Lipid control in patients with and without Type 2 Diabetes Mellitus (T2DM).
The experience of a special unit of a second grade hospital

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Abstract

Introduction: The prevalence of T2DM is worryingly increasing; the current understanding that T2DM is a metabolic disorder rather than a single disease makes the management of patients with T2DM challenging. In parallel, dyslipidemia is a fundamental risk factor for atherosclerotic cardiovascular disease (ASCVD) that can be reversible under pharmaceutical measures and lifestyle changes. Given that the risk of ASCVD is already elevated for patients with T2DM, the lipid management is of great importance to them.

Patients and Methods: Patients with dyslipidemia (n = 114) with T2DM (n1 = 36) and without T2DM (n2 = 78) were included. The patients were treated with statin ± anti-diabetic agent. Smokers (> 5 pack-years) and patients with Chronic Kidney Disease (CKD) were excluded. They were under medical supervision in our Lipid, Diabetes and Metabolism Unit for at least 12 months. There were follow-up appointments once every 3 months for the first year and a full lipid profile, HbA1c and BMI were recorded.

Results: After one year under medical supervision, 8% of the patients with T2DM and 31% of the patients without T2DM had a totally normal lipid profile. The LDL and the triglyceride (TG) goal in the two groups were achieved by 11% / 46% and 31% / 67% respectively. LDL-C, non-HDL-C and TG

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achievement rates were higher in patients without T2DM ($p < 0.05$). 56% of the patients with T2DM achieved HbA1c levels $\leq 6.5\%$.

**Conclusion:** The statistically significant difference in the lipid control between the patients with and without T2DM is a characteristic of the diabetic dyslipidemia. Intensive medical supervision is of paramount importance for those patients.

**Key words:** lipids; lipoproteins; cholesterol; LDL; diabetes mellitus; diabetic dyslipidemia

1. **Introduction**

T2DM has unarguably become a global health problem, keeping a steady increase in developed and developing countries. The situation is getting more and more alarming, considering that the rates of childhood obesity are rising, which leads to T2DM becoming more and more common in teenagers and young adolescents. T2DM, atherogenic dyslipidemia and obesity synthesize a classic triptych for atherosclerotic cardiovascular disease (ACVD) and this fact is well documented. Patients with T2DM are by definition prone to macrovascular and microvascular disease and complications which are attributed to the injurious effects of chronic hyperglycemia. Nonetheless, major studies failed to show the desired positive effects on cardiovascular risk from intensive glycemic control alone. The nature of T2DM is quite complex and insulin resistance seems to play an important role in it; the extreme manifestation of insulin resistance is better known as the metabolic syndrome. Obesity and genetic predisposition are both correlated with insulin resistance which is, in turn, strongly associated with hypertension, dyslipidemia, diabetes and their complications. Therefore, intensive hypolipidemic and anti-hypertensive therapy as well as low-calorie, low-fat diet and body mass index (BMI) reduction is advised, aiming at diminishing the residual cardiovascular risk. Pharmaceutical agents and lifestyle changes have place in treatment. Yet, goals are hard to achieve and even harder to maintain. The management of patients with T2DM is a real challenge as a majority of these patients show poor adherence to the suggested therapy and the recommendations of health care providers. The need for close follow-up after the diagnosis of T2DM has led to the formation of special Diabetes Units in our country which contribute to the primary and secondary prevention of diabetes and its complications. We undertook a retrospective study on the patients with dyslipidemia, with and without T2DM who are under medical supervision in our Lipid, Diabetes and Metabolism Unit, trying to discover the possible differences in the lipid control between the two groups. Additionally, we tried to investigate the results of our efforts to reduce their ACVD.

2. **Patients and Methods**

2.1. **Data source**

Medical charts of the patients who were under medical supervision in the Lipid, Diabetes and Metabolism Unit of the General Hospital of Trikala, Thessaly, Greece were retrospectively reviewed and only those who had at least one year continuous follow-up in our Unit were approved.

2.2. **Definitions**

According to the Hellenic Diabetes Association guidelines, a person was considered to be a “patient with T2DM” when one or more of the following criteria were fulfilled:

- Fasting Plasma Glucose FGP $\geq 126$mg/dL.
- Random Plasma Glucose $\geq 200$mg /dL, AND symptoms of hyperglycemia, namely polyuria, polydipsia, weight loss.
- Abnormal Oral Glucose Tolerance Test (OGTT) (75-g glucose/ 2 h)

Dyslipidemia is used as a synonym to hyperlipidemia. The decision of the statin therapy was made according to each patient profile and the 10-year
risk of developing ASCVD, according to the Hellenic Heart SCORE as mentioned in the updated guidelines of the Hellenic Society of Atherosclerosis for the diagnosis and treatment of dyslipidemia. The body mass index (BMI) is defined as the body mass divided by the square of the body height and is expressed in kg/m².

2.3. Patients and methods
Finally 114 patients with dyslipidemia were included in the study and 36 of them suffered from T2DM as well. Patients with chronic kidney disease (stage > II), smokers (>5 packet-years) and those > 75 years old were excluded. None with homozygous familial hyperlipidemia or an autoimmune disease was in the study. There were follow-up appointments once every 3 months for the first six months and then once per year. All the patients were thoroughly examined. Moreover, FGP, glyated hemoglobin (HbA1c), total cholesterol (Chol), low density lipoprotein (LDL-C), high density lipoprotein (HDLC) and triglycerides (TG) were tested. The blood samples were taken after a 12 hour-fast. When serum TG were measured > 200 mg/dl, the LDL-C levels were directly measured. The body mass index (BMI) of each patient was calculated as well. All the patients were treated with statins and the patients with T2DM were treated with one or more anti-diabetic agents as well. 14 patients were newly diagnosed with dyslipidemia and therefore they were statin-naïve. The rest of the patients had already been receiving statin ± antidiabetic treatment and the necessary interventions were made in an effort to achieve and HbA1c targets levels (Table 1). There was no intervention in the patients’ possible anti-hypertensive or antiplatelet therapy. All the patients were advised to follow a low fat and low cholesterol diet and to do physical aerobic exercise of medium intensity at least four times a week for at least 30 minutes. The outcome on the lipid profile of our patients was considered by the difference of the values of the above parameters at the beginning of the follow-up and at the end of the first year of supervision.

An ADVIA 1800 Clinical Chemistry System (Siemens Healthcare) was used for the photometric analysis of the blood samples.

2.4. Targets
According to the Greek and European Guidelines, the target for the patients who were included in our study are seen in Table 1.

Notably, there is a sub-group of patients without T2DM who are advised to achieve LDL-C levels < 100 mg/dl and those are patients with Familial Hypercholesterolemia (FH), autoimmune diseases, uncontrolled hypertension as well as heavy smokers. Yet, heavy smokers had been initially excluded from our study and none of our patients had FH, uncontrolled hypertension or autoimmune disease. Therefore, the LDL-C and non-HDL-C targets for all the patients without T2DM who were included in our study were 115 mg/dl and 145 mg/dl respectively.
2.5. Statistical analysis

SPSS version 24.0 for Windows (SPSS Inc., Chicago, IL, USA) was used for statistical analysis. Continuous variables are presented as mean ± standard error of mean (SEM), and categorical variables are shown as percentages and numbers. Normally distributed continuous variables were compared using the Student’s t-test. χ²-test was used for identifying the significance in the differences for categorical variables. P values below 0.05 (p < 0.05) were considered to be statistically significant.

3. Results

3.1. Patient Enrollment & characteristics

114 patients with dyslipidemia (47 men and 67 women) were included in the study. All of them were under medical supervision in our Lipid, Diabetes and Metabolism Unit for at least 12 months. The characteristics of the patients are summarized in Table 2. BMI, LDL-C levels and TG levels seem to be significantly higher in patients with T2DM than those without T2DM.

### Table 2. Characteristics of enrolled patients. Values are expressed as percent or mean +/- SEM (standard error of mean)

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<td>Female</td>
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<tr>
<td>Age</td>
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<td>BMI</td>
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<td>LDL-C</td>
<td>158.12 ± 5.6</td>
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<td>nonHDL-C</td>
<td>196.07 ± 7.22</td>
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<tr>
<td>TG</td>
<td>289.5 ± 37.41</td>
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<td>HbA1c</td>
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2. STATINS

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3.2. Comparison of LDL-C, non-HDL-C and TG target level achieving rates between the patients with T2DM and without T2DM

LDL-C and non-HDL-C target level achievement rates were 11% and 8% in patients with T2DM and these rates were 46% and 48%, respectively, in patients without T2DM. Comparing the TG levels...
between the two groups, 31% of the patients with T2DM and 67% of the patients without T2DM managed to achieve the target levels. (Figure 1)

3.3. Comparison of HbA1c levels of the patients with T2DM at the beginning and at the end of the 12-month-supervision
As shown in Table 4, the reduction in the HbA1c levels in the dislipidemic patients with T2DM who were under medical supervision in our Lipid, Diabetes and Metabolism Unit was statistically significant. 56% of the patients with T2DM managed to achieve HbA1c levels ≤ 6.5%.

3.4. Comparison of LDL-C, non-HDL-C, TG and BMI of the patients with T2DM at the beginning and at the end of the 12-month-supervision
The lipid profile seems to be improved in the patients with dyslipidemia and T2DM at the end of the follow-up, but the reduction of LDL-C is not statistically significant. Additionally, only 8% managed to achieve all their targets. As far as BMI is concerned, the results were not encouraging. This phenomenon is usual in patients with T2DM and is attributed to many antidiabetic agents, especially insulin.

3.5. Comparison of LDL-C, non-HDL-C, TG and BMI of the patients without T2DM at the beginning and at the end of the 12-month-supervision
The majority of the patients improved their lipid profile. 31% of them had a totally normal lipid profile. The reduction of all the cardiovascular risk parameters was proved to be statistically significant (Table 3).

4. Discussion
The correlation between T2DM and cardiovascular...
Lipid control in patients with and without Type 2 Diabetes Mellitus (T2DM) S. Papadatos et al.

Hyperlipidemia is another major factor responsible for atherosclerosis, which is reversible and treatment results in improved cardiovascular outcomes. Thus, treatment of dyslipidemia in patients with T2DM is of great importance. The phenotype of hyperlipidemia in patients with T2DM is quite different from the one of the general population. Patients with T2DM tend to have high levels of TG and very low HDL-C levels, while LDL-C levels are similar to the levels of patients with dislipidemia of the general population.

The pathophysiology of hypertriglyceridemia in T2DM is quite complex and is generally attributed to the hepatic overproduction of large, triglyceride-rich very-LDL (VLDL), the diminished activity of lipoprotein lipase enzyme in muscle, liver and adipose tissue because of the peripheral insulin resistance and finally to the large adipose tissue which releases large quantities of non-esterified fatty acids to the liver. High TG and low HDL-C levels are core components of the metabolic syndrome as well. This syndrome, which is characterized by insulin resistance and central obesity, doubles the risk of CVD but since its components are all reversible, the early diagnosis offers an effective treatment approach. In metabolic syndrome, the dyslipidemia usually occurs before diabetes and worsens with time. Not surprisingly, many individuals with metabolic syndrome experience a cardiovascular event slightly before being characterized as patients with T2DM. Obviously, they were on their way to diabetes and the chronic effect of insulin resistance on the endothelial dysfunction had already been proved catastrophic. Hypertension, smoking and physical inactivity are the last traditional risk factors for cardiovascular disease that have to be controlled, especially in patients with diabetes because they multiply the likelihood of suffering from ASCVD by many times. Unarguably, statins play the most important role in controlling dyslipidemia in T2DM patients and in general population as well. The main aim of the therapy with statins was the achievement of the LDL-C target, or at least a reduction of LDL-C < 50% of the initial levels for the very high risk patients. Yet, in patients with dyslipidemia and T2DM, non-high-density lipoprotein cholesterol (non-HDL-C) seems to be a better predictor of CVD than LDL-C and, therefore, non-HDL-C should be the second goal of the therapy. Statins are generally well tolerated; they are considered as a first-line treatment in primary and secondary prevention and should not be withheld without any good reason. Additionally, it does

<table>
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<th>Patients</th>
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<td>Without T2DM</td>
<td>LDL-C</td>
<td>136.57 ± 9.35</td>
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<td>nonHDL-C</td>
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<td>TG</td>
<td>196.53 ± 23.86</td>
<td>145.88 ± 13.02</td>
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<td>BMI</td>
<td>25.99 ± 0.74</td>
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<td>With T2DM</td>
<td>LDL-C</td>
<td>158.12 ± 5.60</td>
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<td>29.42 ± 1.13</td>
<td>-0.31</td>
<td>+0.71</td>
<td>-0.68%</td>
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not appear to be any threshold below which statin therapy is not beneficial.\textsuperscript{20} On the contrary, it has been shown that for every 1 mmol/l reduction in LDL-C, there is a 9\% reduction in all-cause mortality in patients with T2DM.\textsuperscript{21} According to the Japan Atherosclerosis Society 2012 guidelines, patients aged ≥ 75 with dyslipidemia and primary prevention for coronary heart disease should be individually treated by the decisions of their attending physicians based upon the general condition of each patient.\textsuperscript{22} On the other hand, dislipidemic patients aged 65-74 should be treated in the same way as those aged < 65 to achieve their serum lipid goals. Yet, there are clinical trials which clearly demonstrate that intervention with statins may be indicated for the elderly for primary or secondary prevention.\textsuperscript{23} After all, the positive effects of statin therapy are pleiotropic.\textsuperscript{24} As with glycemic control, the benefit of cardiovascular risk reduction depends upon the patient’s frailty, overall health, and projected period of survival. Older patients are more likely to derive greater reduction in morbidity and mortality from cardiovascular risk reduction, particularly lipid lowering with statin therapy, than from tight glycemic control.\textsuperscript{25} Lately, there are reports that long-term use of the majority of statins, but not all of them,\textsuperscript{26} may provoke T2DM or deteriorate the glycemic control in established T2DM.\textsuperscript{27,28} However, the risk is low compared to the cardiovascular benefit from LDL-C reduction. Interestingly, recent evidence show that regardless the alterations on glycemic control, CVD risk is remarkably reduced to those who develop T2DM on statin therapy.\textsuperscript{29} On the other hand, the effect of the anti-diabetic agents on the lipid profile can be controversial. Despite the fact that insulin increases HDL-C and metformin decreases LDL-C, TG and improves insulin resistance, sodium-glucose cotransporter -2 inhibitors are thought to increase LDL-C.\textsuperscript{30,31} With reference to our results, BMI was inadequately controlled in both groups, especially among the patients with T2DM. It is well established that insulin, a major, widely used antidiabetic agent does not favor weight loss. It is also known that compliance with lifestyle measures is globally low.\textsuperscript{32} As far as the lipid profile of the patients with T2DM and without T2DM is concerned, LDL-C, non-HDL-C and TG levels were decreased but in patients with T2DM the reduction in LDL-C levels did not prove to be statistically significant. Yet, statistical insignificance does not necessarily mean clinical irrelevance; statins unarguably decrease LDL-C as well as CVD risk. Despite the fact that intensive statin therapy is suggested for T2DM patients, we found lower achievement rates of LDL-C targets in T2DM group. The poorer results of LDL-C control among T2DM patients are possibly related to their personal characteristics, such as lifestyle or polypharmacy/medication non-adherence, or the nature of T2DM itself. The clinicians should try to explain the possible risks and closely follow-up those patients; they should also maximize the therapeutic lifestyle changes as well as the adherence to therapy; finally, they should educate patients and use safe and effective drugs.

To conclude, serum lipid goal attainment significantly differs between the patients with and without T2DM. Despite the fact that prescription of lipid lowering agents seems to be an everyday practice, achieving and maintaining the target levels may be a tough procedure. The problem becomes prominent when treating patients with T2DM. The complex nature of T2DM suggests that achieving the lipid goals which guarantee a reduction in cardiovascular risk can be very challenging.

5. Limitations
One limitation of the study is the relatively small number of the patients. Additionally, patients with major factors for cardiovascular risk, namely heavy smoking, uncontrolled hypertension and autoimmune diseases were either excluded or absent. Finally, we did not confront any patients suffering from FH, or patients < 20 years old.

Acknowledgements
None.

Conflict of interest
All authors declare no conflict of interest.
Περίληψη

Ο Λιπιδαιμικός έλεγχος σε ασθενείς με ή χωρίς Σακχαρώδη Διαβήτη τύπου II (ΣΔΙΙ)
Η εμπειρία ενός Ιατρείου Λιπίδων και Διαβήτη Δευτεροβάθμιου Νοσοκομείου

Σ.Σ. Παπαδάτος, Α. Μπουρδάκης
B’ παθολογική Κλινική & Ιατρείο Λιπίδων, Διαβήτη και Μεταβολισμού, Γενικό Νοσοκομείο Τρικάλων

Εισαγωγή: Ο επιπολασμός του ΣΔΙΙ αυξάνεται ανησυχητικά και η σύγχρονη θεώρησή του ως ένα σύνδρομο παρά ως ένα άλλο καρδιοκορινθικό παράγοντα, κάνει την αντιμετώπιση του υποκειμένου σε ατομική και οποιοδήποτε παράμετρο αυτόπτικη από τους κλινικούς. Ταυτόχρονα, η υπερλιπαιδαιμία παράγεται ως ένας θεμελιώδης παράγοντας αθηροσκληρωτικής και διαβήτη-οπταθικής παρέμβασης, που όμως δύναται να αναστραφεί μέσω φαρμακευτικών και υγιεινοδιαιτητικών παρεμβάσεων. Οι ασθενείς με ΣΔΙΙ έχουν ήδη αυξημένο καρδιαγγειακό κίνδυνο και συνεπώς η λιπαιδαιμική ρύθμιση είναι απαραίτητη από τον ιατρικό πλευρά, παρόλο που οι στόχοι δόθηκαν κατακτώνται και διατηρούνται.

Υλικό και Μέθοδος: Παρακολουθήθηκαν για τουλάχιστον 12 μήνες 114 δυσλιπαιδαιμονικοί ασθενείς εκ των οποίων οι 36 έπασχαν από ΣΔΙΙ και οι 78 όχι. Καπνιστές (> 5 πακέτα-χρόνια) και ασθενείς με Χρόνια Νεφρική Νόσο αποκλείστηκαν. Προγραμματίστηκαν επισκέψεις ανά τρίμηνο για το πρώτο έτος, όπου και γίνονταν πλήρες λιπαιδαιμικός έλεγχος, μέτρηση γλυκοζυλιωμένης αιμοσφαιρίνης (ΗΒΑ1c) και Δείκτη Μάζας Σώματος (ΔΜΣ).

Αποτελέσματα: Ένα έτος μετά, 8% των ασθενών με ΣΔΙΙ και το 31% των μη-σακχαροδιαβητικών ασθενών είχαν βιολογικό λιπαιδαιμικό προφίλ. Η τιμή-στόχος της LDL-C και των τριγλυκεριδίων (TG) επιτεύχθηκε από τις δύο ομάδες σε ποσοστά 11% / 46% και 31% / 67% αντίστοιχα. Τα ποσοστά επιτυχίας στις τιμές-στόχους της LDL-C, τη non-HDL-C και των TG ήταν υψηλά για τους μη-διαβήτικους ασθενείς (p < 0.05). 56% των ασθενών με ΣΔΙΙ κατάφεραν να πετύχουν HbA1c ≤ 6.5%.

Συμπεράσματα: Η στατιστικά σημαντική διαφορά που παρατηρείται στο λιπαιδαιμικό έλεγχο των σακχαροδιαβητικών και μη ασθενών αποδίδεται πιθανά στη διαβητική δυσλιπαιδαιμία. Η εντατική ιατρική παρακολούθηση είναι απαραίτητη για αυτούς τους ασθενείς.

Λέξεις ευρετηρίου: λιπίδα, λιποπρωτεΐνες, LDL, σακχαρώδης διαβήτης, διαβητική δυσλιπαιδαιμία

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