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ORIGINAL ARTICLE

Achieving lipid goals in type 2 diabetic patients with dyslipidemia: barriers to treatment—the patient perspective

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Abstract

Objective Statin treatment compliance and achieving target levels differ between populations. This study aimed to determine the status of achieving the lipid targets and evaluate patients' compliance to statin treatment in type 2 diabetic patients with dyslipidemia.

Method This cross-sectional study included type 2 diabetes mellitus (T2DM) patients with dyslipidemia who applied for treatment at our polyclinics. Statin compliance was evaluated using the Modified Morisky Adherence Scale (MMAS-8) through a face-to-face interview. Cardiovascular (CV) risk was calculated according to the 2019 ESC (European Society of Cardiology) criteria by evaluating the patients' individual risk factors. LDL targets were determined according to risk categories with the same criteria.

Results A total of 504 patients (F/M: 274/230) were included. The serum LDL levels were 102.6 ± 39.2 mg/dL. Of the patients, 56.1% were under statin treatment. CV risk was very high in 73.6% of patients. LDL levels were significantly lower in users than in non-users (91.2 ± 26.0, 117.3 ± 38.4, $p < 0.0001$). The rate of reaching the LDL target was 14.8% in statin users. Treatment compliance was low for 40.6% of statin users. Discontinuation of statin treatment due to side effects was 15.7% ($n = 14$). $N = 49$ patients willingly discontinued statin treatment. They reported that 40.8% considered the treatment unnecessary.

Conclusion It was observed that 56.1% of type 2 diabetic patients were on statin therapy. A small percentage of them 14.8% ($n = 42$) reached the LDL target. Statin non-compliance and a lack of awareness of the statin treatment are the main reasons for high LDL levels in type 2 diabetic patients.

Keywords Diabetes mellitus · Hyperlipidemia · Medication adherence · Statin

Introduction

Hyperlipidemia is a major cardiovascular risk factor that is observed in 60–97% of type 2 diabetic patients [1, 2]. Primary and secondary CV prevention studies on statin therapy demonstrated significant benefits in cardiovascular protection in hyperlipidemic patients with T2DM [3]. As diabetes is accepted as equal to cardiovascular disease, guidelines recommend a lower LDL target for diabetic patients and moderate- and high-intensity statin therapy for patients with LDL levels above target. However, the rates of achieving LDL targets differ between populations. According to the National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III) data, it is known that 70–80% of diabetic dyslipidemic patients cannot reach the recommended targets even in developed countries [4]. In the EUROASPIRE study, 33% of patients achieved their LDL target [5]. In the data of the Turkish arm of the CEPHEUS study, the rate of reaching the LDL target was found to be 35.1% [6]. Although there is strong evidence for statin treatment in the primary and secondary prevention of diabetes, there are concerns among patients and physicians about the initiation and continuation of statin therapy. Drug compliance is one of the major barriers to achieving LDL targets. Statin compliance studies show that more than 50% of

Highlights
- In diabetic patients, the LDL targets specified by the guidelines cannot be achieved.
- In diabetic patients, compliance with statin therapy is low.
- Diabetic patients consider statin therapy unnecessary.

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patients discontinued treatment in the first year, and statin adherence decreased to 25% [7–9]. The aim of this study was to determine the usage frequency of statin therapy, habits of use, and treatment compliance in patients with T2DM and to reveal the barriers to reaching target LDL levels.

Materials and methods

Study Design

The study was designed as a cross-sectional survey. Five hundred and four patients who applied to Pendik Training and Resarch Hospital of Marmara University School of Medicine for treatment at internal medicine, endocrinology, and cardiology outpatient clinics between November 2020 and August 2021 were included. Inclusion criteria were defined as the patient's diagnosis of T2DM for at least 1 year and diabetic dyslipidemia. Exclusion criteria were defined as the patient's diagnosis of malignancy, pregnancy, or being in the lactation period.

Demographic and clinical data collected through face-to-face interviews were with the patients and the patients' files. Medication history, the patient's statin use, dosage, duration, side effects, and smoking and alcohol habits were questioned. A questionnaire was completed for compliance with statin therapy. The duration of diabetes and hyperlipidemia, medications, and comorbid conditions were collected from patients' files. The total number of drugs used per day was recorded. Height was measured using a stadiometer to the nearest 0.5 cm. Bodyweight was measured using a digital electronic scale closest to 0.1 kg. BMI was calculated by dividing the weight in kilograms by the square of the height in meters.

Laboratory evaluation

Laboratory data from the last 3 months (fasting plasma glucose (FPG), HbA1c, total cholesterol (TC), high-density lipoprotein (HDL), LDL, and triglyceride (TG)) was recorded retrospectively from the patient's file.

Fasting blood glucose was studied with the Cobas 8000 Chemistry Analyzer Series (Roche Diagnostics, Switzerland) using an enzymatic method with hexokinase. HbA1c was studied with the premier Hb9210 (Trinity Biotech) by the boronate affinity chromatography method. The enzymatic colorimetric method studied TC, HDL, LDL, and TG with the Cobas 8000 Chemistry Analyzer Series (Roche Diagnostics, Switzerland).

CV risk calculation

Cardiovascular risk calculation was done according to the 2019 ESC "Diabetes, prediabetes, and cardiovascular diseases guideline" [10]. Each patient was divided into cardiovascular risk categories of moderate, high, and very high. Young patients with DM duration < 10 years with no risk factors were included in the moderate-risk group. Patients with DM duration ≥ 10 years without target organ damage plus any other additional risk factor were included in the high-risk group. Patients with DM and cardiovascular disease or other target organ damage, or three or more major risk factors were included in the very high-risk group. Using the same guideline, individual LDL targets (< 100 for the moderate-risk group, < 70 for the high-risk group, and < 55 for the very high-risk group) and whether the patient reached the LDL target were determined.

Evaluation of statin compliance

The 8-item Morisky Medication Adherence Scale (MMAS-8) questionnaire was used for determining statin compliance. It is a scale that evaluates drug use behaviors with eight questions based on the patient's self-report. This scale has been validated in Turkish studies [11–13]. The total score of the questionnaire was 8, with 1 point for each question; the high-compliance group had 8 points, the medium-compliance group had 6 to 8, and the low-compliance group had < 6 [14]. Patients were also asked whether they were aware they had hyperlipidemia and had been offered statin therapy before. Answers were recorded as yes or no.

Statistical methods

Continuous variables were summarized using descriptive statistics presented as the mean and standard deviation (SD). Categorical variables were summarized using counts and percentages. Categorical data was analyzed using the chi-square (χ^2) test. The independent *T* test and ANOVA test were used for the parametric variables. A value of $p < 0.05$ was considered statistically significant. All statistical analyses were performed using the software Graphpad Instat.

Results

Clinical and demographic characteristics of type 2 diabetic patients are given in Table 1. A total of 504 patients, including 274 (54.3%) women and 230 (45.6%) men, were included in the study. The mean duration of diabetes mellitus (DM) among the patient was 12.3 ± 7.2 years, and 54.5% of them were on insulin therapy. The duration of DM was longer in female patients than in male patients ($p = 0.0144$). Macrovascular complications were more common in male patients than female patients. The mean BMI was 32.8 ± 6.9 kg/m^2 in the entire group, which was higher in female patients than in male patients ($p < 0.0001$). Fasting blood glucose was higher in male patients than in female patients. The mean LDL was

Table 1 Clinical and demographic characteristics of type 2 diabetes mellitus patients

Parameters	Total T2DM patients ($n=504$)	Female T2DM patients ($n=274$, 54.3%)	Male T2DM patients ($n=230$, 45.6%)	p value
Age (years)	58.2 ± 9.2	58.1 ± 9.2	58.2 ± 9.2	0.995
DM duration (years)	12.3 ± 7.2	13 ± 7.4	11.5 ± 6.9	0.0144
Insulin use, *n* (%)	275 (54.5)	152 (55.4)	123 (53.4)	0.7200
Macrovascular complications				
CAD, *n* (%)	127 (25.1)	48 (17.5)	79 (34.3)	< 0.0001
CKD, *n* (%)	54 (10.7)	23 (8.3)	31 (13.4)	0.0904
BMI (kg/m^2)	32.8 ± 6.9	34.5 ± 7.1	30.8 ± 6.2	< 0.0001
FPG (mg/dL)	154.7 ± 67.7	150.6 ± 68.4	159.5 ± 66.7	0.0336
HbA1c (%)	7.9 ± 2.0	7.7 ± 1.9	8.0 ± 2.1	0.0750
TC (mg/dL)	183.5 ± 51.0	192.0 ± 52.9	173.4 ± 46.7	< 0.0001
HDL (mg/dL)	44.6 ± 11.7	47.5 ± 12.6	41.2 ± 9.4	< 0.0001
LDL (mg/dL)	102.6 ± 39.2	107.9 ± 42.6	96.5 ± 33.8	0.0060
TG (mg/dL)	190.0 ± 178.2	194.0 ± 175.0	183.6 ± 182.3	0.1805

Continuous data were presented as mean and standard deviation (SD), and categorical data were presented as numbers (%). Differences between female and male individuals were analyzed using the independent *T* test and chi-square test for categorical data

T2DM type 2 diabetes mellitus, *DM* diabetes mellitus, *CAD* coronary artery disease, *CKD* chronic kidney disease, *BMI* body mass index, *FBG* fasting plasma glucose, *TC* total cholesterol, *HDL* high-density lipoprotein, *LDL* low-density lipoprotein, *TG* triglyceride

102.6 ± 39.2 mg/dL in the entire group; it was higher in the female patients than in the male patients ($p=0.006$).

Of the patients, 56.1% were using statins. A comparison of demographic and clinical data between statin users and non-users is shown in Table 2. Statin users were older ($p=0.0004$). DM duration was longer ($p=0.0014$), and CAD frequency was higher ($p<0.0001$) in statin users than non-users. The mean LDL was lower in the statin users than in the non-users ($p<0.0001$). Of the non-users, 32.1% ($n=71$) had a high CV risk, and 66% ($n=146$) had a very high CV risk. The rates of achieving LDL targets were 14.8% in statin users, 4% in non-users, and significantly higher in statin users ($p<0.0001$).

Clinical data according to CV risk categories is shown in Table 3. The mean LDL levels were similar in the moderate-, high-, and very high-risk groups. Patients categorized in the very high-risk group were older ($p<0.0001$) and had a longer duration of diabetes ($p<0.0001$) compared to patients in the high-risk and moderate-risk groups. The statin use rate was higher (60.6%) in the very high-risk group than in the high- and moderate-risk groups. Of the patients, 16.1% were receiving high-intensity statin treatment. The number of daily drugs they used was higher in the very high-risk group than in the other groups.

Table 4 shows the statin treatment duration, intensity, and compliance results. The patients' mean duration of statin use ($n=283$) was 6.9 ± 6.2 years, and 75.9% of them were on moderate-intensity statin treatments. Although 86.2% of the patients stated that they used statin therapy regularly, only 17.6% showed high compliance, according to the MMAS-8 questionnaire.

Statin users were evaluated according to statin compliance (Table 5). The high-compliance group has lower LDL ($p=0.0216$), lower HbA1c ($p=0.001$), lower BMI ($p=0.0039$), and the highest age ($p=0.0005$) compared to other groups.

A group of 221 patients (43.8%) were not using statin treatment. When questioned, 18% ($n=91$) of the patients did not know that they had hyperlipidemia, and 22.4% ($n=113$) of them self-reported that they had not been offered a statin treatment before. The remainder of patients, 17.6% ($n=89$) used statins before but quit treatment for different reasons. Figure 1 shows the reasons for discontinuing treatment in the group who quit statin therapy. 43.8% of patients stopped the statin treatment following doctors' orders, 55% stopped under their own free will, and 0.1% stopped for unknown reasons. The two main reasons for dropout from statin treatment due to patients' willingness were that they decided treatment was unnecessary (40.8%) or they were using multiple drugs (36.7%). Proven side effects were found in 17.9% of the patients, while 14.2% of patients attributed muscle, gastrointestinal, and headache side effects to statin treatment as a reason to stop the treatment.

Discussion

Patients with T2DM are often accompanied by a lipid abnormality, even if they have good glycemic control. In the coexistence of both clinical conditions, CV risk is thought to be higher and is associated with increased morbidity and

Table 2 Comparison of patients using and not using statins

Parameters	Statin users ($n=283$, 56.1%)	Statin non-users ($n=221$, 43.8%)	p value
Age (years)	59.5 ± 8.5	56.4 ± 9.8	0.0004
Sex			
Female	155 (54.7)	119 (53.8)	0.9072
Male	128 (45.2)	102 (46.1)	
BMI (kg/m^2)	33.1 ± 7.2	32.5 ± 6.5	0.4655
DM duration (years)	13.3 ± 7.3	11.2 ± 6.8	0.0014
Macrovascular complications			
CAD, *n* (%)	101 (35.6)	26 (11.7)	< 0.0001
CKD, *n* (%)	28 (9.8)	26 (11.7)	0.5622
Number of drugs (*n*)	8.0 ± 3.2	5.2 ± 2.7	< 0.0001
Blood parameters			
FPG (mg/dL)	152.2 ± 62.5	157.9 ± 73.9	0.8376
HbA1c (%)	7.8 ± 1.8	8.0 ± 2.2	0.6180
TC (mg/dL)	169.4 ± 44.3	201.5 ± 53.4	< 0.0001
HDL (mg/dL)	43.5 ± 10.6	46.1 ± 12.8	0.0496
LDL (mg/dL)	91.2 ± 26.0	117.3 ± 38.4	< 0.0001
TG (mg/dL)	183.9 ± 148.1	197.9 ± 210.6	0.8775
CV risk category			
Moderate risk	4 (1.4)	4 (1.8)	0.0029
High risk	54 (19)	71 (32.1)	
Very high risk	225 (79.5)	146 (66)	
LDL target reaching status			
On-target	42 (14.8)	9 (4)	< 0.0001
Off-target	240 (84.8)	210 (95)	

Continuous data were presented as mean and standard deviation (SD), and categorical data were presented as numbers (%). Differences between female and male individuals were analyzed using the independent *T* test and chi-square test for categorical data

BMI body mass index, *DM* diabetes mellitus, *CAD* coronary artery disease, *CKD* chronic kidney disease, *FBG* fasting plasma glucose, *TC* total cholesterol, *HDL* high-density lipoprotein, *LDL* low-density lipoprotein, *TG* triglyceride, *CV* cardiovascular

mortality, so it is very important to determine treatment targets well. Statins are the most important antihyperlipidemic agents with proven safety and efficacy in the prevention of atherosclerotic cardiovascular disease. Despite this, studies conducted with T2DM showed that 44–67% of patients could not reach the recommended treatment goals [15, 16]. According to the National Cholesterol Education Program-Adult Treatment Panel III (NCEP-ATP III) data, it is known that 70–80% of diabetic dyslipidemic individuals cannot reach the recommended targets, even in developed countries [4]. In the EUROASPIRE study conducted in Europe, it was reported that 33% of the patients had the desired target LDL level [17]. According to the data from the Turkish arm of the CEPHEUS study investigating the target LDL level in patients using statins, the rate of reaching the LDL target was 35.1% [18]. In our study, the rate of reaching the LDL target value in statin users was 14.8%, which was lower than the literature data. Of the $n=504$ patients who applied to our hospitals' outpatient clinics with the diagnosis of T2DM and dyslipidemia, 56.1% were under statin treatment, 26.1% had never used statins before, and 17.6% had discontinued statin therapy. Only 17.6% ($n=50$) of patients using statins had high compliance. The plasma LDL value of 84.8% ($n=240$) of the patients using statins was higher than the target LDL value determined for that individual; in other words, patients were undertreated. The results obtained from our study show that the rate of compliance with statin therapy in type 2 diabetic patients and reaching lipid targets is low. Our study's lower target realization rates may be because the target values determined in the current guidelines are lower than the previous ones.

Patients' knowledge and drug compliance are important in initiating and continuing statin therapy. It is known that there are problems with compliance with statin treatment in Turkey and the rest of the world. Insufficient knowledge of the patients' diseases and their treatments, the development of side effects or the fear of their development, the fact that the patients use multiple drugs due to their comorbidities, public perception, and prescription/report problems can cause treatment non-compliance. As a result of MMAS-8 performed to evaluate compliance with statin therapy, 40.6% of our patients showed low compliance, 41.6% moderate compliance, and 17.6% high compliance. Considering the mean age, it was seen that the patients in the high-compliance group were older than the patients in the moderate- and low-compliance groups. At the same time, the metabolic data of the patients in this group is better due to the lower body mass index and mean TC, LDL, and HbA1c.

In the EPHESUS study, which is a multicenter study conducted in Turkey, it was observed that 52.6% of the patients did not know that they had hyperlipidemia [19]. In our study, 18% ($n=91$) of the patients did not know that they had hyperlipidemia. This low rate may be due to fact that the hospital where the study was conducted was a third-level center and the patients were under follow-up.

In a study by Ergin et al., in a single center, 45.3% of patients who were started on statin treatment stated that they used it irregularly [20]. In our study, 13.7% of patients using statins stated that they used statin therapy irregularly. The majority (38.4%) of the group who used the treatment irregularly said they took it when they thought of it. It was determined that they received the treatment at lower rates: once every 2 days, after heavy meals, and twice a week. Although our irregular use rate seems low, 38.1% of the patients who stated that they use it regularly show low compliance, 42.6% moderate compliance, and 19.2% high compliance.

Physicians' hesitations in the application of statin treatment seem to be an obstacle to the initiation of treatment. Their doctors did not recommend statin treatment to 82.5%

Table 3 Clinical and demographic parameters according to cardiovascular risk in type 2 diabetes mellitus patients

Parameters	Moderate risk ($n=8$, 0.01%)	High risk ($n=125$, 24.8%)	Very high risk ($n=371$, 73.6%)	p value
Age (years)	44.6 ± 4.2	55.3 ± 9.6	59.4 ± 8.7	< 0.0001
Sex				
Female	2 (25)	61 (48.8)	211 (56.8)	0.0713
Male	6 (75)	64 (51.2)	160 (43.1)	
BMI (kg/m^2)	25.8 ± 3	30.3 ± 6.5*	33.8 ± 6.8**	< 0.0001
DM duration (years)	5.0 ± 1.6	10.6 ± 6.0	13.1 ± 7.4	< 0.0001
Insulin use	2 (25)	55 (44)	218 (58.7)	0.0039
Statin use				
User	4 (50)	54 (43.2)	225 (60.6)	
Never use	4 (50)	55 (44)	74 (19.9)	< 0.0001
Quit	0 (0)	16 (12.8)	72 (19.4)	
Statin intensity				
Low	0 (0)	0 (0)	4 (10.7)	
Moderate	4 (50)	52 (41.6)	161 (43.3)	0.0028
High	0 (0)	2 (1.6)	60 (16.1)	
Total number of drugs (n)	3.1 ± 2.1	4.9 ± 2.4^	7.5 ± 3.2^^	< 0.0001
LDL (mg/dL)	90.8 ± 15.4	99.7 ± 34.3	103.8 ± 41	0.7440
LDL target reaching status				
On-target	5 (62.5)	23 (18.4)	23 (6.1)	< 0.0001
Off-target	2 (25)	102 (81.6)	346 (93.2)	

Continuous data were presented as mean and standard deviation (SD), and categorical data were presented as numbers (%). Comparisons between the two groups were analyzed using the ANOVA test, and comparisons between the three groups were analyzed using the independent *T* test and chi-square test for categorical data

BMI body mass index, *DM* diabetes mellitus, *LDL* low-density lipoprotein

*$p > 0.05$ compared to the moderate-risk group

**$p < 0.001$ compared to the moderate- and high-risk groups

^$p > 0.05$ compared to the moderate-risk group

^^$p < 0.001$ compared to the moderate- and high-risk groups

Table 4 Statin treatment compliance of type 2 diabetes mellitus patients using statin therapy

Parameters	Statin users Total ($n=283$)	Statin users Female ($n=155$, 54.7%)	Statin users Male ($n=128$, 45.2%)	p value*
Duration of statin use (years)	6.9 ± 6.2	7.5 ± 6.8	6.1 ± 5.2	0.3668
Statin intensity				
Low	4 (1.4)	2 (1.2)	2 (1.5)	0.9413
Moderate	215 (75.9)	118 (76.1)	99 (77.3)	
High	64 (22.6)	35 (22.5)	27 (21)	
Statin use				
Regular	244 (86.2)	133 (85.8)	111 (86.7)	0.8639
Irregular	39 (13.7)	22 (14.1)	17 (13.2)	
Statin compliance according to MMAS-8 (n)				
Low	115 (40.6)	72 (46.4)	43 (33.5)	0.0766
Moderate	118 (41.6)	60 (38.7)	58 (45.3)	
High	50 (17.6)	23 (14.8)	27 (21)	

Continuous data were presented as mean and standard deviation (SD), and categorical data were presented as numbers (%). Differences between female and male individuals were analyzed using the independent *T* test and chi-square test for categorical data

MMAS-8 Modified Morisky Adherence Scale-8

Table 5 Comparison of patients using statins according to their statin treatment compliance

Parameters	Low compliance ($n=115$, 0.05%)	Moderate compliance ($n=118$, 41.6%)	High compliance ($n=50$, 17.6%)	p value
Age (years)	57.2 ± 8.5[a]	60.4 ± 7.7[b]	62.9 ± 9	0.0005
Sex				
Female	72 (62.6)	60 (50.8)	23 (46)	0.0766
Male	43 (37.3)	58 (49.1)	27 (54)	
BMI (kg/m^2)	34.5 ± 7.5[d]	32.6 ± 6.9[e]	31.1 ± 6.8	0.0039
DM duration (years)	13.9 ± 9.3	12.5 ± 7	13.7 ± 8.2	0.3046
Laboratory data				
HbA1c (%)	8.3 ± 2[m]	7.5 ± 1.7[n]	7.3 ± 1.4	0.001
LDL (mg/dL)	98.5 ± 38.8	86 ± 30.2	86.7 ± 39.5	0.0216
Total number of drugs (n)	8.2 ± 3	8 ± 3.3	7.3 ± 3.1	0.2456
Insulin use	78 (67.8)	71 (60.1)	24 (48)	0.0538
CV risk category				
Moderate	2 (1.7)	2 (1.6)	0 (0)	0.8608
High	24 (20.8)	21 (17.7)	9 (18)	
Very high	89 (75.4)	95 (80.5)	41 (82)	

Continuous data were presented as mean and standard deviation (SD), and categorical data were presented as numbers (%). Comparisons between the two groups were analyzed using the ANOVA test, and comparisons between the three groups were analyzed using the independent T test and chi-square test for categorical data

BMI body mass index, *DM* diabetes mellitus, *LDL* low-density lipoprotein, *TG* triglyceride, *CV* cardiovascular

[a]$p < 0.05$ compared to the medium-compliance group, $p < 0.01$ compared to the high-compliance group

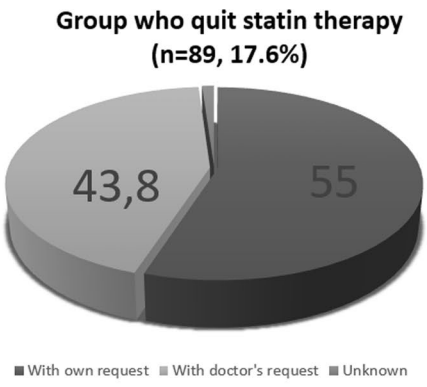
[b]$p > 0.05$ compared to the high-compliance group

[d]$p > 0.05$ compared to the medium-compliance group, $p < 0.01$ compared to the increased compliance group

[e]$p > 0.05$ compared to the increased compliance group

[m]$p < 0.01$ compared to the moderate- and high-compliance groups

[n]$p > 0.05$ compared to the high-compliance group



	With doctor's request (%) n=39
Told that the blood values are good	24 (61.5)
Not reported a spesific reason	8 (20.5)
Development of side effects	7 (17.9)
Liver	3 (42.8)
Muscle	2 (28.5)
Decreased libido	1 (14.2)
Headache	1 (14.2)

	With own request (%) n=49
Thinks treatment is unnecessary	20 (40.8)
Multiple drug use	18 (36.7)
Concern of side effects	14 (28.5)
Exposure the public perception	10 (20.4)
Prescription/report problem	8 (16.3)
Development of side effects	7 (14.2)
Gastrointestinal	5 (71.4)
Muscle	1 (14.2)
Headache	1 (14.2)

Fig. 1 Reasons for discontinuation of statin therapy

of our patient group who had never received statin treatment before. It is noteworthy that the rate of those in the group who were not recommended statin treatment was higher than the rate of those who refused. It is known that most patients in Turkey can stop their treatment without their doctors' knowledge.

In a study conducted by Yiğiner et al. on statin use, the rate of discontinuation of treatment without the knowledge of their doctor was 56.2%, and in a study by Tokgözoğlu et al., it was 73.7% [21, 22]. Patients discontinuing statin therapy without their doctor's knowledge may result from inadequate visits.

Although the frequency of statin-related side effects appears to be low in randomized controlled studies, real-life data show that the frequency of side effects can reach 30% [23]. In the study of Tokgözoğlu et al., the reason for the discontinuation of statin treatment was primarily liver-related side effects, and the rate of discontinuation of treatment was 13.9% because they considering the treatment unnecessary [22]. In a study by Kocas et al., it was observed that statin use decreased with the treatment of statin topics in social media [24]. In our study, side effects were observed in 14.2% of those who voluntarily discontinued the treatment; 57.1% of these patients discontinued treatment due to gastrointestinal system side effects. 40.8% of the patients who quit voluntarily quit the treatment because they thought it was unnecessary (22.4% of the total group who started the treatment and stopped it because they thought it was unnecessary). 36.7% of patients discontinued treatment due to using too many drugs; 28.5% of patients due to fear of developing side effects; 20.4% of patients due to adverse effects from social media; and 16.3% of patients due to report-prescription problems.

In 61.5% of the group who discontinued statin treatment at the request of their doctor, the patients were told that their blood values were good as the reason for discontinuation of statin treatment. This rate shows that the recommendation that statin therapy should be a lifelong treatment has not been adopted. The fact that 20.5% of patients' doctors did not know why they discontinued statin treatment reveals that patients should be included in the treatment process. It was determined that 17.9% of the patients had their treatment discontinued by their doctors due to the development of side effects. Elevated liver enzymes were the cause of 42.8% of the group whose treatment was discontinued due to side effects. The rate of patients whose treatment cannot be continued due to side effects is lower than the rate of patients who do not know the need for treatment and are worried about possible side effects. This is evidence of poor communication with patients.

Lipid-lowering treatments for primary prevention of diabetes patients were given to 61% of patients in the USA and 24% of patients in Germany; for secondary protection, it has been shown that these rates increase to 80% in the USA and 46% in Germany [25]. The rate of patients who received statin therapy among our patients with diabetes and CAD was 79.5%, while the rate of patients without CAD receiving statin therapy was 48.2%. This shows that we use statin therapy more in our diabetes patients with CAD.

In a study by Gant et al., it was observed that the target LDL level was reached in approximately 75% of patients with type 2 diabetes with high cardiovascular risk, and the use of statins was higher in the target group [26]. In a study by Özkan et al., 84.9% of patients with diabetes were started on statins, but only 8.7% of the patients received effective statin treatment, while 24.3% received an acceptable level of statin treatment [27]. Although 73.6% of our patients were in the study's very high-risk group, the rate of patients receiving high-intensity statin therapy was only 22.6%. Although our rate of using high-intensity statin therapy is higher than similar studies, the fact that this rate should be even higher shows that we are insufficient in the titration of therapy. This may be due to physicians' hesitations about LDL targets.

Our study had some limitations. It was carried out at a time when the COVID-19 pandemic was effective worldwide. It is thought that the negative effects of the pandemic, such as inaccessibility to health services, an increase in sedentary life, and a deterioration in drug use due to a tendency to depression, may affect the results.

Conclusion

It seems that the rates of compliance with statin therapy and reaching our treatment goals in our patients are very low. Our patients often consider statin therapy unnecessary. The patient-physician relationship is very important in statin treatment management, as in all treatments. It is necessary to explain the scientific data about statins to the patients and to eliminate their concerns. Although the guidelines explain what the target LDL levels should be in diabetic patients, the different risk classifications and targets in different country and group guidelines may cause confusion. Therefore, a global consensus is needed.

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Data Availability Data sharing not applicable.

Declarations

Ethics approval and consent to participate The clinical study was approved by the Ethics Committee of Marmara University Faculty of Medicine (Approval Date: 12.06.2020, Approval Number: 09.2020.626). The research protocol was implemented according to the principles expressed in the World Medical Association Declaration

of Helsinki and under the International Ethical Guidelines for Biomedical Research Involving Subjects (GIOMS, Geneva, 1993). Informed consent was obtained from all subjects.

Competing interests The authors declare no competing interests.

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