثنائية) مع عدم وجود مدة QRS غير طبيعية (0%) . النتائج الأخرى : peaked T wave (20%) . 70 % من المرضى يعانون من تضخم البطين الأيسر . تم تقسيم المرضى إلى مجموعته مع و مجموعته بدون تضخم البطين الأيسر ، نسبة QT-dispersion أكبر في المجموعة مع تضخم البطين الأيسر من تلك بدون تضخم البطين الأيسر (44 % ، 22 % على التوالي) ، ولكن إحصائياً الفرق غير معنوي . الاستنتاجات: تخطيط القلب هي أدوات منخفضة التكلفة وسريعة في تشخيص المرضى المعرضين عدم انتظام ضربات القلب ، قياس QTc interval و QT dispersion هي طريقة سريرية بسيطة التي يمكن استخدامها لتحليل عودة الاستقطاب البطيني خلال غسيل الكلى .

الكلمات المفتاحية : مسافة QT، تشتت QT.

Introduction

Cardiovascular diseases continue to be the leading mortality cause worldwide. Cardiac and renal diseases frequently coexist and significantly increase mortality, morbidity, and the complexity and cost of care (Ronco *et al.*, 2010). Cardiovascular diseases and complications are the major causes of death in patients with chronic kidney disease and on dialysis (Polak-Jonkisz *et al.*, 2009; Hager *et al.*, 2010; Whitman *et al.*, 2012). Sudden cardiac death (SCD) is an unexpected death from a cardiovascular cause with or without structural heart disease (Wu *et al.*, 2005). It is very often caused by ventricular arrhythmia (Ioana, 2014). Cardiovascular disease, particularly myocardial dysfunction, is an important cause of morbidity and mortality in patients undergoing maintenance dialysis. One of the manifestations of myocardial dysfunction in end-stage renal disease (ESRD) is arrhythmia in patients (Christopher & William, 2012). Several ECG markers were suggested as potential predictors of ventricular arrhythmias in dialysis patients such as mean QRS duration, corrected QT interval, and QT dispersion (Morris *et al.*, 1999; Wu *et al.*, 2005; Stewart *et al.*, 2005).

QT interval : is the time between the onset of the Q wave and the end of the T wave in ECG . The QT interval is the electrocardiographic expression of ventricular depolarization and repolarization and, if prolonged, a predictor of fatal ventricular arrhythmias and sudden cardiac death (Al-Khatib *et al.*, 2003; Rautaharju *et al.*, 2009). QT interval is measured manually by different methods such as the threshold method, as the end of T wave defined by the return of the T wave to the isoelectric line or the tangent method, in which the end of the T wave is determined by the intersection of a tangent line extrapolated from the T wave at the point of maximum downslope to the isoelectric baseline. This interval is influenced by heart rate , so correction of heart rate is required in the assessment of repolarization duration. Bazett's square root formula is most commonly used to correct the interval . QTc is equal to QT interval in seconds divided by the square root of the RR interval in (seconds) (Ilan *et al.*, 2006). QTc interval exceeding 450 mSec is considered prolonged. When heart rate is particularly fast or slow, the Bazett's formula may overcorrect or undercorrect, respectively, but it remains the standard for clinical use.

QT interval duration varies between leads on the standard electrocardiogram (ECG) (Cowan *et al.*, 1988; Butrous *et al.*, 1989). These interlead differences, called QT dispersion or QT range. QT dispersion is a crude and approximate measure of a general abnormality of repolarization (Malik & Batchvarov, 2000).

QT dispersion is linked to the occurrence of malignant arrhythmias in different cardiac diseases as it reflects regional differences in ventricular recovery time (Lorincz *et al.*, 1999). Reported values of QT dispersion vary widely, ranging from 10 to 71 mSec in normal subjects (16-18). There is little or no sex difference in QT dispersion (Savelieva *et al.*, 1999).

Tpeak Tend: is a marker of ventricular arrhythmogenesis by early studies which indicate the prolongation of (Tpeak to Tend [TpTe]) on the 12-lead ECG predispose to arrhythmia. TpTe interval Prolongation in lead V5 was associated with SCD (Ragesh *et al.*, 2011). Recent studies identified prolonged TpTe > 100 mSec as predictor of SCD of coronary artery disease and arrhythmias.

Patients with end-stage renal disease (ESRD) undergoing hemodialysis have a high mortality rate, which is correlated with the occurrence of cardiovascular disorders, such as ventricular arrhythmias and sudden cardiac death (Shamseddin & Parfery, 2011). The changes in ventricular electrical systole during the dialytic therapy are associated with an increased risk of potentially malignant ventricular arrhythmias

due to QT interval prolongation and dispersion(Bruno *et al.*, 2013). So it is of a paramount important to detect these abnormalities as early as possible by the non invasive technique like ECG

Aim of the study : Role of non invasive rapid methods in predicting arrhythmias in ESRD patients on hemodialysis to prevent sudden cardiac death is by evaluating QTc-interval, QT-dispersion ,Tp-Te interval and other parameters that are considered as a risk fact for occurrence of arrhythmias .

Methods: 60 patients (23 female, 37 male) with end stage renal disease on hemodialysis were enrolled in this cross sectional study with mean age (52 ± 5.5), from January,2016 to March,2016 .

A resting 12-lead surface ECG was recorded for each patient, QT interval was measured from the beginning of QRS complex to the end of T wave defined by the return of the T wave to the isoelectric line and averaged in every lead,figure.1. If the end of T wave was not determined properly in any lead, this particular lead was excluded from analysis(24). The longest and shortest QT intervals are measured then these intervals are corrected by using Bazett's square root formula :

$QT_c = QT \text{ interval in seconds} / \sqrt{RR \text{ interval (seconds)}}$ (Ilan *et al.*, 2006).

QT. dispersion calculated as the difference between the longest and the shortest QTc interval in all measurable lead(Ioana , 2014).

The Tp-e interval was defined as the interval from the peak of T wave to the end of T wave. Measurements of Tp-Te interval were performed from precordial leads (Malik & Batchvarov, 2000). The Tp-Te was measured in each precordial lead and obtained by the difference between QT interval and QT_{peak} interval; measured from the start of the QRS to the peak of the T-wave(Jesus *et al.*, 2006).

Study limitations: there was some limitation in measurement QT interval and this in accordance with a number of studies that reported poor reproducibility of manual measurements of the QT intervals (MacFarland, 1998; Coumel *et al.*, 1998). This also applies to the measurement of the Tp-Te and Tp-Te dispersion as well (Jesus *et al.*, 2006).

For evaluation of LVH : Two-dimensional echocardiographic studies were performed with a phased-array sector scanner (3.5-MHz transducer) (Foale *et al.*, 1986). LV septal wall thickness, posterior wall thickness, and cavity size were measured from the LV left parasternal long axis view by two-dimensionally guided M-mode echocardiography(Jamil *et al.*, 1996).The QRS duration and PR interval (from the beginning of p wave to the beginning of QRS wave of ECG) are measured .

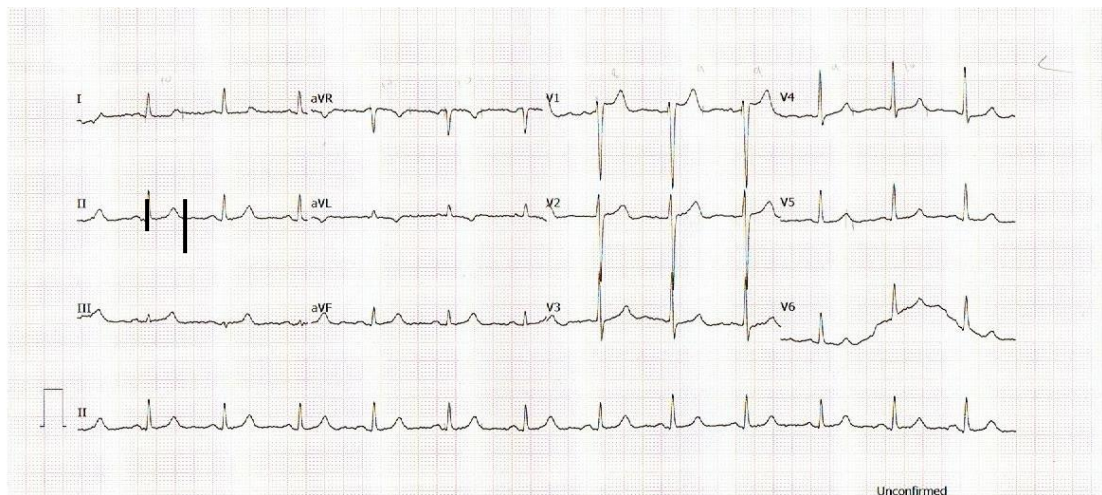


Figure.1 Measurement of the longest and shortest QT interval (from the onset of QRS complex to the end of T wave)

Results

Parameters	Mean $\pm$ SD	Range
QTc interval(mSec) [longest, shortest]	479.06 $\pm$ 45.2, 400.28 $\pm$ 79.31	402-554, 343-487
QT-dispersion (mSec)	78.83 $\pm$ 25.97	37-111
TpTe (mSec)	87 $\pm$ 17.15	60-120
PR-interval (Sec)	0.22 $\pm$ 0.02	0.112- 0.24
QRS-duration (Sec)	0.84 $\pm$ 0.031	0.12- 0.66

Percentage and range of Abnormal values of these parameters includes:

QTc interval 83.3 % (456-554 mSec) , QT-dispersion 67% (81-111mSec), TpTe 22.2%(110-120 mSec), and PR interval 5% (0.22-0.24 Sec)) with no abnormal QRS duration (0%) . Other findings : peaked T-wave (20%).Figure.2

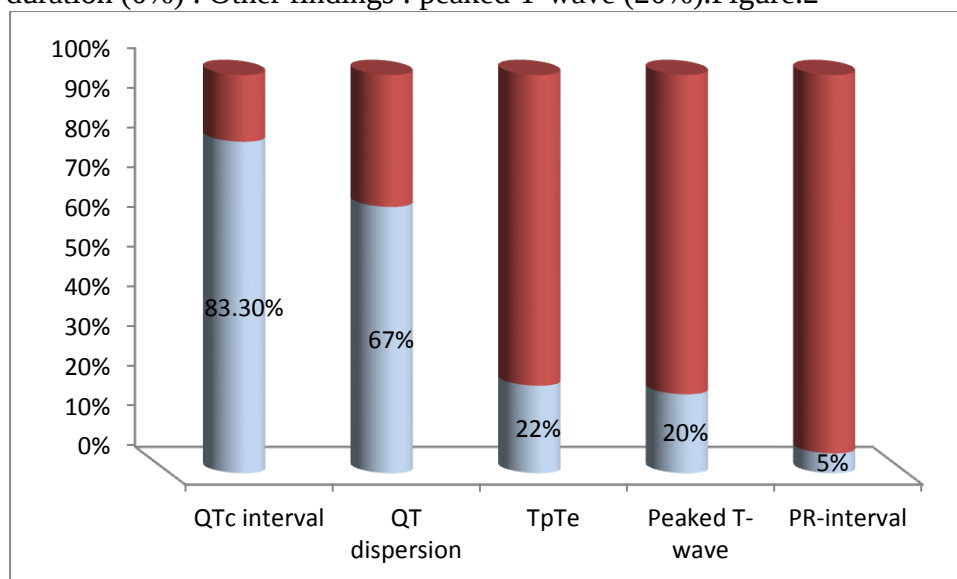


Figure.2 Percentage of abnormal values of QTc interval ,QT-dispersion , TpTe, PR-interval.

70% of the patients were with LVH. Patients were divided into those with and those without LVH, maximal QT-dispersion is greater in the group with LVH than those without LVH (44%, 22% respectively), but statistically, there is no significant difference

(p-value is 0.425556), Figure.3

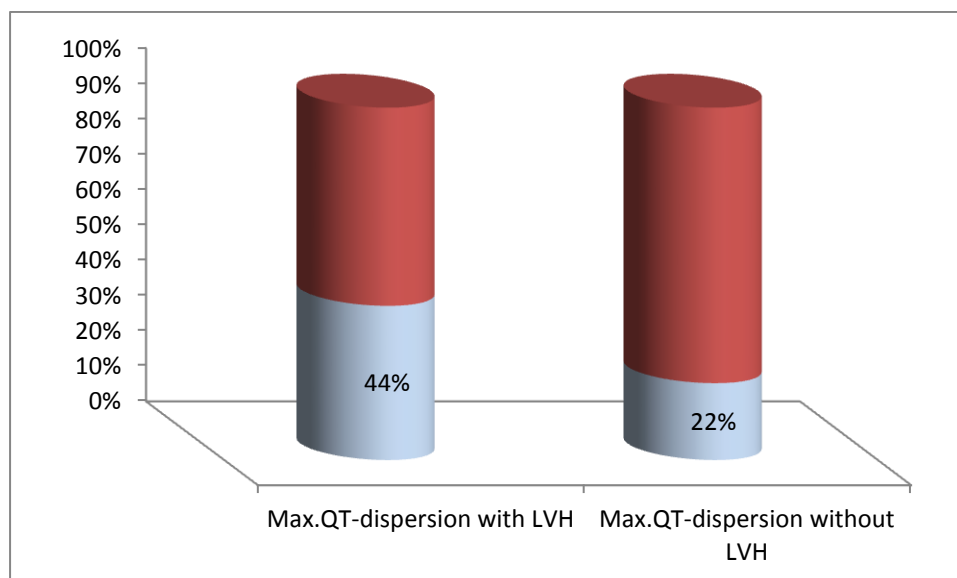


Figure.3 Percentage of maximum QT-dispersion in end stage renal disease patients with and without LVH (left ventricular hypertrophy).

Discussion

This study demonstrate high percentage of abnormal values of QTc interval (83.3%) and QTc dispersion (67%), this goes with Lorincz et al(16) who conclude that hemodialysis prolong the QT, QTc interval and QTc dispersion in uremic patients with end stage , this is due to the increase in nonhomogeneity of regional ventricular repolarization .

A common feature of uremic cardiomyopathy is LVH ,it is present in 60% to 80% of patients on dialysis(Amann *et al.*, 1998). Other study showed that hemodialysis patients, LVH is present in 68-89% of them (Charytan, 2014). Occurrence of sudden death in ESRD due to arrhythmia caused by pathological myocardial changes of LVH (Charytan, 2014). So presence of higher percentage of prolonged QTc interval and dispersion in LVH may predict patients who are susceptible for arrhythmia .Other patients had prolonged QT-interval and max.QT-dispersion without the presence of LVH (22%) ,this might reflect that prolongation of QT interval could occur before the presence of LVH, this goes with the study that showed a large number of sudden death of patients on dialysis were with no significant left ventricular dysfunction (Mangrum *et al.*, 2006).

Prolonged TpTe interval give idea about susceptibility of patients to develop cardiac arrhythmia as one of the marker of ventricular arrhythmogenesis is the prolongation of the interval between the peak and the end of the T wave on the 12-lead ECG. (Panikkath *et al.*, 2011) concluded that TpTe interval prolongation was associated with SCD.

Some ECG showed peaked T-wave (20%) as the earliest abnormalities seen in the ECG in patient with hyperkalaemia is the T-waves (“tenting” or “peaking”). Delayed atrioventricular conduction presented by prolonged PR interval showed only

small percentage (5%) of the cases. This prolongation due to fact that mild to moderate hyperkalaemia could cause depression of conduction between adjacent cardiac myocytes (Webster *et al.*, 2002).

Conclusion

Electrocardiograms are low cost diagnostic tools for renal therapy centers, and the nephrologists must use a simple bedside measure for evaluation of ventricular repolarization in ESRD patients on hemodialysis which are QTc interval and QTc dispersion .

References

- Al-Khatib, S. M. ; N. M. Allen LaPointe, J. M. Kramer, and R. M. Califf, "What clinicians should know about the QT interval," *Journal of the American Medical Association*, vol. 289, no. 16, pp. 2120–2127, 2003. View at Publisher · View at Google Scholar · View at Scopus
- Amann K, Rychlík I, Miltenberger-Milteny G, Ritz E. Left ventricular hypertrophy in renal failure. *Kidney Int.* 1998; 68 (): S78– S85.
- Bruno Valentim^{I,II}; Alexandre Pereira^{I,II}; Patrícia Coelho^{II}; Telmo Pereira. Study of ventricular electrical systole in patients with end-stage kidney disease on hemodialysis. *Arq. Bras. Cardiol.* vol.100 no.3 São Paulo Mar. 2013.
- Butrous GS, Dabbas N, Patel PR, *et al.* Measurement of the QT Interval. In: *Clinical Aspects of Ventricular Repolarization*, Butrous GS, Schwartz PJ (Eds), Farrand Press, London 1989. p.41
- Charytan D¹. Is left ventricular hypertrophy a modifiable risk factor in end-stage renal disease. *Curr Opin Nephrol Hypertens.* 2014 Nov;23(6):578-85.
- Christopher D. and William L. Henrich. Myocardial dysfunction in end-stage renal disease. 2016. Morris ST, Galiatsou E, Stewart GA, Rodger RS, Jardine AG. QT dispersion before and after hemodialysis. *J Am Soc Nephrol.* 1999; 10: 160– 163.
- Coumel P, Maison-Blanche P, Badilini F. Dispersion of ventricular repolarization. Reality? Illusion? Significance. *Circulation.* 1998;97:2491–3.
- Cowan JC, Yusoff K, Moore M, *et al.* Importance of lead selection in QT interval measurement. *Am J Cardiol* 1988; 61:83.
- Foale RA, Nihoyannopoulos P, McKenna W, Kleinebenne A, Nadazdin A, Rowland E, Smith G. Echocardiographic measurement of the normal adult right ventricle. *Br Heart J.* 1986;56:33-44.
- Hager, C. S. ; S. Jain, J. Blackwell, B. Culp, J. Song, and C. D. Chiles, "Effect of renal function on survival after implantable cardioverter defibrillator placement," *American Journal of Cardiology*, vol. 106, no. 9, pp. 1297–1300, 2010
- Ilan Goldenberg, M.D.; Arthur J. Moss, M.D.; Wojciech Zareba. QT Interval: How to Measure It and What Is "Normal". *J Cardiovasc Electrophysiol.* 2006;17(3):333-336.
- Ioana Mozos. Laboratory Markers of Ventricular Arrhythmia Risk in Renal Failure. Volume 2014 (2014), Article ID 509204, 9 pages.
- Ioana Mozos. Laboratory Markers of Ventricular Arrhythmia Risk in Renal Failure. Volume 2014 (2014), Article ID 509204, 9 pages.
- Jamil Mayet, Manjit Shahi, Katherine McGrath, Neil R. Poulter, Peter S. Sever, Rodney A. Foale, Simon A. McG. Thom. Left Ventricular Hypertrophy and QT Dispersion in Hypertension. *Hypertension.* 1996; 28: 791-796.
- Jesus Castro Hevia, MD,* Charles Antzelevitch, PhD, FACC,† Francisco Tornés Bázquez, MD,* Margarita Dorantes Sánchez, MD,* Francisco Dorticós Balea, PhD,* Roberto Zayas Molina, MD,* Miguel A. Quiñones Pérez, MD,* and Yanela Fayad Rodríguez . Tpeak-Tend and Tpeak-Tend Dispersion as Risk Factors for

- Ventricular Tachycardia/ Ventricular Fibrillation in Patients With the Brugada Syndrome. *J Am Coll Cardiol*. 2006 May 2; 47(9): 1828–1834.
- Lorincz I, Mátyus J, Zilahi Z, Kun C, Karányi Z, Kakuk G *J Am Soc Nephrol*. QT dispersion in patients with end-stage renal failure and during hemodialysis. 1999 Jun;10(6):1297-302.
- MacFarland PW. Measurement of QT dispersion. *Heart*. 1998;80:421–3. [PMC free article] [PubMed]
- Macfarlane PW, McLaughlin SC, Rodger JC. Influence of lead selection and population on automated measurement of QT dispersion. *Circulation* 1998; 98:2160.
- Malik M, Batchvarov VN. Measurement, interpretation and clinical potential of QT dispersion. *J Am Coll Cardiol* 2000; 36:1749.
- Mangrum JM, Lin D, Dimarco JP, Lake DE, Bolton WK, Mangrum AJ. Prognostic value of left ventricular systolic function in renal dialysis patients. *Heart Rhythm*. 2006; 3: S154.
- Murat Celik, Uygur Cagdas Yuksel, Yalcin Gokoglan, Baris Bugan, Emre Yalcinkaya, Hilmi Umut Unal, Turgay Celik, Atila Iyiso, and Selim Kilic. QT dispersion increases with low glomerular filtration rate in patients with coronary artery disease. *Pak J Med Sci*. 2014 Mar-Apr; 30(2): 266–271.
- Panikkath R¹, Reinier K, Uy-Evanado A, Teodorescu C, Hattenhauer J, Mariani R, Gunson K, Jui J, Chugh SS. Prolonged Tpeak-to-tend interval on the resting ECG is associated with increased risk of sudden cardiac death. *Circ Arrhythm Electrophysiol*. 2011 Aug;4(4):441-7.
- Polak-Jonkisz, D.; K. Laszki-Szczachor, L. Purzyc *et al.*, “Usefulness of body surface potential mapping for early identification of the intraventricular conduction disorders in young patients with chronic kidney disease,” *Journal of Electrocardiology*, vol. 42, no. 2, pp. 165–171, 2009. View at Publisher · View at Google Scholar · View at Scopus
- Ragesh Panikkath, Kyndaron Reinier, , Audrey Uy-Evanado, Carmen Teodorescu, Jonathan Hattenhauer, , Ronald Mariani, Karen Gunson, Jonathan Jui, and Sumeet S. Chugh, . Prolonged Tpeak-to-Tend Interval on the Resting ECG Is Associated With Increased Risk of Sudden Cardiac Death. *Circulation: Arrhythmia and Electrophysiology*. 2011; 4: 441-447.
- Rautaharju, P.M.; B. Surawicz, and L.S. Gettes, “AHA/ACCF/HRS recommendations for the standardization and interpretation of the electrocardiogram: part IV: the ST segment, T and U waves, and the QT interval A scientific statement from the American heart association electrocardiography and arrhythmias committee, council on clinical cardiology; the American college of cardiology foundation; and the heart rhythm society endorsed by the international society for computerized,” *Journal of the American College of Cardiology*, vol. 53, no. 11, pp. 982–991, 2009
- Ronco, C.; P. McCullough, S. D. Anker *et al.*, “Cardio-renal syndromes: report from the consensus conference of the acute dialysis quality initiative,” *European Heart Journal*, vol. 31, no. 6, pp. 703–711, 2010. View at Publisher · View at Google Scholar · View at Scopus
- Savelieva I, Camm AJ, Malik M. Gender-specific differences on QT dispersion measured in 1100 healthy subjects (abstract). *Pacing Clin Electrophysiol* 1999; 22:885.
- Shamseddin MK, Parfrey PS. Sudden cardiac death in chronic kidney disease: epidemiology and prevention. *Nat Rev Nephrol*. 2011;7(3):145-54.

- Stewart GA, Gansevoort RT, Mark PB, Rooney E, McDonagh TA, Dargie HJ, Stuart R, Rodger C, Jardine AG. Electrocardiographic abnormalities and uremic cardiomyopathy. *Kidney Int.* 2005; 67: 217– 226.
- Surawicz B. Will QT dispersion play a role in clinical decision-making? *J Cardiovasc Electrophysiol* 1996; 7:777.
- Webster, A ; W Brady, F Morris. Recognising signs of danger: ECG changes resulting from an abnormal serum potassium concentration. *Emerg Med J* 2002;19:74-77 .
- Whitman, I. R. ; H. I. Feldman, and R. Deo, “CKD and sudden cardiac death: epidemiology, mechanisms, and therapeutic approaches,” *Journal of the American Society of Nephrology*, vol. 23, pp. 1029–1039, 2012
- Wu VC, Lin LY, Wu KD. QT interval dispersion in dialysis patients. *Nephrology (Carlton)*. 2005; 10: 109– 112.

,