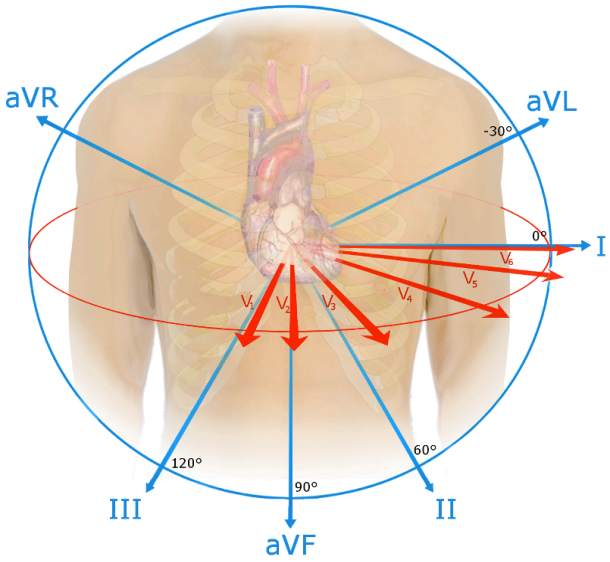
LONG-TERM PROGNOSIS OF Q WAVE LOCATION ACCORDING TO THIRD UNIVERSAL DEFINITION OF MYOCARDIAL INFARCTION



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RESUME

BAGGRUND

Det nekrotiserende område, svarende til myokardieinfarkt (MI), har ikke nogen elektrisk aktivitet, hvilket vil sige, at det ikke kan depolarisere og således ses forekomsten af patologiske Q-takker, som et tegn på forudgående MI. Lokaliseringen af Q-tak giver omtrentlige oplysninger om, hvor infarkt anatomisk har fundet sted, og desuden er der stadig ikke klarhed omkring, hvilke steder for infarkt, der har den værste prognose. De forskellige EKG klassifikationssystemer såsom Minnesota kode og Novacode er værdifulde systemer designet som værktøj, der ofte bruges i undersøgelser for at finde individer med forudgående MI på grundlaget af en EKG fund. Disse systemer er også kendt for at være kompliceret og er for svære til anvendelse i klinisk praksis. I 2012 hvor Third Universal Definition of Myocardial Infarction (UDMI) blev oprettet som et resultat af en konsensus mellem de europæiske og amerikanske guidelines. UDMI indeholder en række diagnostiske Q-tak kriterier; en Q-tak er patologisk, hvis den vises med en varighed ≥ 20 ms, eller en QS kompleks i afledning V_2 og V_3 eller en Q-tak, som er ≥ 30ms og ≥ 0,1 mV dyb, eller en QS kompleks i afledning I, II, III, aVL, aVF eller V_4-V_6. Dette kriterium kræver tilstedeværelse af patologiske Q-takker i to afledninger af anatomisk relaterede grupper og derfor kaldes de sammenhængende afledninger. Den posterior infarkt diagnosticeres ved tilstedeværelse af reciprokkale Q-takker. I følge UDMI defineres dette som brede og lange R-takker, som er ≥ 40 ms og R / S-ratio ≥1 og T-tak ≥ 0,05 mV (positiv T-tak) i den posterior afledningsgruppe (V_1 og V_2).

FORMÅL

Formålet med studiet var, at beskrive den prognostiske værdi af Q-takkens placering i sammenhængende og isolerede afledninger.

METODER

Vi inkluderede digitaliserede EKG´er registrerede i Københavns Praktiserende Lægers Laboratorium, i årene 2001-2011 efter en henvisning af egne praktiserende læge. Ved brug af disse EKG´er og de danske registre kunne vi identificere og følge individer med patologiske Q-takker i 5 år. Multivariat-justeret Cox proportionel hazards model var brugt til at beregne dødsrisikoen hos individer med patologiske Q-takker i sammenhængende og isolerede afledninger. De sammenhængende afledninger var overordnet sammensat af 5 grupper, og hvor de anteriore prækordiale afledninger i var opdelt to grupper nemlig V_2-Q-tak-V_3 og V_4-V_6, laterale afledninger (I og aVL), inferiore afledninger (II, III og aVF) og posteriore afledninger (V_1-V_2-R-tak). Endvidere har vi også lavet en ny definition for at undersøge betydning af Q-takker i isolerede afledninger, som blevet defineret ved at de andre afledninger i den samme afledningsgruppe de indgår i skal ikke have Q-takker samtidigt.

RESULTATER

Der blev identificeret i alt 655,345 EKG'er. Af disse 309,824 personer blev inkluderet i vores undersøgelse og fulgt i 5 år efter deres første registrerede EKG. Af disse 90,010 blev observeret med Q-takker og 219,814 uden patologiske Q-takker.

Efter opfølgningsperioden, blev der observeret 10,080 dødsfald. Patienter uden Q-takker og med Q-takker i andre grupper end den i undersøgte gruppe, blev brugt som referencegruppe. At have en Q-tak i én af de sammenhængende afledninger (V_2-Q-tak og V_3, V_4-V_6, I og aVL, II, III og aVF), var forbundet med en betydeligt øget risiko for død i næsten alle afledninger, og især V_2-Q-tak og V_3 [hazard ratio (HR): 1.47, konfidensinterval (95% CI): 1.41-1.53]. At have Q-tak i de isolerede afledninger viser varierende risiko, med den stærkeste association ses i afledning V_2-Q-tak, V_3, aVL og II (HR: 1.33, 95% CI: 1.26-1.40, P <0.001), HR: 1.19, 95% CI: 1.11-1.27, P <0.001, HR: 1.36, 95% CI:1.29-1.43, P <0.001, HR: 1.89, 95% CI: 1.74-2.06, P <0.001, hhv.).

KONKLUSION

Q-takker i anteriore-, laterale- og inferiore afledninger var forbundet med betydelig risiko for dødsfald hos patienter, der opfyldte Third Universal Definition of Myocardial Infarction kriterier. Derudover viser nogle isolerede afledninger også høj risiko for død, og derfor tilfældigt fund af Q-takker i disse afledning bør ikke overses.

ABSTRACT

BACKGROUND We sought to describe the prognostic value of Q wave location according to Third Universal Definition of Myocardial Infarction in contiguous and in lone leads.

METHODS We included individuals with ECG recorded in a general practitioner's facility from 2001 to 2011. We estimated the risk of all-cause mortality with a multivariable-adjusted Cox proportional hazard model in both contiguous and lone leads. The contagious leads were composed of 5 groups: 2 anterior precordial leads V_2-Q wave - V_3 and V_4-V_6, the lateral leads I and aVL, inferior leads II, III and aVF and posterior leads V_1-V_2-R wave. The lone leads required that the lead group, they were anatomically related to do not have other pathologic Q waves. The reference group included individuals without Q waves and with Q waves in all groups, but the one investigated.

RESULTS A total of 90,010 individuals with pathologic Q waves were identified. After a follow-up period of 5 years, there were 10,080 death cases. Having a Q wave in a contiguous leads (V_2-Q and wave-V_3, I and aVL, V_4-V_6, II, III and aVF) was associated with significant increased risk of death in almost all the leads, especially contiguous lead V_2-Q wave and V_3 [hazard ratio (HR): 1.47, confidence interval (95%CI): 1.43–1.53]. While having Q wave in lone leads show varying risk, with the strongest association seen in lead V_2-Q wave, V_3, aVL and II (HR: 1.33, 95% CI: 1.26-1.40, P <0.001), HR: 1.19, 95% CI: 1.11-1.27, P <0.001), HR: 1.36, 95% CI: 1.29-1.43, P <0.001, HR: 1.89, 95% CI: 1.74-2.06, P <0.001, respectively).

CONCLUSIONS Q waves in anterior, lateral and inferior leads were associated with significant risk of death in patients who fulfilled the Third Universal Definition of Myocardial Infarction. In addition, some isolated leads showed also a high risk of death, and therefore a coincidental finding of Q waves in these leads should not be neglected.

INTRODUCTION

Previous literature investigating the prognostic value of Q waves has been based on different and heterogeneous algorithms for defining pathologic Q waves such as Minnesota and Novacode Classification system[1] . As an attempt for increasing the homogeneity by using a common definition of Q waves, the Universal Definition of Myocardial Infarction (UDMI) was defined in 2000 by the Joint European society of Cardiology and the American College of Cardiology. Recently in 2012 there was a third redefinition of the UDMI; consequently, there are only a few studies that examine the UDMI-defined Q waves, therefore there is a need for investigating the clinical value of UDMI defined Q waves [2,3].

In addition to Q waves´ diagnostic value for prior MI, the different locations of Q waves have also a prognostic value in predicting the mortality risk[4–7]. Several studies have debated this subject. However, consensus has not been reached about an association between Q wave locations and whether risk differs according to location. Thus, there is great uncertainty on this topic. Most of the previous studies indicated that anterior location Q wave – MI was related with significantly higher cardiac mortality than inferior location. Meanwhile few studies claimed there is no association between Q wave- MI location and prognosis [8,9]. At present, there is one study that have reported that specific Q wave locations defined by UDMI are related with increased mortality[10].

Thus, knowledge about the value of Q wave location defined after the UDMI will contribute to better risk stratification of patients following either silent or apparent MI. We have used a registry with more than half a million digitized electrocardiograms from general practitioners to examine this question. In this registry-based study, we have two aims: 1) to examine the mortality risk of Q waves locations appearing in contiguous leads following UDMI criteria, 2) to examine the mortality risk of Q waves in lone leads.

METHODS

DATABASES

In Denmark, all residents are assigned a unique and permanent personal civil registration number. This number allows individual linkage between administrative registries with respect to emigration, death, use of prescription medication, and hospital diagnoses. In the greater region of Copenhagen, the majority of general practitioners referred their patients to one main facility (Copenhagen General Practitioners´ Laboratory) for different clinical tests like ECG recordings and blood tests. This study used a database that includes all patients who had an ECG recorded at the Copenhagen General Practitioners´ Laboratory during 2001-2011 by request of their general practitioner [11]. In order to identify the patients who had previous MI, the Danish National Patient Register were used. It contains all diagnoses according to International Classification of Diseases, the 8th revision (ICD-8) was used until 1994, and from 1994 onwards the 10th revision (ICD-10). The diagnoses are given at discharge after each hospitalization since 1978. From the Central Personal Registry and the Danish Register of Causes of Death and the Central Personal Registry, information about birthday date, sex, eventual death date and reason of death were obtained.

STUDY POPULATION

The risk of mortality in individuals with pathologic Q waves in contiguous leads or lone leads were compared with the reference group that included both those without Q waves and with Q waves in other groups than the one investigated.

The study population included all ECGs recorded between 2001 and 2012. Individuals were excluded because of various conditions that may affect Q wave appearance on ECG, Figure 1.

When the patient had more than one recorded ECG, only the first one was included and it represented time 0 for the study. The follow-up period was 5 years and patients were censored after

December 31, 2013. The primary outcome was all-cause mortality; the secondary outcome was cardiovascular death.

ELECTROCARDIOGRAPHY

All ECGs were recorded digitally at Copenhagen General Practitioners´ Laboratory and analyzed by the GE Healthcare Marquette 12 SL algorithm version 21. ECGs defined as poor quality were excluded. In addition, ECGs with AV blocks, complete heart block, atrial fibrillation, atrial flutter, tachy-arrhythmias, junctional rhythms, paced rhythms, premature ventricular or aberrantly conducted complexes, intraventricular conduction and pre-excitation like Wolff-Parkinson-White and ventricular pre-excitation WPW pattern type A, wide QRS rhythm (> 120 msec), right bundle branch block, left bundle branch block and left anterior fascicular block were all excluded[12,13]. Individuals younger than 16 years were excluded. Individuals with missing data on sex and age were also excluded.

DEFINING Q WAVES

Measurements of intervals, durations, and amplitudes obtained by GE 12 SL program, were used to define the presence of pathologic Q waves consistent with prior myocardial infarctions as defined by the UDMI[3,14,15].

CONTIGUOUS LEADS

Contiguous leads represent the presence of pathologic Q waves in minimum two leads that are anatomically related and form a lead group. In the UDMI the leads of ECG are divided into three anatomical areas, i.e. anterior (V_1-V_6), inferior (II, III, aVF) and lateral (I, aVL) [3]. However, when reciprocal Q waves (tall and wide R wave) appear in V_1 and V_2, then it is seen as posterior

infarction[16]. Therefore lead V_1 and V_2 were named posterior leads. Meanwhile, V_2 with Q waves or QS complexes was considered as an anterior lead and a part of the anterior lead group along with V_3-V_6. Further, the anterior group was divided into two groups due the size difference of Q waves in these leads. The first anterior lead group included lead V_2 and V_3, Q waves with duration ≥ 20 ms, or a QS complex are considered pathologic. QS complex was defined as Q amplitude >0 and R amplitude = 0.

Q wave with duration ≥ 30 ms and amplitude ≥ 0.1 mV or QS complex in lateral (I and aVL), the second anterior group (V_4-V_6), inferior (II, III, aVF), are considered pathologic if they appear in minimum two leads of the lead group.

R wave which is ≥ 40 ms and the R/S ratio ≥1 and T wave ≥ 0.05 mV (positive T wave) in the posterior lead group (V_1 and V_2) in the absence of conduction defect (LBBB and RBBB) are considered pathologic.

V_2 was considered pathologic when it has Q waves or R waves (reciprocal Q waves) and therefor it was decided to rename and look at each finding separately; V_2-Q wave when Q waves were present in V_2 and V_3 and V_2-R wave when R waves were present in V_1 and V_2.The different contiguous leads were not exclusive of one another

LONE LEADS

We defined a new criterion in order to isolate lone leads. The lone leads were only exclusive of the lead group that they were anatomically related to, but not exclusive of the other contiguous or lone leads. The UDMI was utilized to define the morphology of Q waves such as the duration and amplitude etc. in lone leads.

We also investigated the exclusive presence of Q-wave in lone leads, and this required no Q-wave presence in other lone and contiguous leads.

STATISTICAL ANALYSIS

Cumulative mortality over time for the different lead groups and lone leads were described by Kaplan-Meier curves.

To investigate relationships between Q wave locations and hazards of all-cause mortality, Cox proportional hazard regression were used. Cox models were adjusted for age and sex. Hazard ratios (HRs) with 95 % confidence intervals were presented and p-values of <0.05 considered significant. The assumptions regarding proportionality and linearity of the Cox proportional hazard regression model were tested and found valid.

The different analyzes were done using SAS version 9.4 (SAS Institute Inc., Cary, NC, USA) and R statistics (version 3.2.2, Development Core Team).

ETHICS

According to Danish law, register- based studies need no approval from ethics committee, but Danish Data Protection Agency gave approval for use of registry data for this study (GEH-2014-014/I-Suite no: 02732).

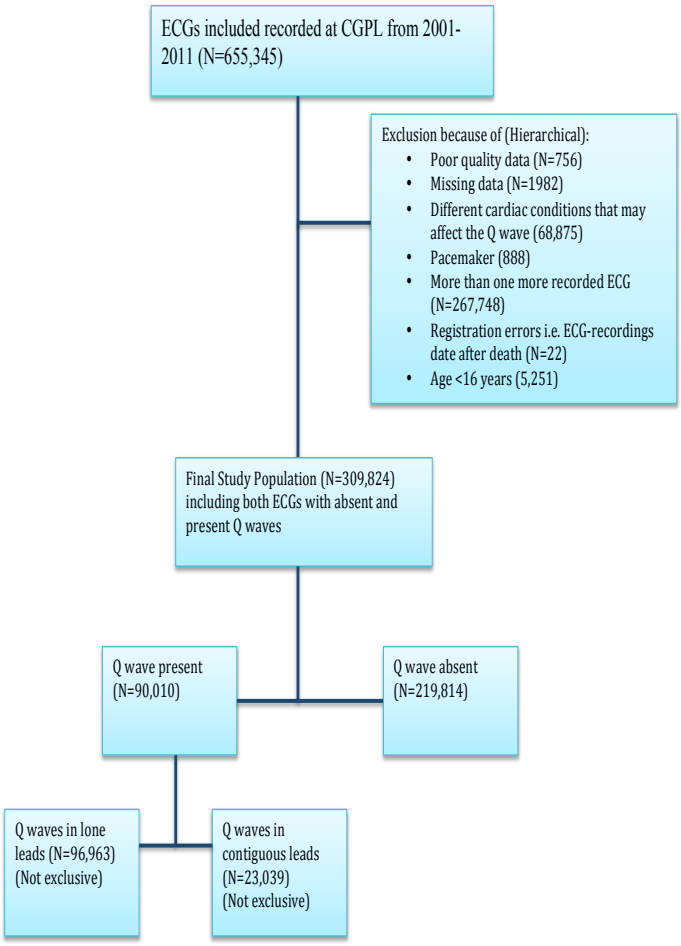


Figure 1 Flow chart of the study population selection showing the number of individuals excluded for various reasons. The final study population includes ECGs with and without Q waves. The contiguous and lone groups are not exclusive. CGPL = Copenhagen General Practitioners´ Laboratory, ECG = electrocardiography.

RESULTS

DEMOGRAPHICS

A total of 655,345 ECGs were identified from Copenhagen General Practitioners´ Laboratory, which had been recorded during 2001-2011. Of these 309,824 individuals were included in our study and followed 5 years after their first recorded ECG until the endpoint. Figure 1. Of these 90,010 were observed with Q wave present and 219,814 without any pathological Q waves. There were 51.6% male and the average age for the Q wave present population was 57.4 years (standard deviation [SD] ± 17). Among individuals with Q waves 5,540 (6.2%) had a diagnosis of MI, Table 1. Lone lead groups were not exclusive of each other neither contiguous leads groups. Thus, an individual having Q waves in contiguous or/and lone leads can appear in multiple groups simultaneously.

	Q wave present N =90,010	Q wave absent N=219,814	Total N=309,824
Age			
Mean ± SD	57.4 ± 17.0	52.2 ± 17.0	53.7 ± 17.1
Sex			
Female	43,585 (48.4%)	127,615 (58.0%)	171,200 (55.3%)
Male	46,425 (51.6%)	92,199 (42.0%)	138,629 (44.7%)
Previous MI	5,540 (6.2%)	4,187 (1.9%)	9,727 (3.1%)
All-cause mortality	10,080 (11.2%)	15,168 (6.9%)	25,248 (8.1%)
Cardiovascular-death	4,795 (5.3%)	6,173 (2.8%)	10,968 (3.5%)

Table 1 Characteristics of study population.

UNIVARIATE ANALYSIS

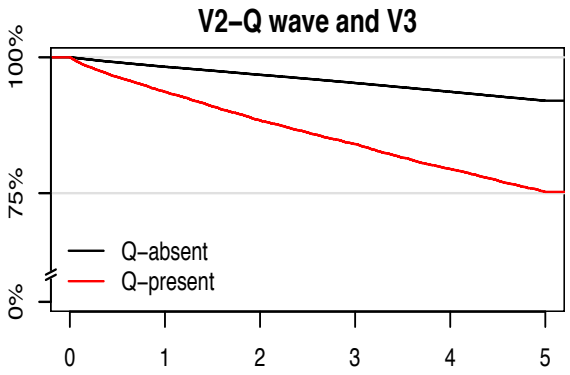
Kaplan-Meier curves were plotted for comparison of survival according to Q wave location in the contiguous leads and lone leads. Only the lone leads with most observations were plotted. The two anterior groups (V_2-Q wave and V_3) and (V_4-V_6), lateral (I and aVL) and inferior (II, III, aVF) lead groups all shown increased mortality, conversely, the posterior lead group (V_1 and V_2-R wave) did not differ from reference group (all individuals except those with Q waves in the posterior leads). A total of 10,080 (11.2%) of those with Q waves reached the primary endpoint within the follow up time of 5 years and 4,795 (5.3%) patients reached the secondary endpoint i.e. cardiovascular death, Table 1. Survival curves for contiguous and lone leads are shown in Figure 2 and 3, respectively.

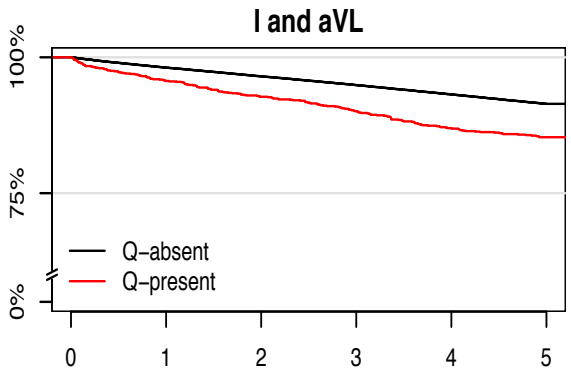
MULTIVARIATE ANALYSIS OF FIVE-YEAR SURVIVAL

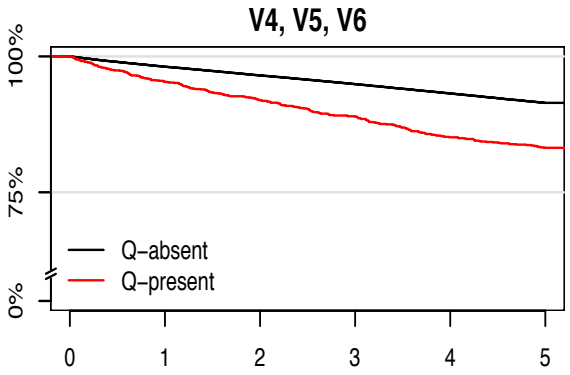
The Cox proportional hazard models were performed to verify the survival analysis´ results. The model was adjusted for gender and age. The results of multiple analyzes for contiguous and lone leads are shown in Figure 4 and 5, respectively.

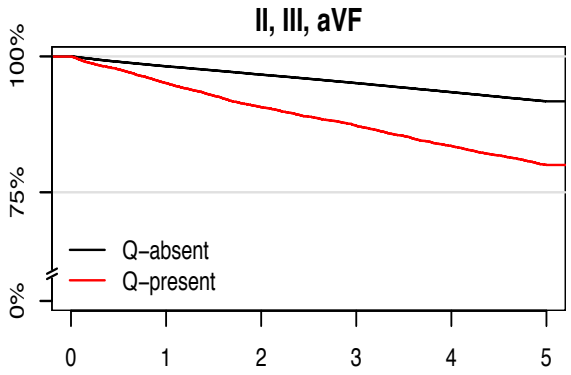
CONTIGUOUS LEADS AND ALL-CAUSE MORTALITY

Q waves in V_2-Q wave and V_3, V_4-V_6, I and aVL, and inferior (II, III, and aVF) lead groups were all significantly associated with mortality (Figure 4). Among them, the anterior lead group (V_4-V_6) had the highest risk (HR: 1.71, 95% CI: 1.50-1.94, P <0.001). R-waves in V_1 and V_2 were inversely associated with mortality (HR: 0.74, 95% CI: 0.57-0.95, P =0.020).









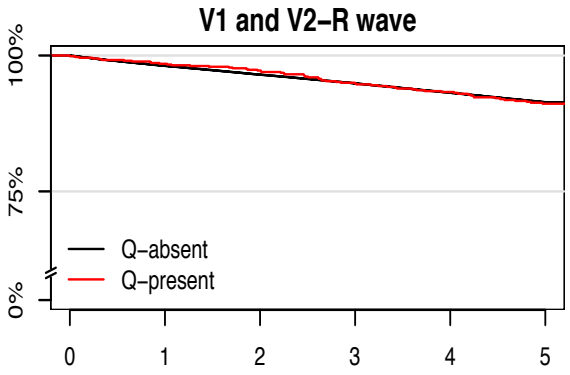


Figure 2 Kaplan-Meier survival analysis of Q wave in the contiguous leads, anterior lead group (V_2-Q wave and V_3), lateral lead group (I and aVL), anterior lead group (V_4-V_6), inferior lead group (II, III, aVF) and posterior lead group (V_1-V_2 –R wave).

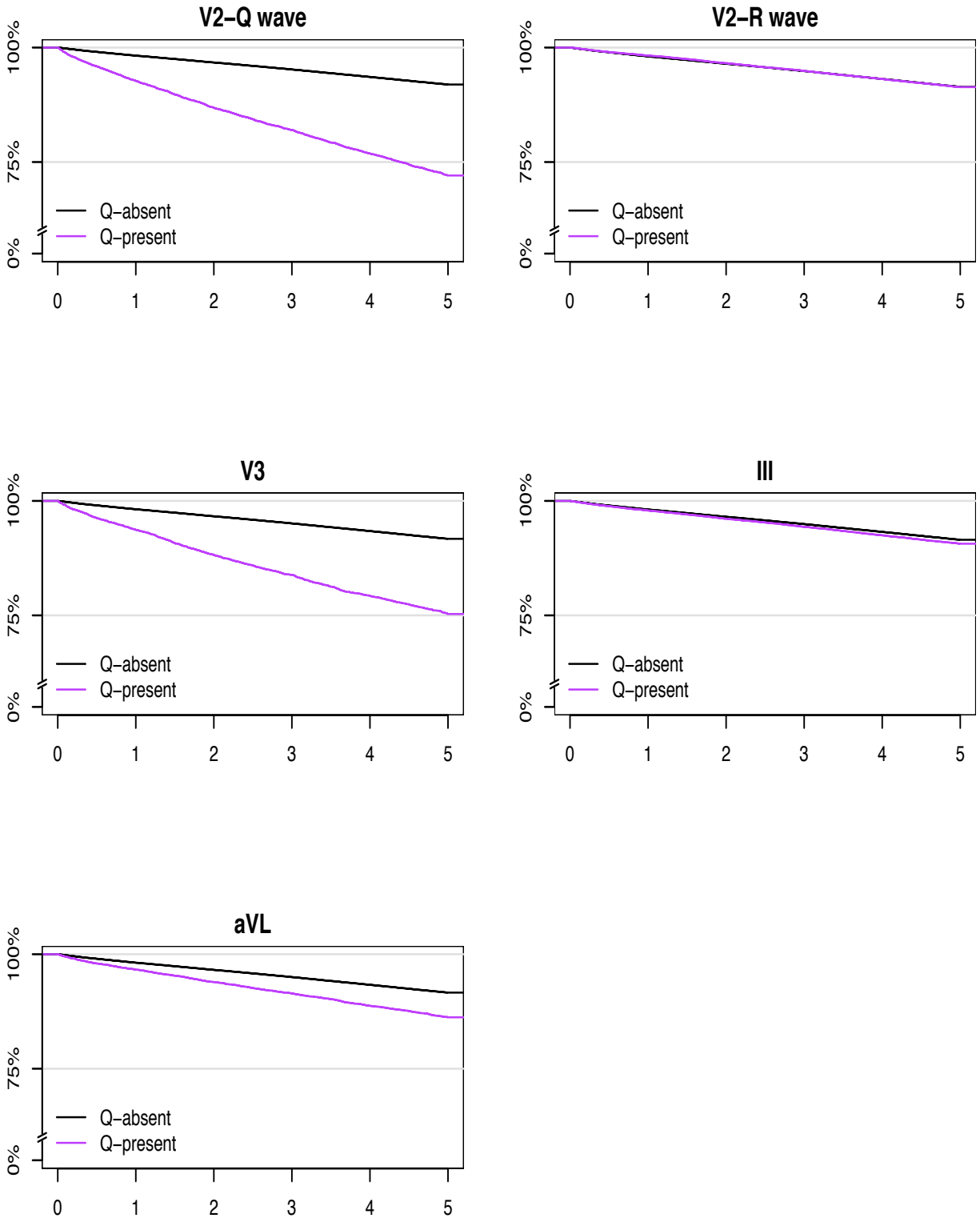


Figure 3 Kaplan-Meier survival of Q wave in lone leads, selection based on highest proportion of observations in each group.

LONE LEADS AND ALL-CAUSE MORTALITY

The association between Q wave location in lone leads and all-cause mortality was more heterogenic compared with contiguous leads, Figure 5.

Q waves that appeared in lone leads, V_2-Q wave or V_3, were associated with significantly increased mortality.

We found that lone lead aVL was correlated with increased mortality; while lone I did not follow the same pattern (HR: 1.10, 95% CI: 0.96-1.26, P=0.181). Both lone V_4 and lone V_5 were associated with increased mortality (HR: 1.37, 95% CI: 1.16-1.61, P <0.001 and HR: 1.83, 95% CI: 1.13-2.94, P= 0.013, respectively).

Lone V_6, III and aVF were not significantly associated with mortality (HR: 1.03, 95% CI: 0.85-1.26, P=0.732, HR: 1.02, 95% CI: 0.98-1.06, P=0.311, HR: 1.05, 95% CI: 0.89-1.23, P=0.597, respectively). Lone II were on other side correlated with increased mortality (HR: 1.89, 95% CI: 1.74-2.06, P<0.001). Lone V_1 were associated with increased mortality, while lone V_2-R wave

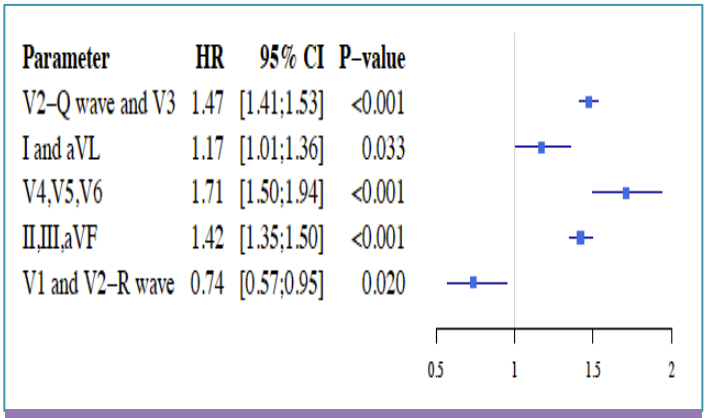


Figure 4 All-cause mortality in patients with Q waves defined by UDMI N=23,039 (5-year follow-up). Q waves are present in minimum two contiguous leads. Model adjusted for gender and age.

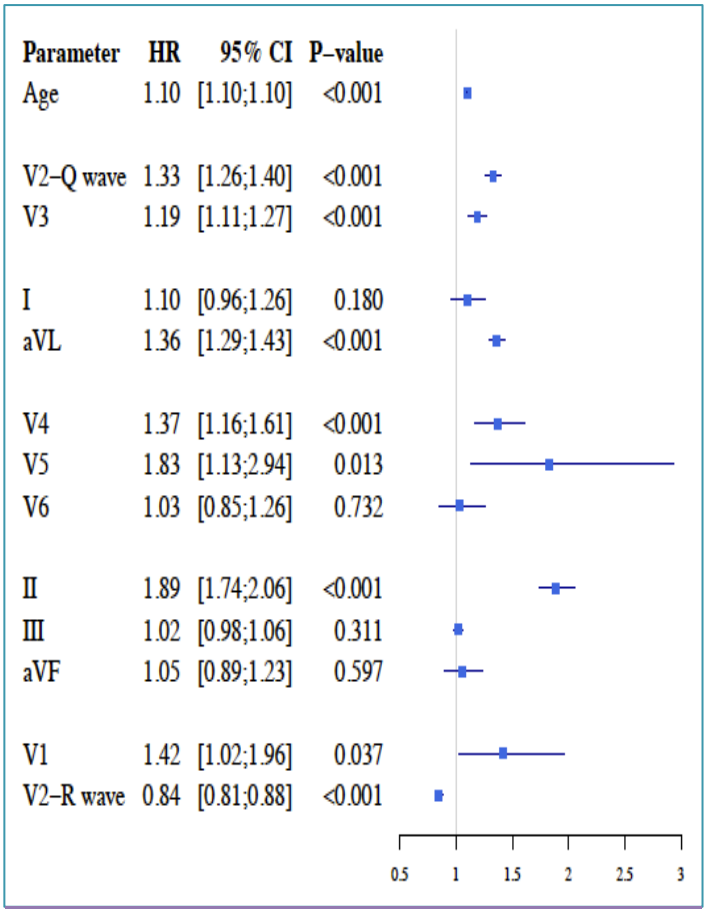


Figure 5 All-cause mortality in patients with pathologic Q waves in lone leads N=96,963 (5-year follow-up). When Q wave are present in one lead it was secured that Q waves was not present simultaneously in the other lead/leads of the same lead group. The model adjusted for gender and age.

did not show the same association (HR: 1.42, 95% CI: 1.02-1.96,P=0.037, HR: 0.84, 95% CI: 0.81-0.88, P <0.001, respectively).

Q WAVES AND RISK OF CARDIOVASCULAR DEATH

In general, we found almost the same pattern as when the endpoint was all-cause mortality. However when the cardiovascular mortality was set as the endpoint, the HR marginally increased for almost all groups, lone and contiguous leads. However, there were few leads that changed considerably when the endpoint was changed from all-cause to cardiovascular mortality. Lone lead III showed significantly higher mortality (HR: 1.13, 95% CI: 1.07-1.19, P <0.001), also lone V_1 changed dramatically from being a high risk in all-cause mortality to becoming statically insignificant. The contiguous lead group of V_1 and V_2-R wave also became statistically insignificant.

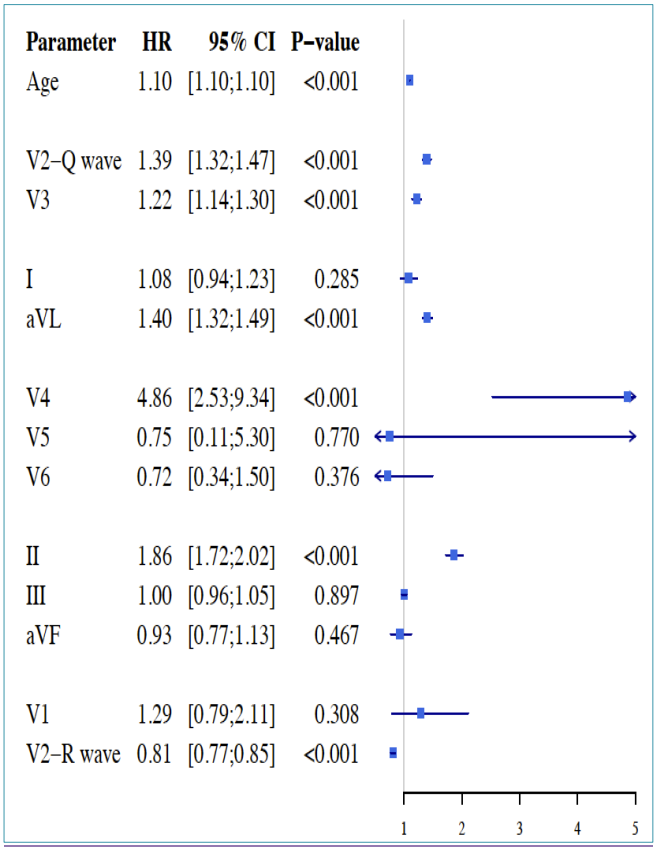


Figure 6 All-cause mortality in patients with pathologic Q waves exclusively in lone leads N=85,879 (5-year follow-up). When Q wave are present in one lead it was secured that Q waves was not present simultaneously in the other lone and contiguous lead/leads. The model adjusted for gender and age. In V4 only lower limit is shown.

Other analysis

We also look at the exclusive presence of Q wave in lone leads, and found that the confidence interval generally became wider in lone V_4, V_5, V_6 (HR: 4.86, 95% CI: 2.53-9.34, P <0.001, HR:

0.75, 95% CI: 0.11-5.30, P =0.770, HR: 0.72, 95% CI: 0.34-1.50, P =0.376, respectively), the results are shown in Figure 6.

DISCUSSION

The main findings of our study were that the presence of Q waves in lone leads in certain locations was associated with increased mortality. The same pattern was found when Q waves appeared in contiguous leads in certain cardiac segments. Our analysis showed that the contiguous leads; anterior (V_4-V_6) and (V_2-Q wave and V_3), inferior (II, III, aVF), and lateral (I and aVL) were associated with increased mortality. However, some lone leads have significantly higher mortality than the reference and therefore it is reasonable to discuss and further investigate the isolated leads role in predicting mortality even though they are not included in the UDMI criteria.

Surprisingly the posterior lead group that included V_1 and V_2-R wave had the least prediction of mortality. This group was defined by the presence of reciprocal Q waves, which in turn identified by the presence of wide and tall R wave. The results may be explained that we cannot distinguish between if the R waves we found in those leads were actual reciprocal Q waves or there were conditions that may simulate the tall and wide R wave such as misplacement of the ECG electrodes or as a normal variant[12].

As well known Q waves in lone III are not associated with increased mortality since they can appear as normal variants in these leads, especially the presence of Q waves in lead III which are considered as a normal variant up to 50 ms [13]. We did find similar findings for both lone III and aVF. Lone II was related with increased mortality, since the QRS vectors of inferior MI are detected by III and aVF but more frequently by lead II [17].

COMPARISON WITH OTHER STUDIES

The majority of studies, including the Framingham study, show that anterior infarctions are associated with a worse prognosis than inferior infarctions[18–23]. Meanwhile, our study showed a significantly increased risk of death in individuals with Q wave despite MI locations.

Godsk et al.[24] reported that the Q-waves in anterior and inferior of unrecognized MI had the same serious prognosis. Maisel´s et al.[25] study that included 997 patients, they found that the prognosis for anterior and inferior Q waves after an MI became identical in the long term. Also, Benhorin et al.[8] demonstrated in a retrospective cohort study that the Q wave location did not cause a significant independent contribution to the risk for cardiac morbidity or mortality. Our study showed similar findings as Godsk, Maisel and Benhorin that having Q wave in anterior and inferior were correlated with the same risk of death. We also found that having Q wave in posterior leads do not imply a high risk of death.

In a new study by Perino et al.[10] investigating the long-term prognosis of Q wave defined after UDMI compared to the classical criteria of ≥ 40 msec in 43,661 patients, they found that all contiguous leads and also lone leads were associated with high mortality risk. Lead V_3-V_6 being the most predictive while III and aVL being least predictive. These findings resemble some of our findings such as that V_4-V_6 as a group is the most predictive for mortality and that a lone III has not a high predictive value for the mortality. The study, however, differs from our in several points such the majority of their study population consists of 90% men and the estimation of the risk for the different variables were performed by univariate analysis. Furthermore, they did not include V_1 or V_2-R wave in their analysis. When defining the contiguous lead groups, they only chose specific combinations such as II and aVF or III and aVF to meet the UDMI criteria for inferior leads. Also, the lone leads were defined to be exclusive of Q waves in all other leads. Meanwhile in our study, the

contiguous lead groups were composed after the UDMI criteria, that any 2 leads in the same group were acceptable to fulfill the criteria. We also defined a new criterion in order to isolate lone leads which were required that the remaining leads in the same lead group did not have Q waves in contiguous leads. This definition of lone lead was chosen because of small sample size and lack of power when lone lead was required no Q wave in other lone or contiguous leads especially in leads V_4, V_5, and V_6, Figure 6.

CONCLUSIONS

Q wave in anterior, lateral and inferior leads was associated with significant risk of death in patients who fulfilled Third Universal Definition of Myocardial Infarction. In addition, some isolated leads show also a high risk of death, and therefore, a coincidental finding of Q wave in these leads should not be neglected.

STUDY LIMITATION

Although of our large study population, this study is an observational study, and therefore, we shall be aware of possible confounders. Consequently, we included factors that considered as probable confounders in our multivariable analysis.

Our study is based on ECGs taken on refer of general practitioners, which can be a limitation to our study since the reason for the ECGs is unknown to us and has definitely lead to some selection bias.

CLINICAL IMPLICATIONS

This study shows that Q wave in contiguous leads defined by the Third Universal Myocardial Definition in the anterior (V_2-Q wave and V_3) and (V_4-V_6), lateral (I and aVL) and inferior leads (II, III and aVF) are associated with increased mortality, where the posterior leads (V_1 and V_2-R) wave are

not. Almost all lone leads except for V_6, III, aVF and V_2-R wave, are associated with increased mortality. Although pathologic Q wave is a sign of previous myocardial infarction, our findings indicate a need for further investigation of the lone leads significance in mortality. This knowledge will contribute to a better estimation of mortality risk in patients with the lone and contiguous leads.

FUTURE PROSPECTIVE

Next to be investigated is whether there is an interaction between MI and Q waves.

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