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ECG in nonagenarians

EKG dziewięćdziesięciolatków

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Abstract

Introduction. *Electrocardiogram abnormalities occur more frequently in older age but studies in the oldest old are rare. We evaluated ECG, therapy and functional status in nonagenarians.* ***Material and methods.*** *This was the retrospective study of patients ≥ 90 years old, hospitalized between March 2017 and March 2018 in the internal ward of the medical university hospital. ECG, functional dependence and therapy were evaluated.* ***Results.*** *55 patients (34 females) aged 91 (90-98) years have been included into the study. On admission 25 (45.5%) were on sinus rhythm, 24 (43.6%) had atrial fibrillation, 4 (7.3%) had atrial flutter, 1 (1.8%) had junctional escape rhythm and 1 (1.8%) had atrio-ventricular paced rhythm. There was no difference in gender or Bathel index score among patients on sinus and non-sinus rhythm, who in their majority received anticoagulant therapy, which the most frequently was rivaroxaban. The most frequent abnormalities in ECG were: suggestive of ischemic heart disease: ST segment depression (25.5% and 12.8%) and negative T waves (14.9% and 8.5%) in lateral and inferior sites respectively and Q wave in inferior site (12.8%); conduction abnormalities: 1st degree a-v block (17.0%), left anterior hemiblock (14.9%), right bundle branch block (12.8%) and non-specific interventricular conduction delay (14.9%); left ventricular hypertrophy (12.8%) and ventricular premature contraction (14.9%). QTc prolongation was frequent (40.4%), especially with atrial fibrillation/flutter, ST-T abnormalities and left ventricular hypertrophy.* ***Conclusions.*** *Atrial fibrillation is frequent in hospitalized nonagenarians and they usually receive anticoagulation. The most frequent in nonagenarians' ECG are ST-T abnormalities, conduction abnormalities and LV hypertrophy. (Gerontol Pol 2019; 27; 5-10)*

Key words: *ECG, nonagenarian, atrial fibrillation*

Streszczenie

Wstęp i cel pracy. *Nieprawidłowości w elektrokardiogramie są częste u pacjentów w podeszłym wieku, ale badań dotyczących pacjentów najstarszych jest niewiele. Oceniano EKG, leczenie i status funkcjonalny u dziewięćdziesięciolatków.* ***Materiał i metody.*** *Było to retrospektywne badanie pacjentów ≥ 90 r.ż., hospitalizowanych od marca 2017 do marca 2018 r. w oddziale chorób wewnętrznych szpitala uniwersyteckiego. Oceniano EKG, stopień sprawności funkcjonalnej i stosowane leczenie.* ***Wyniki.*** *Do badania włączono 55 pacjentów (34 kobiety) w wieku 91 (90-98) lat. Przy przyjęciu u 25 (45,5%) stwierdzano rytm zatokowy, u 24 (43,6%) migotanie przedsionków, u 4 (7,3%) trzepotanie przedsionków, u 1 (1,8%) zastępczy rytm z łącza przedsionkowo-komorowego i u 1 (1,8%) stymulację przedsionkowo-komorową. Nie było różnic płci ani punktacji w skali Barthel między pacjentami z rytmem zatokowym i pozazatokowym, którzy w większości otrzymywali leczenie przeciwzakrzepowe, najczęściej rywaroksaban. Najczęstszymi nieprawidłowościami w EKG były: sugerujące chorobę niedokrwienną serca: obniżenie odcinka ST (25,5% i 12,8%) i ujemne załamki T (14,9% i 8,5%) odpowiednio w odprowadzeniach znad ściany bocznej i dolnej oraz załamki Q w odprowadzeniach znad ściany dolnej (12,8%); zaburzenia przewodzenia: blok p-k 1° (17,0%), blok przedniej wiązki lewej odnogi pęczka Hisa (14,9%), blok prawej odnogi pęczka Hisa (12,8%) i niespecyficzne zaburzenia przewodnictwa śródkomorowego (14,9%); przerost lewej komory (12,8%) i przedwczesne pobudzenia komorowe (14,9%). Wydłużenie QTc występowało często (40,4%), zwłaszcza wspólnie z migotaniem/trzepotaniem przedsionków, zmianami ST-T i przerostem lewej komory.* ***Wnioski.*** *Migotanie przedsionków występuje często u hospitalizowanych dziewięćdziesięciolatków. Zwykle otrzymują oni leczenie przeciwzakrzepowe. Najczęściej w EKG u dziewięćdziesięciolatków stwierdza się: zmiany ST-T, zaburzenia przewodnictwa i przerost lewej komory. (Gerontol Pol 2019; 27; 5-10)*

Słowa kluczowe: *EKG, dziewięćdziesięciolatkowie, migotanie przedsionków*

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Introduction

As far as European population gets older it is becoming more common to see octogenarians, nonagenarians or even centenarians in clinical practice.

Electrocardiogram abnormalities occur more frequently in older age but studies so far mostly include population in their seventies and eighties. Studies that analyze ECG in the oldest old are rare and their sample size is usually low.

According to the literature the oldest old display more frequently arrhythmias such as premature supraventricular or ventricular contractions [1]. Also there is the increasing occurrence of atrial fibrillation in older age, namely in patients between 66 and 93 years of age persistent atrial fibrillation was registered in 10% and paroxysmal in 5,5% [2] while in centenarians it has reached about 26% [1].

With advancing age conduction defects appear. In the study on centenarians 1st degree atrio-ventricular block was observed in 10% and 2nd degree in 1.3% of patients [1].

In octogenarians and centenarians right bundle branch block incidence of 15% was reported [1] while 10% in case of left bundle branch block [1].

It is known that from 70 years of age there is an increase in incidence of Q waves or QS pattern [1]. In octogenarians ST segment changes were observed in about 8% [3] while in centenarians abnormalities suggestive of ischemia were noted in as much as 39% of examined individuals [1].

A significant correlation between aging and prolongation of QTc interval is noted [4-6]. E.g. in octogenarians prolonged QTc was observed in 28% of elderly patients [7].

We attempted to evaluate ECG as well as therapy and functional status in nonagenarians.

Patients and methods

This was the retrospective study of patients ≥ 90 years old, hospitalized between March 2017 and March 2018 in one of the internal wards of the medical university hospital. The files were evaluated and relevant demographic and clinical data were recorded.

To assess functional independence Barthel index was used [8]. Results were expressed both as continuous variable as well as in 3 intervals:

score 0-20 – total dependence, score 21-85 – severe to moderate dependence and score 86-100 – slight dependence to independence [9].

ECG obtained on admission was evaluated according to the classification of the Working Group of Noninvasive Electrocardiology and Telemedicine of Polish Cardiac Society. Prolonged corrected QT (QTc) was defined as > 460 ms in females and > 450 ms in males [10,11].

55 patients (34 females (61.8%) and 21 males (38.2%) aged 91 (90-98) years) have been included into the study. Most patients (56.4%) were admitted due to cardiovascular disease. Patients characteristics is presented in Table I. The in-hospital mortality rate was 3.6% - 1 female patient aged 93 years died of mesenteric embolism and 1 male patient also aged 93 years died of pneumonia.

Table I. Clinical data of 55 patients

hospitalization cause	No.	%
congestive heart failure	12	21,8
paroxysmal atrial fibrillation	5	9,1
fainting	7	12,7
pneumonia	7	12,7
anemia	6	10,9
dehydratation/electrolyte imbalance	6	10,9
ischemic heart disease	2	3,6
venous thromboembolism	1	1,8
malignancy	2	3,6
diverticulitis	1	1,8
gout	1	1,8
hypertension	1	1,8
sepsis	1	1,8
pericarditis	1	1,8
mesenteric embolism	1	1,8
digoxin overdose	1	1,8
relevant diseases		
hypertension	30	54,5
diabetes mellitus	10	18,2
chronic renal failure	17	30,9
ischemic heart disease	17	30,9
congestive heart failure	19	34,5
atrial fibrillation chronic or paroxysmal	26	47,3
tricuspid regurgitation	13	23,6
mitral regurgitation	12	21,8
aortic stenosis	9	16,4
hypothyroidism	9	16,4

Statistical analysis

The obtained data were expressed as median with range as far as normality Kolmogorov-Smirnow test showed not-normal distribution. The Chi square test with Yates' correction and Fisher's exact test were used to compare discrete variables. U Mann-Whitney test was

used to compare two independent groups of continuous variables while Kruskal-Wallis test was used to compare multiple independent groups. R Spearmann correlation was used to assess relationship between continuous variables. To examine the influence of age, gender and functional status on anticoagulant therapy logistic regression analysis was performed. A value of $p < 0.05$ was considered statistically significant. For statistical analysis STATISTICA 13.1 software was used.

Results

The median of Barthel index score was 95 (0-100) and it was lower in female than in male nonagenarians (80 (0-100) vs. 95 (50-100), $p = 0.01$). However, median of age was similar in both group. Barthel index score correlated negatively with age only in male nonagenarians ($r = - 0.56$, $p < 0.005$). Eight patients (14.5%) were in total dependence group - they were only females and also females dominated in severe to moderate dependence group (10 vs. 4 patients, $p = 0.02$).

Fifteen patients (27.3%) had implanted pacemaker. There was no difference in age and gender. Eight patients (14.5% of population) had only paced QRS complex and were not included into QRS complex, QT interval, ST segment and T wave analysis.

On admission, of 55 nonagenarians only 25 (45.5%) were on sinus rhythm, 24 (43.6%) had atrial fibrillation, 4 (7.3%) had atrial flutter, 1 (1.8%) had junctional escape rhythm and 1 (1.8%) had atrio-ventricular paced rhythm. There was no difference in gender or Bathel index score among patients on sinus and non-sinus rhythm. The median of heart rate (HR) in atrial fibrillation or flutter was faster than in sinus rhythm (96.6 (65-170) vs. 77.5 (48-120) 1/min, $p = 0.0001$).

The ECG data are described in Table II. The most frequent changes were: ST segment depression in lateral and inferior site, negative T wave in lateral site, Q wave in inferior site, 1st degree atrio-ventricular block, nonspecific intraventricular conduction delay, right bundle branch block (RBBB), left anterior hemiblock (LAH), left ventricular hypertrophy (LVH) and ventricular premature contraction.

There was no difference in ECG changes in female and male nonagenarians. As far as Barthel index score – only patients with biphasic T wave had lower score (5 [0-30] vs. 95 [0-100], $p = 0.02$). The median of P wave duration, PQ interval, QRS complex duration, QT and QTc interval were within normal ranges. P wave duration and PQ interval correlated with age in males ($r = 0.8$ and $r = 0.72$, $p < 0.05$, respectively). PQ interval correlated with HR ($r = - 0.42$), RR interval ($r = 0.45$) and P wave duration ($r = 0.57$). This last correlation was especially prominent in male nonagenarians ($r = 0.91$). QT interval moderately correlated with QRS complex duration in females ($r = 0.41$, $p < 0.05$), while QTc correlated negatively with PQ interval in males ($r = - 0.72$, $p < 0.05$).

QTc was prolonged in 19 patients (40.4%), with no difference in gender. In 8 patients with only paced QRS complex, QTc was prolonged in 6 patients. HR and RR interval correlated with QT interval ($r = - 0.57$ and

Table II. ECG data of 47 patients with native QRS complex

	no.	%
LA enlargement	3	6,4
RA enlargement	0	0
1st degree a-v block	8	17
2nd degree a-v block	0	0
3rd degree a-v block	0	0
RBBB	6	12,8
LBBB	1	2,1
non-specific interventricular conduction delay	7	14,9
left anterior hemiblock	7	14,9
left posterior hemiblock	1	2,1
bifascicular block	3	6,4
left ventricular hypertrophy	6	12,8
right ventricular hypertrophy	3	6,4
Q wave anterior site	3	6,4
Q wave lateral site	1	2,1
Q wave inferior site	6	12,8
ST elevation anterior site	1	2,1
ST elevation lateral site	0	0
ST elevation inferior site	0	0
ST depression anterior site	3	6,4
ST depression lateral site	12	25,5
ST elevation inferior site	6	12,8
negative T wave anterior site	4	8,5
negative T wave lateral site	7	14,9
negative T wave inferior site	4	8,5
biphasic T wave	3	6,4
U wave	4	8,5
supraventricular premature contraction	3	6,4
ventricular premature contraction	7	14,9
	median	**range**
RR interval [ms]	740	360-1600
HR [1/min.]	85	37-170
P wave [ms]	80	60-140
PQ interval [ms]	160	140-320
QRS complex [ms]	100	80-160
QT interval [ms]	360	280-640
QTc interval [ms]	441	345-572

r = 0.45, p < 0.05, respectively). Patients with prolonged QTc had faster HR (95 (48-170) vs. 80 (37-160), p = 0.005) and shorter RR interval (680 (360-1280) vs. 760 (400-1600), p = 0.016). Patients with prolonged QTc had more often atrial fibrillation/flutter than sinus rhythm (73.7% vs. 26.3%, p = 0.005). The majority (83.3%) of patients with LVH had also prolonged QTc (p = 0.02). All patients with ST segment depression or negative T wave in anterior site as well as biphasic T wave had prolonged QTc (p = 0.03, p = 0.01, p = 0.03, respectively).

The majority of patients was treated with diuretics – loop, thiazide or thiazide-like (78.2%) and beta-adrenolitics (69.1%). About one third received statin (32.7%) and angiotensin converting enzyme inhibitor (ACE-I) or angiotensin receptor blocker (ARB) (32.7%). There was no difference in these drugs use in male and female nonagenarians. Neither Barthel index score influenced treatment type. However, only six female nonagenarians were treated with digoxin (p = 0.04). 18.2% received antiplatelet treatment and 54.5% were on anticoagulant.

95% of patients with either paroxysmal or chronic atrial fibrillation/flutter, irrespectively of age, gender or Barthel index score, received anticoagulation treatment. It was acenocoumarol in 18.5%, warfarin in 11.1%, dabigatran in 18.5%, rivaroxaban in 29.6%, apixaban in 7.4% and low molecular weight heparin (LMWH) in 14.8% of patients.

In the total dependence group LMWH was the most frequent choice (3 patients), 1 patient received rivaroxaban, there was no patient on acenocoumarol or warfarin (p = 0.02).

Ten female patients with native QRS complex received ACE-I or ARB. Only 1 of them had prolonged QTc (p = 0.02). This correlation was not observed in male nonagenarians.

Discussion

Although the oldest old – nonagenarians and centenarians have been proposed as a model of successful aging, studies suggest a high prevalence of cardiovascular diseases. It is possible that the present day European nonagenarians in their majority have reached this age rather because of developed medical care they have obtained in their 70-ties and 80-ties, thus they represent population of multiple co-morbidities.

In our group of nonagenarians congestive heart failure was the most frequent cause of hospital admission. Also congestive heart failure, as well as valvular heart disease and atrial fibrillation were the most common co-morbidities.

The increasing occurrence of atrial fibrillation in older age poses a challenge for health care. According to the literature in patients between 66 and 93 years of age persistent atrial fibrillation occurred in 10% and paroxysmal in 5.5% [2]. In centenarians it was registered on ECG in about 26% [1,12]. These data, however, are derived from out-patient population. Atrial fibrillation or flutter was present in as much as the half of our patients. There were only 5 patients (9.1%) hospitalized for paroxysmal atrial fibrillation, thus indicating chronic character of arrhythmia in our population of nonagenarians.

In the study that concerned cumulative lifetime incidence of atrial fibrillation, it was 5.0% in octogenarians, 5.4% in nonagenarians and 2.3% in centenarians [13]. This supports thesis that in patients in their 90-ties new arrhythmia onset is less probable.

In Finnish prospective study on 5-year cardiovascular mortality in population aged over 85 years, the highest mortality rate was found in individuals with atrial fibrillation, atrio-ventricular blocks, right and left bundle branch block [3]. On the other hand in more recent study the presence of abnormalities on preoperative ECG in older patients was not associated with an increase in postoperative cardiac complications [15].

In our population of hospitalized nonagenarians the most frequent ECG abnormalities were suggestive of ischemic heart disease: ST segment depression, negative T waves and Q waves. It is known that from 70 years of age there is an increase in incidence of Q waves or QS pattern [1,14]. In octogenarians ST segment changes were observed in about 8% [3] while in centenarians abnormalities suggestive of ischemia were noted in as much as 39% of examined individuals [1].

It was suggested that ST segment depression in elderly may be a vascular risk factor for cognitive deterioration [15]. But we have not noticed correlation between ST segment abnormalities and Barthel index score. Only patients with biphasic T wave had lower score.

Among our patients LVH prevalence on ECG was 12.8%. In literature it was reported from 14% to 31% in octogenarians [3,16]. One study on centenarians in Spanish population reported 8% [1] while other conducted in southern Italy reported 30 % prevalence [17].

In literature 2% prevalence of right atrium enlargement was reported [16]. None of our patients had enlarged right atrium. Unfortunately smoking status or functional lung tests results were not available in all our patients.

With advancing age conduction defects appear [5,14]. Although median of PQ interval in our group was within normal range, we have recorded in 17% of nonagenarians 1st degree atrio-ventricular block. Literature reports

longer PQ interval in people older than 80 years [5], in the study on centenarians 1st degree atrio-ventricular block was observed in 10% and 2nd degree in 1.3% of patients [1]. Among our patients there was no 2nd or 3rd degree atrio-ventricular block on ECG. Maybe those patients with more advanced atrio-ventricular conduction defects received earlier – in their 70-ties or 80-ties – pacemaker.

LAH in our study concerned almost 15% of patients. Other studies report cumulative number of left anterior hemiblock and left axis deviation in the oldest old as high as 38% [17]. We also observed frequent nonspecific intraventricular conduction delay and more often right (12.8%) than left bundle branch block (2.1%). In octogenarians and centenarians RBBB prevalence of 15% was reported [1,3] while 10% in case of LBBB [1].

The oldest old display more frequently premature contractions on standard ECG. 14.9% of our patients had ventricular and 6.4% supraventricular premature contractions. Studies in centenarians report arrhythmias as total in 36.3% of patients [1].

A significant correlation between aging and prolongation of QTc interval is noted [4-6]. E.g. in octogenarians mean QTc was 410 ms [3] and prolonged QTc was observed in 28% of elderly patients [7], more frequently in males [7,18], maybe because of their decreasing with age testosterone level [7]. In our population median of QTc was 441 ms while prolonged QTc was observed in 40.4% of patients, but it was not related to gender. We did not observed correlation with gender but with LVH, ST segment depression and negative T wave presence, which are associated with ventricular myocardial repolarization and depolarization pattern. Prolonged QTc was also present more often in patients with atrial fibrillation or flutter, whose HR was usually faster than those on sinus rhythm. As far as faster HR is reported to positively relate to QTc [19] it may explain longer QTc interval in our population of nonagenarians.

We have used Barthel index because in our country it is commonly used to assess risk of someone institutionalization. The median of Barthel index score in our group was 95, suggesting relatively good performance in activities of daily living, and it correlated with age (admittedly only in males). Lower Barthel index score was noted in female nonagenarians, and in the total dependence group there were only women. It may be at least partially explained by higher prevalence of fragility syndrome in elderly women [20].

In-hospital mortality in our group was 3.6%. The oldest old patients have a priori high risk of in-hospital mortality. In one study it was reported as 6% [19]. In other study 30-day mortality in octogenarians with out-of-hospital cardiac arrest was higher than in younger patients [21]. Nonetheless the majority of octogenarians survivors was discharged with favorable neurological outcome, thus withholding resuscitation and postresuscitation care in this population does not seem justified [21].

In our nonagenarians group pharmacological therapy apparently was not influenced by the old age. Even the majority of patients with atrial fibrillation or flutter received anticoagulant therapy. Other studies report often less 'aggressive' therapy in patients in their 80-ties and 90-ties [21]. In Berlin AF Registry, which was the real-world cohort of very elderly patients, rhythm control and oral anticoagulation were chosen in only a minority of cases (26.5% in hospital and 35.6% in follow-up) [22]. Those patients, however, received mostly vitamin K antagonists while in our study direct thrombin inhibitors or factor Xa inhibitors. It may reflect their recently growing popularity also in very old patients, as far as Berlin Registry concerns years 2001-2014.

Of notion our nonagenarians group relatively often received diuretics (78.2%) probably due to frequent prevalence of congestive heart failure. Only 10.9% received digoxin, which historically was associated with heart rate control in elderly and with congestive heart failure. This decreasing popularity of digoxin can be partially explained with growing awareness of its narrow safety window and problems with dose adjustment in patients with impaired with age renal function.

Conclusions

1. On admission to the hospital half of the nonagenarians had atrial fibrillation or flutter. In their majority they received anticoagulant therapy, which the most frequently was rivaroxaban.
2. The most frequent abnormalities in nonagenarians' ECG were:
   suggestive of ischemic heart disease: ST segment depression and negative T waves in lateral and inferior sites and Q wave in inferior site
   conduction abnormalities: 1st degree a-v block, LAH, RBBB and non-specific interventricular conduction delay LVH and ventricular premature contraction.
3. QTc prolongation was frequent in nonagenarians, especially with atrial fibrillation/flutter, ST-T abnormalities and left ventricular hypertrophy.

Conflict of interest
None

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