COMPARATIVE ANALYSIS AND DYNAMICS OF ECHOCG PARAMETERS IN PATIENTS WITH IHD AND T2DM WITH DIFFERENT CATEGORIES OF LVEF AT THE STAGES OF OBSERVATION

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Abstract*. This article is devoted to assessing the relationships between EchoCG parameters and their dynamics in the ranges of preserved and moderately reduced LVEF in patients with coronary artery disease and type 2 diabetes. We examined 130 patients with type 2 diabetes and coronary artery disease with varying LVEF at the age of 65.6±9.7 years with an experience of 8.8±5.2 and 7.5±3.6 years, respectively. The results of the LVDP value between groups 2 and 3 at the outcome differed in the E/e` indicator (t==7.02, p=0.008), due to the E parameter (t==6.011, and p=0.01). At the observation stages, positive dynamics were recorded on the part of E/A in groups 2 (t==6.727, p=0.009) and 3 (t==15.830, p=0.000), E/e' (t==7.422, p=0.006) and (t==17.775, p=0.000) respectively. Conclusion: the identified main indicators of LVDD respond to therapy with Empagliflozin with a fairly high statistically significant power.*
Keywords*: diabetes mellitus type 2; cardiac ischemia; heart failure; ejection fraction; left ventricular diastolic dysfunction.*

Introduction. Patients with T2DM are at higher risk of death and cardiovascular outcomes than the general population. Epidemiological studies have shown that in the next 20 years the number of patients suffering from T2DM will double [4]. This group of patients faces two main problems: the prognosis of the disease worsens and the number of drugs that doctors prescribe to them increases. NGLT-2 are a class of anti-diabetic drugs that can improve the quality of life and prognosis in patients with CHF in combination with T2DM, occurring in 12–46% of cases [2]; [3], as well as in the absence of DM-2 [1]. Expected results from ongoing studies will determine whether SGLT-2 inhibitors have an impact on patient-centered endpoints, including physical activity and quality of life [5]. The study of the relationships between echocardiography parameters in patients with preserved and moderately reduced LVEF in the context of coronary artery disease and type 2 diabetes is extremely relevant, since these categories of patients may demonstrate different clinical manifestations and response to treatment. Understanding these relationships will help improve diagnosis, prognosis, and treatment, which may ultimately lead to decreased morbidity and mortality in this patient population. Thus, the study of this topic helps to deepen knowledge about the pathophysiology of coronary artery disease and type 2 diabetes, improve the quality of medical care and increase the effectiveness of treatment for patients with cardiovascular diseases.

Purpose: To assess the relationships between echocardiography parameters and their dynamics in the ranges of preserved and moderately reduced LVEF in patients with coronary artery disease and diabetes mellitus-2. Material and methods. The study included 130 patients with

diabetes mellitus 2 (WHO, 1999) and coronary artery disease (EOC) at the age of 65.6 ± 9.7 years, the duration of diabetes mellitus 2 and coronary artery disease was 8.8 ± 5.2 and 7.5 ± 3 ,6 years respectively. EchoCG parameters were analyzed: EF, LA, LA volume, LA volume index, EDR, ESR, LV mass, LVMM index, PP, MPAP, E, A, E/A, e septal, e later, e average, E/e, degree of LVDD. Depending on LVEF, patients are divided into two subgroups (A 1 – EF <41-49% and B group EF>50%). Then, according to the H2FPEF scale [6], to determine the probability of HF, patients with shortness of breath and preserved EF with increased BNP (B) are divided into 2 subgroups: subgroup 2 (with a probability of HF >50%) and 3 (with a probability of HF <50%). From the parameters we analyzed, only data with statistically significant differences were selected for discussion. Patients received basic cardiac and antihyperglycemic therapy: anticoagulants, antiplatelet agents, nitrates, beta blockers, RAAS blockers, statins, empagliflozin, antihypertensive drugs. The observation period was 2 years. Static processing was carried out using the nonparametric one-way analysis of variance by Kruskal–Wallis.

Results. According to the results of echocardiographic studies, there are intergroup differences in all analyzed parameters. In particular, there were intergroup differences in outcome between 1 and 2 (t=49.29, 0.000) and 1 and 3 (t=78.55, 0.000), respectively, and at follow-up (t=34.70, p=0.000) and (t=66.20, p=0.000) respectively. During the therapy, a statistically significant increase in LVEF was recorded in group 1 by Δ 3.78% (t=15.892, p=0.000).

Intergroup differences between groups A and B in terms of LA size before (t=13.653, p=0.000), after treatment (t=8.103, p=0.004) are similar to the LA volume parameter before (t=79.854, p=0.000) and after (t=69.072, p=0.000) respectively.

Moreover, the dynamics are expressed by a decrease in the indicator by Δ 2.23 mm (t=9.591, p=0.002) and the indexed LA volume by Δ1.22 ml/m2 (t= 5.076, p=0.024) in the group with LVEF 41-49 %. Assessing intergroup differences in LA volume, a statistically significant difference is recorded not only between groups A and B both before (t= 82.924, p-0.000) and after treatment (t= 67.010, p=0.000), but also between groups 2 and 3 before (t=5.17, p=0.022) and after 2 years of observation (t=6.20 p=0.001). Similar changes are observed in LA i-volume, with a decrease during therapy (t = 5.189 p = 0.023) in group 1, with a statistical difference between groups 1 and 2 and 1 3 before and after treatment. According to echocardiography studies conducted in patients in the initial state and at the 2nd stage, the average values of EDR in patients from groups 1, 2 and 3 were, respectively, 5.69±0.71 5.8 [5.2, 6.1], 5.2 [4.9, 5.7], 4.9 [4.5, 5.3] cm.

The difference between the values obtained at each stage and the initial state turned out to be statistically significant ($^{1}\overline{\ }^{2}$t= 5.37, p= 0.02) and ($^{1}\overline{\ }^{3}$t= 26.03, p=0.00). There is a statistical difference between groups 2 and 3 ($^{2}\overline{\ }^{3}$ t= 4.72, p=0.03). In patients with ischemic heart disease and diabetes at identical stages of observation, similar data were obtained; they were 5.4 [5.1, 6.0], 5.2 [4.9, 5.5], 4.8 [4.5, 5.3] cm, respectively, while the intergroup differences for each corresponding stage of observation were statistically significant and the difference between groups 2 and 3 remained ($^{2}\overline{\ }^{3}$t= 6.72, p=0.01).

The results of the analysis of the initial average values of ESR and its dynamics in patients at the stages of observation during intergroup comparison turned out to be similar. In groups 2 and 3, there is a difference both before ($^{2}\overline{\ }^{3}$ t=7.36, p= 0.007) and during therapy ($^{2}\overline{\ }^{3}$ t=5.17, p=0.02). In all three studied groups, no statistically significant changes were observed compared to the initial state (P for all cases >0.1).

Table 1.

EchoCG and LVDP parameters in patients with coronary artery disease with diabetes mellitus-2 with different categories of LVEF at the stages of observation. (M±ð, M (Q1-Q3).

		ΦB>50, n-70 Group V		
Index/ Visit	ΦB <50, n-60 Group A (1)	H2FPEF, P>50% (N=23) (2)	H2FPEF, P<50% (N=47) (3)	(t, P)
EF% / 1, 2	45.32±2.78 45.2 [43.2, 47.8]	60.59±2.30 60.0 [59.0, 61.7]	60.86±2.37 60.0 [60.0, 62.8]	1¯249.29, 0.00 1¯378.55, 0.00
	49.18±5.52 47.9 [45.2, 54.3]	59.58±6.04 61.0 [59.8, 61.8]	60.66±3.87 60.4 [59.1, 62.0]	1¯234.70, 0.00 1¯366.20, 0.00
(t, P) 1st and 2nd visit	15.892, 0.000	0.070, 0.792	0.117, 0.732	
LP, mm / 1, 2	4.06±0.56 4.0 [3.7, 4.2] (N=60)	3.81±0.24 3.8 [3.6, 4.0] (N=23)	3.76±0.21 3.7 [3.6, 4.0] (N=47)	1¯24.979, 0.026 1¯312.85, 0.000
	3.91±0.56 3.8 [3.6, 4.2] (N=60)	3.73±0.22 3.8 [3.5, 3.9] (N=23)	3.63±0.20 3.6 [3.5, 3.8] (N=47)	1¯38.86, 0.003 2¯32.905, 0.088
	2.493, 0.114	1.360, 0.244	6.352, 0.012	
LA volume, ml / 1, 2	61.10±5.31 60.0 [59.0, 64.0]	47.35±6.44 46.0 [40.5, 54.0]	43.55±7.55 41.0 [38.0, 50.0]	1¯244.37, 0.00 1¯366.35, 0.00 2¯35.17, 0.02
	58.83±5.66 58.0 [55.0, 61.2]	46.61±7.41 45.0 [40.0, 53.0]	42.53±8.11 39.0 [36.0, 48.5]	1¯231.05, 0.00 1¯355.51, 0.00 2¯36.20, 0.01
(t, P) 1st and 2nd visit	9.519, 0.002	0.329, 0.566	1.527, 0.217	
	30.85±2.89 30.5 [29.0, 32.5]	22.89±2.69	23.15±3.42 23.1 [20.6, 24.7]	1¯245.64, 0.00

ind. LA volume, ml/m2/ 1, 2		22.5 [20.8, 24.5]		1¯3 61.66, 0.00
	29.62±3.02 29.3 [28.0, 32.0]	22.65±3.40 22.4 [20.2, 25.6]	22.60±3.68 22.0 [20.4, 23.7]	1¯2 36.77, 0.00 1¯3 54.95, 0.00
(t, P) 1st and 2nd visit	5.189, 0.023	0.314, 0.575	1.244, 0.265	
CDR cm/ 1, 2	5.69±0.71 5.8 [5.2, 6.1]	5.31±0.66 5.2 [4.9, 5.7]	5.83±6.24 4.9 [4.5, 5.3]	1¯2 5.37, 0.02 1¯3 26.03, 0.00 2¯3 4.72, 0.03
	5.53±0.66 5.4 [5.1, 6.0]	5.30±0.55 5.2 [4.9, 5.5]	4.91±0.57 4.8 [4.5, 5.3]	1¯2 2.93, 0.08 1¯3 21.53, 0.00 2¯3 6.72, 0.01
(t, P) 1st and 2nd visit	2.130, 0.144	0.001, 0.974	0.074, 0.785	
DAC cm/ 1, 2	4.20±0.66 4.2 [3.7, 4.7]	3.55±0.56 3.4 [3.2, 3.8]	3.17±0.43 3.2 [2.8, 3.5	1¯2 15.69, 0.00 1¯3 49.89, 0.00 2¯3 7.36, 0.007
	4.08±0.65 4.0 [3.5, 4.6]	3.64±0.53 3.4 [3.3, 4.0]	3.20±0.47 3.2 [2.8, 3.5]	1¯2 44.37, 0.00 1¯3 66.35, 0.00 2¯3 5.17, 0.02
(t, P) 1st and 2nd visit	1.605, 0.205	0.167, 0.683	0.083, 0.773	

With a natural intergroup difference in LV mass and indexed LVMM volume, a statistically significant decrease was recorded in the group of patients with moderately reduced LVEF (Group A) Δ 26.68 (t=3.630, p=0.057) and Δ 13.6 (t=5.285, p=0.022) respectively. There was a difference in LV mass in groups 2 and 3 (divided by H2FPEF scale) 232.5 [207.8, 283.1] versus 211.1 [175.0, 235.0] (t=5.73, p=0.01) at baseline. At the observation stage, a decrease in the LV mass parameter

was recorded in groups 2 (t=0.679, p=0.410) and 3 (t=0.394, p=0.530), but the intergroup difference was not significant (t=0.394, p=0.530). According to the LV myocardial mass index, there was an intergroup difference of 1 and 2 (t=8.94, p=0.003), 1 and 3 groups before (t=20.8, p=0.000), respectively, and after 2 years of observation[1¯2] (t=5.52, p =0.019) and [1¯3](t=11.1, p=0.001), respectively. The most interesting are the identified intragroup differences when analyzing the parameters of the right atrium and pulmonary artery SBP (PA SBP). In the absence of changes in the dynamics of observation (2 years), PP and SBP of the LA in A (t = 0.285, p = 0.593) and (t = 0.082, p = 0.775) and in groups (t = 0.012, p = 0.912) and (t =0.118, p=0.731) significant differences were revealed between 2 and 3 groups in patients with preserved LVEF with different probability of HF according to the analyzed H2FPEF scale. Thus, in patients with type 2 diabetes with coronary artery disease, the PP index in group 2 before treatment was 3.1 [3.0, 3.4] mm versus group 3 2.7 [2.3, 3.2] mm[2¯3] (t = 5.73, p = 0.01), respectively, continuing to maintain this a tendency to difference after 2 years of observation 3.2 [2.8, 3.5] mm - 2.8 [2.5, 3.1][2¯3](t= 5.66, p=0.01), respectively. Similar differences can be seen in LA SBP indicator, group 2 before treatment 28.0 [17.0, 30.0] mm versus group 3 23.0 [16.0, 28.0][2¯3](t=1.690, p=0.694), clearly manifested at the stage of therapy 26.0 [21.5, 30.5] versus group 3 24.0 [16.5, 28.0] [2¯3](t=3.1, p=0.074) due to differences in outcome indicators.

Table 2.

EchoCG and LVDP parameters in patients with coronary artery disease with diabetes mellitus-2 with different categories of LVEF at the stages of observation. (M±ð, M (Q1-Q3).

		FV>50, n-70 V group		
	EF <50, n-60 A group (1)	H2FPEF, P>50% (N=23) (2)	H2FPEF, P<50% (N=47) (3)	(t, P)
LV mass, g/m2,/ 1, 2	292.28±93.11 297.6 [237.5, 337.1]	249.83±62.00 232.5 [207.8, 283.1]	212.34±57.87 211.1 [175.0, 235.0]	[1¯2]5.28, 0.021 [1¯3]23.18, 0.00 [2¯3]5.734, 0.01
	265.60±81.49 260.5 [205.1, 305.8]	236.46±59.16 222.7 [195.7, 273.5]	207.54±66.15 200.1 [164.0, 249.9]	[1¯3]14.39, 0.00
(t, P) 1st and 2nd visit	3.630, 0.057	0.679, 0.410	0.394, 0.530	
LVM index/ 1, 2	146.20±42.17 149.3 [119.0, 169.0]	121.03±31.04 115.9 [100.1, 127.7]	112.59±26.57 111.1 [94.4, 126.8]	[1¯2]8.948, 0.003 [1¯3]20.82, 0.000

	132.64±37.64, 126.3 [108.1, 156.4]	115.56±32.80 104.0 [96.3, 123.9]	109.58±30.43 106.3 [89.0, 131.6]	1‾2 5.524, 0.019 1‾3 11.11, 0.001
(t, P) 1st and 2nd visit	5.285, 0.022	0.956, 0.328	0.463, 0.496	
PP, cm-/ 1, 2	3.41±0.65 3.4 [3.0, 3.6]	3.10±0.40 3.1 [3.0, 3.4]	2.83±0.76 2.7 [2.3, 3.2]	1‾2 4.81, 0.028 1‾3 23.5, 0.000 2‾3 5.73, 0.01
	3.46±0.69 3.5 [3.0, 3.8]	3.13±0.53 3.2 [2.8, 3.5]	2.85±0.76 2.8 [2.5, 3.1]	1‾2 3.37, 0.066 1‾3 22.9, 0.000 2‾3 5.66, 0.01
(t, P) 1st and 2nd visit	0.285, 0.593	0.341, 0.559	0.149, 0.699	
MPAP, mm Hg / 1, 2	29.10±9.48 28.0 [24.0, 33.2]	25.22±9.24 28.0 [17.0, 30.0]	22.17±7.12 23.0 [16.0, 28.0]	1‾3 14.3, 0.000
	29.83±7.84 28.0 [26.0, 32.2]	25.91±7.05 26.0 [21.5, 30.5]	22.19±7.09 24.0 [16.5, 28.0]	1‾2 4.34, 0.037 1‾3 20.8, 0.000 2‾3 3.19, 0.074
(t, P) 1st and 2nd visit	0.082, 0.775	0.001, 0.974	0.000, 0.991	

It is noteworthy that the main indicators of LVDP with a fairly high statistically significant power respond to therapy in the dynamics of observation: the average peak speed of early diastolic movement of the septal and lateral parts of the mitral fibrous ring (e`average) in 1 ↑Δ 0.2 cm/sec (t=12.702, p=0.000) ↑Δ 0.19 cm/sec (t=4.879, p=0.027) in 2 groups [7].

The average index of early diastolic filling of the LV (E/e`) at the beginning of observation had pronounced differences between groups (t=9.917, p=0.002) and at the stage (t=3.996, p=0.046).

The severity of index recovery was noted in both groups 1 (t=21.526, p=0.000) and 2 (t=10.374, p=0.001).

Table 3.

EchoCG and LVDP parameters in patients with coronary artery disease with diabetes mellitus-2 with different categories of LVEF at the stages of observation. (M±σ, M (Q1-Q3).

		FV>50, n-70 V group		
Index/ Visit	EF <50, n-60 A group (1)	H2FPEF, P>50% (N=23) (2)	H2FPEF, P<50% (N=47) (3)	(t, P)
E m/sec/ 1.2	0.73±0.19 0.7 [0.6, 0.9]	0.63±0.07 0.6 [0.6, 0.7]	0.61±0.06 0.6 [0.6, 0.7]	1¯³6.312, 0.012
	0.69±0.17 0.6 [0.5, 0.9]	0.61±0.05 0.6 [0.6, 0.6]	0.58±0.05 0.6 [0.6, 0.6]	1¯³6.930, 0.008 2¯³6.011, 0.014
(t, P) 1st and 2nd visit	3.500, 0.061	1.776, 0.183	8.636, 0.003	
A m/sec/1.2	0.75±0.10 0.7 [0.7, 0.8]	0.84±0.10 0.8 [0.8, 0.9]	0.81±0.09 0.8 [0.8, 0.8]	1¯²10.34, 0.001 1¯³9.024, 0.003
	0.76±0.11 0.8 [0.7, 0.8]	0.84±0.08 0.8 [0.8, 0.9]	0.81±0.07 0.8 [0.8, 0.9]	1¯²10.08, 0.001 1¯³7.465, 0.006
(t, P) 1st and 2nd visit	0.237, 0.626	0.269, 0.604	0.163, 0.687	
E/A / 1, 2	1.02±0.37 0.8 [0.8, 1.4]	0.75±0.06 [0.8 [0.7, 0.8]	0.75±0.05 0.8 [0.7, 0.8]	1¯²7.08, 0.008 1¯³12.1, 0.000
	0.94±0.34 0.8 [0.7, 1.3]	0.72±0.05 0.7 [0.7, 0.8]	0.71±0.05 0.7 [0.7, 0.7]	1¯²6.57, 0.010 1¯³16.7, 0.000
(t, P) 1st and 2nd visit	6.725, 0.010	6.727, 0.009	15.830, 0.000	
e septal, cm/sec / 12	5.87±0.42 5.8 [5.5, 6.2]	5.79±0.31 5.7 [5.5, 6.0]	5.74±0.36 5.7 [5.5, 6.0]	
	6.05±0.36 6.0 [5.7, 6.3]	5.93±0.33 5.9 [5.7, 6.1]	5.92±0.37 5.9 [5.5, 6.2]	
(t, P) 1st and 2nd visit	5.631, 0.018	1.695, 0.193	5.117, 0.024	
e lateral cm/sec / 12	8.16±0.68 8.0 [7.8, 8.6]	8.09±0.45 8.1 [7.8, 8.4]	8.10±0.39 8.1 [7.8, 8.3]	

	8.35±0.64 8.3 [8.0, 8.8]	8.28±0.45 8.3 [8.0, 8.6]	8.40±0.40 8.5 [8.2, 8.7]	
(t, P) 1st and 2nd visit	3.465, 0.063	2.093, 0.148	13.204, 0.000	
e average, cm/s / 12	7.02±0.47 7.0 [6.7, 7.5]	6.94±0.34 7.0 [6.7, 7.1]	6.92±0.32 6.9 [6.7, 7.1]	
	7.20±0.41 7.2 [6.9, 7.5]	7.10±0.35 7.0 [6.9, 7.3]	7.16±0.31 7.2 [7.0, 7.4]	
(t, P) 1st and 2nd visit	4.527, 0.033	1.892, 0.169	11.946, 0.001	
E/e' / 1, 2	10.38±2.20 9.8 [8.6, 12.9]	9.09±0.92 9.3 [8.5, 9.7]	8.84±0.93 8.8 [8.2, 9.6]	1¯3 10.8, 0.001
	9.23±1.97 8.7 [7.5, 10.4]	8.52±0.62 8.7 [8.3, 8.9]	8.08±0.66 8.1 [7.6, 8.5]	1¯3 6.27, 0.012 2¯3 7.02, 0.008
(t, P) 1st and 2nd visit	9.901, 0.002	7.422, 0.006	17.775, 0.000	
1 Degree LVDD [1]	65.0% (39)	100.0% (23)	100.0% (47)	
	71.7% (43)	100.0% (23)	100.0% (47)	
(t, P) 1st and 2nd visit	inf, 0.000	inf, 0.000	inf, 0.000	
2 Degree LVDD	35.0% (21)	0.0% (0)	0.0% (0)	
	28.3% (17)	0.0% (0)	0.0% (0)	
(t, P) 1st and 2nd visit	1.312 0.252	inf, 0.000	inf, 0.000	

Changes were identified in indicators that determine structural changes according to the recommendations of the ESC and RKO/OSSN/RNMOT in the parameter i-LVMM (t=7.677, p=0.006) between groups 1 and 2 (and groups 2 and 3 (t=5.53, p=0.01) .

Indicators, the presence of which determines structural changes according to the recommendations of the ESC and RKO/OSSN/RNMOT*

Index	EF <50% (1)	EF>50% P>50% (2)	EF>50% P<=50% (3)	t, p 1 co 2	t, p 1 c 3	t, p 2 c 3
LA I-volume (>34 ml/m2)	18.3% (11)	0.0% (0)	0.0% (0)	inf, 0.000	inf, 0.000	nan, nan
I-LVMM	38.3% (23)	52.2% (12)	40.4% (19)	7.677 0.006	0.182, 0.670	5.53, 0.01
M≥115/F≥95 e aver< 9 cm/s	100.0% (60)	100.0% (23)	100.0% (47)	nan, nan	nan, nan	nan, nan
E/e ≥13	25.0% (15)	0.0% (0)	0.0% (0)	inf, 0.000	inf, 0.000	nan, nan

Conclusion. In the initial echocardiographic indicators of intracardiac hemodynamics, a statistically significant difference was revealed between groups A and B. At the observation stage, patients in group A recorded a statistically significant increase in LVEF (p = 0.000), a decrease in LA volume (p = 0.002), and LVMM (p = 0. 05), LVMM index (p=0.02). the ratio of early and late mitral velocity E/A showed a significant decrease (t=6.725, p=0.010). The dynamics of the indicator of the speed of movement of the lateral sections of the fibrous ring of the mitral valve in the early diastole phase is noted, e average (t = 4.527, 0.033). It is noteworthy that the main indicators of LVDP with a fairly high statistically significant power respond to therapy in the group with LVEF 41-49%. These include a decrease in: LA volume (p=0.002), indexed LA volume (p=0.024), LVMM index (p=0.024), E/A in both groups (t==0.000 and p=0.007), transmitral velocity ratio and transtricuspid flow in early diastole to the speed of movement of the lateral part of the fibrous ring of the mitral and tricuspid valves in both groups E/e` (t==0.000, and p=0.001). The parameter of the ratio of the peak velocity of mitral inflow during early diastole (E) to the average velocity of the septal and lateral mitral annular early diastolic peak (e') - E/e' reflects the LV filling pressure, and the parameters are found in the “gray zone” and decrease (t =9.901, 0.002), which indirectly indicates an improvement in diastolic function.

In patients of group B, to determine the probability of HF using the H2FPEF scale, differences were identified in the following initial indicators between groups 2 and 3: LA volume (t==5.17, 0.02). ESR (t==4.72, p=0.03), ESR (t==7.36, p=0.007), LVMM (t==5.734, p=0.01). PP (t==5.73, p=0.01), PA SBP (t==3.19, p=0.07) retaining their direction at the observation stage.
The values of LVDP between groups 2 and 3 at the outcome differed in the E/e` indicator (t==7.02, p=0.008), due to the E parameter (t==6.011, and p=0.01). At the observation stages, positive dynamics were recorded on the part of E/A in groups 2 (t==6.727, p=0.009) and 3 (t==15.830, p=0.000), E/e' (t==7.422, p=0.006) and (t==17.775, p=0.000) respectively.

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