Lower MPV Can Independently Predict Erectile Dysfunction in T2DM

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Abstract

Objectives: To find out the frequency of erectile dysfunction in diabetic patients and the association between erectile dysfunction and various clinical and laboratory parameters such as diabetic neuropathy, diabetes control, and cardiovascular risk factors.

Subjects and methods: 91 type 2 diabetic patients were screened for erectile dysfunction. Clinical data were collected and included body mass index (BMI), blood pressure (BP), heart rate, duration of diabetes and diabetes complications mainly peripheral diabetic neuropathy (PDN). Laboratory data included testosterone, pituitary gonadotropins, fasting plasma glucose (FPG), HbA1c, complete blood count (CBC), serum creatinine and lipid profile. Associations of testosterone and erectile dysfunction with various clinical and biochemical parameters were studied.

Results: Erectile dysfunction (ED) was present in 56% of our patients. No significant difference in total testosterone level, LH, FSH or prolactin level between patients with and those without erectile dysfunction. Patients with peripheral diabetic neuropathy were significantly at higher risk for erectile dysfunction (ED) (p=0.008). High HbA1c, Low MPV and low MCH were significant and independent risk factors for ED (p=0.033, 0.033, 0.004 respectively). Testosterone level was negatively and significantly associated with BMI, heart rate and RDW (p=0.005, 0.047, 0.028 respectively).

Conclusion: Erectile dysfunction is very common among type 2 diabetic patients. It is strongly and directly associated with peripheral diabetic neuropathy (PDN) so, questionnaire and patient examination for PDN and further interrogation of patients complaining of PDN for ED is of utmost significance. Erectile dysfunction in T2DM is not related to serum testosterone level. Proper control of blood glucose and reaching the target HbA1c can protect diabetic patients from development of such disorder as HbA1c is found to be a significantly independent predictor of it. Other significant risk factors and independent predictors of ED in our study population are low MPV and low MCH (p=0.036, 0.034 respectively) which can be easily traced by a simple complete blood count (CBC).

Keywords: Diabetes; Erectile dysfunction; MPV; MCH; Neuropathy; Testosterone

Introduction

Erectile dysfunction (ED) is a difficulty in achieving and maintaining adequate erection for a satisfactory sexual performance and the stability of this condition more than 25% of sexual attempts [1]. It is the most common problem, affecting 80 to 85% of the patients seeking medical help for sexual dysfunction and its prevalence is expected to reach 322 million people worldwide in 2025 [2]. It occurs due to the complicated interaction between neural, vascular, endocrine, medical and pharmacological factors [3]. Most of these causes affect the intrapenile vasculogenic mechanisms, whether arterial or venous. A common finding is a decrease in local nitric oxide, which is considered as the main neurotransmitter involved in initiation of erection. Fibrosis may also be present within the corpora cavernosa, which limits their expandability, prevents the venules from compressing against the tunica albuginea, and thereby allows venous leakage from the penis [4]. There is an increasing evidence identifying ED as an early finding for atherosclerotic cardiovascular disease and its associated stroke and mortality [5].

Materials

The study was approved by the Research and Ethics Committee of King Fahd Hospital, Asir Province, Saudi Arabia and informed consent was obtained from each participant. Ninety-one male type 2 diabetic patients, aged 19 to 79 years, were recruited from the out-patient endocrinology clinics from January to June, 2018. Patients were excluded if they had been hospitalized for acute illness such as infection or inflammation within the recent month and if they were already receiving testosterone replacement therapy. Cardiovascular and peripheral arterial disease, Kidney disease, thyroid or other
endocrine disorder, smoking and anemia were also exclusion criteria.

Detailed history and complete physical examination were done for all participants. Data regarding age, duration of diabetes, presence of diabetes complications and medication were collected. Laboratory investigations included complete blood count (CBC), fasting plasma glucose, HbA1c, lipid profile, serum creatinine, prolactin, total testosterone and pituitary gonadotropins (LH, FSH).

Blood pressure and pulse rate were measured using automatic BP machine after 5 minutes of rest. Body mass index was also calculated using the formula: BMI=weight (kg)/height (m2). The International Index of Erectile Function (IIEF) was applied for diagnosis of ED [6] and the revised NDS clinical scoring system was used for diagnosis of peripheral diabetic neuropathy (PDN) [7].

After an overnight fasting venous blood samples were taken into tripotassium ethylene diamine tetracetic acid, using a Roche Minos cell counter and automatic blood cell counter (Avid CELL-DYN 3500; Abbot Laboratories, Abbot Park, IL, USA) immediately after sample collection for platelet indices, WBC count, and RBC indices. Standardization, calibration of instrument, and processing of samples were done according to the manufacturer’s instructions. Fasting blood glucose was measured using the glucose oxidase method (Spinreact, Girona, Spain). Total Hb was measured colorimetrically. HbA1c was measured by BioMerieux Laboratory, Marcy l’Etoile, France; LDL cholesterol was calculated as follows: LDL-C=TC – HDL-C – TG/5 according to the method used by Friedewald [9]. Creatinine was measured by kinetic colorimetric assay based on the Jaffé method on Cobas c701 (Roche Diagnostics, Mannheim) according to the manufacturer’s instructions.

Hormonal assay, FSH, LH, prolactin and total testosterone, TSH, FT4, FT3, in serum were determined by electrochemiluminescent immunoassay on a Roche Modular E170 autoanalyser. Total cholesterol, HDL, cholesterol and TG were measured by BioMerieux Laboratory, Marcy l’Etoile, France; LDL cholesterol was calculated as follows: LDL-C=TC – HDL-C – TG/5 according to the method used by Friedewald [9].

Creatinine was measured by kinetic colorimetric assay based on the Jaffé method on Cobas c701 (Roche Diagnostics, Mannheim) according to the manufacturer’s instructions.

Our laboratory reference ranges

Testosterone: 6.7-29 nmol/l, LH: 1.5-12.4 mol/l, FSH: 1.5-12.4 nmol/l, prolactin 65.2-539.1 nmol/l. TSH: 0.35-4.9 ulU/ml, FT4: 7.5-21.1 pmol/l, FT3: 3.8-7.8 pmol/l. FPG mmol/l, HbA1c as % of total hemoglobin. RBC 4.5-6.3 10/L, MCH 26-36 pg, MCHC 32-36 gm/dL, HCT 38-52%, Hb 14-18 gm/dL, Platelets 140-440 10/L, RDW 11-14%, MPV 7-13 fL, TC: 3.5-5.2 mmol/l, LDL-C: 3.5-5.2 mmol/l, HLD-C: 1.04-1.55 mmol/l, TG: 0.34-1.95 mmol/l, creatinine 80-115 µmol/l.

Statistical analysis

Sample size was calculated by PASS software version 11.0.8 Hintze J. PASS 11. NCSS, LLC. Kaysville, Utah, USA.

www.ncss.com). Calculation relied upon a previous study by Ugwu et al. In this study HbA1c was 6.8 ± 0.8 in those without ED and 8.0 ± 1.9 in those with ED. Group sample sizes of 40 patients with ED and 40 without achieve 95% power to detect a difference of 1.2 between the null hypothesis that both group means are 6.8 and the alternative hypothesis that the mean of group 2 is 8.0 with estimated group standard deviations of 0.8 and 1.9 and with a significance level (alpha) of 0.05000 using a two-sided two-sample t-test.

Data were entered and analyzed using SPSS software (version 21). Categorical data were presented as frequencies and percentages while quantitative data were presented as mean ± SD if normally distributed (Kolmogorov-Smirnov test p >0.050) or median and interquartile range (IQR) if skewed (Kolmogorov-Smirnov test p ≤ 0.050). Comparing categorical data for two groups was performed by Chi-square test while comparing quantitative data for two groups was performed by Independent-Samples t-test for normally distributed data or Mann-Whitney U test for skewed data. Correlation of a continuous data with binominal data was done by point bi-serial correlation while its correlation with ordinal/continuous data was done by Spearman’s correlation. A diagnostic cut off value of a test to discriminate diseased cases from non-diseased cases was evaluated using Receiver Operating Characteristic (ROC) curve analysis. Predictors were initially tested at univariate level then those with rather significant result were entered into a prediction model using binary logistic regression analysis to detect the independent predictors with their odds ratios (95% CI). Results were considered significant if p value < 0.050 and graphs were used when appropriate.

Results

Fifty-one patients of the study group (56% of total number of patients) had erectile dysfunction. These were older in age and had more prevalence of peripheral diabetic neuropathy (p=0.039, 0.008 respectively). There was a clear trend towards higher HbA1c in ED patients (p=0.05). They also had significantly higher hemocrit (HCT) [0.034], and on the other hand, they had significantly lower MCH (p=0.036) and lower MPV (p=0.017).

A binominal logistic regression was performed to ascertain the effects of presence of PDN, age (years), HbA1c, low MCH (<34 versus ≥ 34), non-low MCV (≥ 80 versus <80) and low MPV (≥ 9.35 versus<9.35) on the likelihood that participants have ED. Cut off values of 34 for MCH and 80 for MCV were drawn from the normal reference ranges while a cutoff of 9.35 for MPV was drawn from a ROC curve analysis of our data. The diagnostic accuracy of this cutoff value showed 82.4% sensitivity, 55% specificity, 70% PPV and 71% NPV (AUC=0.707, p value=0.001) (Figures 1-5).

High HbA1c proved to be an independent risk factor of erectile dysfunction (p=0.033) meanwhile low MPV and low MCH were independent predictors for this disorder (p=0.036, 0.034 respectively). Peripheral diabetic neuropathy was a significant risk factor for ED (p=0.009) but it did not prove to be an independent predictor (Tables 1-4).
Testosterone did not correlate with erectile dysfunction and was not significantly different between both groups of patients \((p=0.645, 0.642\) respectively). Testosterone correlated positively and significantly with TC, RBC, Hb, HCT, FSH \((p=0.037, 0.043, 0.01, 0.046, 0.045\) respectively). Testosterone correlated negatively with BMI values and class, pulse rate, serum creatinine, WBC, RDW and platelet count \(p=<0.0005, <0.0005, 0.047, 0.028, 0.032, 0.028, 0.021\) respectively Tables 2 and 5.

**Table 1:** Clinical data of patients with and without erectile dysfunction.

| Variable                                      | Group            | P1     | Crude OR | P2     |
|-----------------------------------------------|------------------|--------|----------|--------|
| Age (years)                                   | With ED (n=51)   | Without ED (n=40) | *0.039   | 1.038  | 0.060 |
| BMI class: Count (Percent)                    | 60 (47-64)       | 51 (42.25-61)  |          |        |
| Ideal (18.5-24.9 kg/m²)                       | 3 (5.9%)         | 3 (7.5%)  | **0.689** | 0.805  | 0.333 |
| Overweight (25-29.9 kg/m²)                    | 15 (29.4%)       | 9 (22.5%)   |          |        |
| Class I obesity (30-34.9 kg/m²)               | 24 (47.1%)       | 16 (40%)    |          |        |
| Class II obesity (35-39.9 kg/m²)              | 7 (13.7%)        | 9 (22.5%)   |          |        |
| Class III obesity (>40 kg/m²)                 | 2 (3.9%)         | 3 (7.5%)    |          |        |
| BMI kg/m²                                     | 30.8 (28.7-33.9) | 31.5 (27.9-35.6) | *0.349  | 0.975  | 0.574 |
| SBP mmHg                                      | 130 (120.5-141)  | 134 (120-140) | *0.956  | 0.992  | 0.582 |
| DBP mmHg                                      | 77 (69-80)       | 78 (69-84)  | *0.421   | 0.977  | 0.338 |
| Mean BP                                       | 94 (88.2-99.8)   | 93.3 (88.3-103.3) | *0.548  | 0.977  | 0.333 |
| Pulse (Mean ± SD) bpm                         | 77.8 ± 9.4       | 81.3 ± 10.5 | **0.098** | 0.964  | 0.101 |
| Presence of Diabetic neuropathy Count (Percent) | 38 (74.5%)      | 19 (47.5%)  | **0.008** | 3.231  | 0.009 |
| Duration of DM (years)                        | 12 (6-16)        | 8 (2.5-15)  | *0.085   | 1.047  | 0.152 |

Data are presented as Median (IQR) unless otherwise stated. P1 by *Mann-Whitney U test, **Independent Samples t-Test, ***Chi-Square test and ****Fisher’s Exact Test. P2 by Binary Logistic Regression.

**Table 2:** Laboratory variables of patients with and without erectile dysfunction.

| Variable                      | Group            | P1     | Crude OR | P2     |
|-------------------------------|------------------|--------|----------|--------|
| Serum total testosterone nmol/l | With ED (n=51)  | Without ED (n=40) | *0.642  | 0.982  | 0.660 |
| LH nmol/l                     | 11.25 (9.2-17.9) | 14.1 (8.7-16.9) |          |        |
| FSH nmol/l                    | 4.06 (3.26-5.17) | 3.35 (2.77-5.27) | *0.217  | 0.934  | 0.357 |
| Prolactin nmol/l              | 4.25 (3.53-6.65) | 5.05 (2.95-7.83) | *0.636  | 0.911  | 0.219 |
| TSH uIU/ml                    | 134.9 (121.8-152.9) | 136 (90.6-154.1) | *0.301  | 0.999  | 0.595 |
| FT4 pmol/l                    | 1.91 (1.31-3.21) | 2.39 (1.72-3.595) | *0.334  | 0.840  | 0.331 |
| FPG mmol/l                    | 14.9 ± 3.3       | 14.6 ± 2.3   | **0.741** | 1.041  | 0.733 |
| HbA1C %                       | 7.6 (6.05-11.9)  | 8.3 (6.73-11.0) | *0.713   | 1.017  | 0.766 |

OR=Odds Ratio, BMI: Body mass index, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, BP: Blood pressure.
Data are presented as Median (IQR) unless otherwise stated. P1 by *Mann-Whitney U test, **Independent Samples t-Test. P2 by Binary Logistic Regression. OR=Odds Ratio.

LH: luteinizing hormone, FSH: follicle stimulating hormone, TSH: thyroid stimulating hormone, FT4: free tetraiodothyronine, FT3: Triiodothyronine, FPG: Fasting plasma glucose, HbA1c: glycosylated hemoglobin, LDL-C: low density lipoprotein cholesterol, HDL-c: high density lipoprotein cholesterol, TG: triglycerides, Scr: serum creatinine

WBC: White blood cell count, RBC: Red blood cell count, Hb: hemoglobin, HCT: Hematocrete, MCV: Mean corpuscular volume, MCH: Mean corpuscular hemoglobin, MCHC: Mean corpuscular hemoglobin concentration, RDW: Red cell distribution width, PC: platelet count, MPV: Mean platelet volume.

Table 3: MCV, MCH and MPV in the two study groups.

| Parameter | ED group | χ² | P1 | Crude OR (95% CI) | P2 |
|-----------|----------|----|----|------------------|----|
|           | With ED  |     |    |                  |    |
|           | (n=51)   |     |    |                  |    |
| Low MCH pg| 36 (70.6%)| 13 (32.5%)| 13.086| <0.0005| 4.99 (2-12.2) <0.0005|
| Non-low MCV fl | 37 (72.5%) | 20 (50%) | 4.870 | 0.027 | 2.6 (1.1-6.3) 0.029 |
| Low MPV fl | 42 (82.4%) | 18 (45%) | 13.925 | <0.0005 | 5.7 (2.2-14.8) <0.0005 |

Table 3 showed the difference between those with and without ED as regard to these three parameters. There was two studentized residuals with values of -2.988 and -3.494 standard deviations which were kept in the analysis. The logistic regression model was statistically significant (χ²(6)=33.553, p<0.0005). The model explained 43.4% (Nagelkerke R²) of the variance in ED and correctly classified 72.1% of cases. Sensitivity and positive predictive value were 75.5%, while specificity and negative predictive value were 67.6%. Of the 6 predictor variables, HbA1C, MCH and MPV were statistically significant as shown in Table 4. Patients had 1.65 times higher odds to exhibit ED for every 1% rise in HbA1C, had 9.5 times higher odds to exhibit ED for those with MCH<34, and had 5.56 times higher odds to exhibit ED for those with MPV ≤ 9.35.
Data are presented as count (%). P1 value by Chi-square. OR=Odds ratio, CI=confidence interval. P2 value by simple logistic regression.

This table showed that the frequency of low MCH (<34), non-low MCV (≥80) and low MPV (≤9.35) were statistically significantly higher in those with ED as compared to those without ED.

Table 4: Independent predictors of ED.

| Predictor        | B    | S.E.   | Wald   | P value | OR   | 95% CI for OR |
|------------------|------|--------|--------|---------|------|---------------|
|                  |      |        |        |         |      |               |
|                  |      |        |        |         | Lower| Upper         |
| PDN Absent       | 0.194| 0.651  | 0.089  | 0.766   | R    | 1.214         |
| PDN Present      |      |        |        |         |      | 0.339 - 4.352 |
| MCV fL <80       | -0.908| 0.780  | 1.357  | 0.244   | R    | 0.403         |
| MCV fL ≥80       |      |        |        |         |      | 0.087 - 1.858 |
| MCH pg ≥34       | 2.254| 0.783  | 8.296  | 0.004   | R    | 9.524         |
| MCH pg <34       |      |        |        |         |      | 2.055 - 44.146|
| Age (years)      | 0.044| 0.027  | 2.592  | 0.107   | 1.045| 0.990 - 1.103 |
| HbA1C (%)        | 0.501| 0.236  | 4.529  | 0.033   | 1.651| 1.040 - 2.620 |
| MPV fL >9.35     | 1.716| 0.577  | 8.835  | 0.003   | R    | 5.562         |
| MPV fL ≤9.35     |      |        |        |         |      | 1.794 - 17.244|
| Constant         | -8.100|        |        |         |      |               |

Table 5: Correlation of total serum testosterone with clinical and laboratory variables.

| Variable                        | Correlation coefficient | P     |
|---------------------------------|------------------------|-------|
| Erectile dysfunction            | -0.049                 | *0.645|
| Age (years)                     | -0.074                 | 0.485 |
| BMI class                       | -0.491                 | <0.0005|
| BMI kg/m²                       | -0.509                 | <0.0005|
| SBP mmHg                        | 0.125                  | 0.250 |
| DBP mmHg                        | 0.181                  | 0.091 |
| MBP mmHg                        | 0.198                  | 0.066 |
| Pulse bpm                       | -0.212                 | 0.047 |
| Presence of Diabetic neuropathy | 0.044                  | *0.681|
| Duration of DM (yrs)            | 0.028                  | 0.793 |
| FPG mmol/l                      | -0.124                 | 0.252 |
| HbA1C %                         | -0.047                 | 0.665 |
| TC mmol/l                       | 0.229                  | 0.037 |
| LDL-C mmol/l                    | 0.194                  | 0.079 |
| HDL-C mmol/l                    | 0.168                  | 0.129 |
| TG mmol/l                       | -0.097                 | 0.381 |
| Test                | Mean 1 | SD 1 | Mean 2 | SD 2 |
|---------------------|--------|------|--------|------|
| S cr µmol/l         | -0.241 | 0.028| 0.028  | 0.028|
| TSH uiU/ml          | 0.042  | 0.731| 0.042  | 0.731|
| T4 pmol/l           | 0.293  | 0.078| 0.293  | 0.078|
| T3 pmol/l           | -0.058 | 0.825| -0.058 | 0.825|
| LH mmol/l           | 0.188  | 0.080| 0.188  | 0.080|
| FSH mmol/l          | 0.244  | 0.045| 0.244  | 0.045|
| Prolactin nmol/l    | 0.052  | 0.696| 0.052  | 0.696|
| WBC 10/L            | -0.288 | 0.032| -0.288 | 0.032|
| RBC 10/L            | 0.271  | 0.043| 0.271  | 0.043|
| Hb gm/dL            | 0.340  | 0.010| 0.340  | 0.010|
| HCT %               | 0.270  | 0.046| 0.270  | 0.046|
| MCV fl              | 0.224  | 0.098| 0.224  | 0.098|
| MCH pg               | -0.086 | 0.529| -0.086 | 0.529|
| MCHC gm/dL          | -0.223 | 0.098| -0.223 | 0.098|
| RDW %               | -0.294 | 0.028| -0.294 | 0.028|
| PC 10/L             | -0.311 | 0.021| -0.311 | 0.021|
| MPV fl              | 0.143  | 0.294| 0.143  | 0.294|

*p value by Spearman’s Correlation and *Point Bi-serial Correlation.

LH: luteinizing hormone, FSH: follicle stimulating hormone, TSH: thyroid stimulating hormone, FT4: free tetraiodothyronine,

FT3: Triiodothyronine, FBG: Fasting blood glucose, HbA1c: glycosylated hemoglobin, LDL-C: low density lipoprotein cholesterol,

HDL-c: high density lipoprotein cholesterol, BUN: Blood urea nitrogen, WBC: White blood cell count, RBC: Red blood cell count,

HCT: Hematocrete, MCV: Mean corpuscular volume, MCH: Mean corpuscular hemoglobin,

MCHC: Mean corpuscular hemoglobin concentration, RDW: Red cell distribution width, MPV: Mean platelet volume.

**Figure 1**: Gender difference in prevalence of thyroid dysfunction.

This figure shows that female gender predominates among those with thyroid dysfunction while male gender predominates among those without thyroid dysfunction. However, this difference didn’t achieve a statistical significance.


Discussion

Several researchers reported a high prevalence of ED in diabetic patients ranging from 20 to 90% with more affection at an earlier age than non-diabetic population. The differences in prevalence may be attributed to different criteria of the studied groups [10-12].

For example, in Lal Meena’s study the prevalence was 78% and was associated with higher cardiovascular risk [13] and increased with increasing age. The prevalence increased from 20% in the age group less than 40 to 100% in the age group more than 60 years.

In the Massachusetts male ageing study, men with treated diabetes had a 28% prevalence of complete ED, about three
times higher than the prevalence in the entire study (10%). It also showed the extremely deleterious epidemiologic link between coronary artery disease, diabetes and ED [14]. In our study, ED was present in 56% of the study group who were older in age (p= 0.039) than those without ED.

The effect of age on prevalence and severity of the disease might be due to age-related changes occurring in the body and various other complications that may coexist in diabetic patients, but ultimately the accelerated atherosclerosis is the common factor for increased prevalence of ED and cardiovascular disease in aging population [14].

Although Romeo [12] declared peripheral neuropathy as an independent predictor of ED (p= 0.023), in our study, diabetic peripheral neuropathy was significantly associated with ED (p=0.008), and it was a significant predictor (0.009), however, not independent predictor.

In a study of 90 patients, Spanish researchers [15] uncovered clear links between erectile dysfunction and peripheral neuropathy. They found strong association between the severity of neuropathy symptoms and ED (p=0.009).

Similarly, in another study of Japanese, diabetic neuropathy was positively associated with severe erectile dysfunction among diabetic patients aged less than 65 years [16]. In Ugwu’s study, autonomic neuropathy was significant only when duration of diabetes was removed from the model [17].

Our patients suffering from ED showed a significant trend towards higher HbA1c (p=0.05) and high HbA1c proved to be an independent predictor of erectile dysfunction (p=0.033). Similar to our observation, HbA1c was also reported by Romeo and Ugwu and others as an independent predictor of ED in diabetic patients [12,17].

Available studies indicate that increased MPV triggers arterial atherosclerotic processes and thrombosis including penile arteries. Sensitivity of high MPV in detection of arteriogenic ED was mentioned in some reports reaching 54% with a specificity of 88% and 82% positive predictive value [18,19].

In contrast to most literature reports, our study demonstrated statistically significant association of ED with low MPV and accuracy of cut off value ≤ 9.35 fl was shown by an AUC of 0.707 (p value=0.001) with sensitivity, specificity, positive predictive value and negative predictive value of 82.4%, 55%, 70% and 71% respectively.

However, our observation is in agreement with a recent and interesting study that was published in 2018, demonstrating the strong association between low MPV and high risk for critical limb ischemia in patients with peripheral arterial atherosclerotic disease. In that study, diabetes was one of the criteria to define critical limb ischemia and ROC analysis revealed a cut-off of ≤ 10.2 fl for MPV to best predict critical limb ischemia (sensitivity: 65%, specificity: 42%, positive predictive value: 71%, negative predictive value: 36%). MPV was not associated with myocardial infarction or stroke in the same study [20].

Decreased MPV could be regarded as an enhanced consumption of large platelets in inflammatory states [21].

Atherosclerosis affects all vascular beds, so, the earliest symptom development is expected in the artery with the narrowest lumen such as the penile artery. The negative impact of ED on coronary arteries has been published [22].

In our study low MCH was also an independent predictor of ED (p= 0.004). This is a new observation that is up to our knowledge documented for the first time.

In this study, there was no significant difference between both groups of patients in testosterone level indicating that erectile dysfunction in diabetic patient is mostly due to factors other than hypogonadism. Although erections are clearly androgen-dependent, as evidenced by the marked reduction in the frequency, amplitude, and rigidity of erections in marked hypogonadism, the level of androgens required to induce ED is debatable. It is believed that there is a level of testosterone that is required for normal erection in adults and once this threshold is achieved, additional amounts do not further affect the frequency, amplitude, or rigidity of erections [23].

Total testosterone correlated negatively with BMI value and class in our study population. Similarly, Chuang reported inverse correlation between testosterone level and BMI. It is believed that this inverse correlation is responsible for the modulation of the lean body mass, fat mass and body composition [24].

In agreement with our results is the positive correlation between serum total cholesterol (TC) and testosterone observed by Chuang [24]. We did not find significant associations between testosterone and other lipids that may be explained by the fact that most of our patients were receiving hypolipidemic drugs according to the American Diabetes Association clinical practice guidelines 2017.

Al-Chalabi et al. [25] found a significant negative correlation between testosterone and diastolic blood pressure. She also reported a significant negative correlation between testosterone and TC and LDL-C. In our study we did not find such association between testosterone and blood pressure. However, testosterone level correlated negatively with heart rate. The higher the testosterone, the lower the heart rate that may indicate more cardiac fitness and decreased work of the heart. In Poliwczak’s study, testosterone therapy reduced heart rate variability in the treated group of patients [26].

It is noteworthy mentioning that in the present study higher testosterone level was associated with lower serum creatinine level (p=0.028). Effect of testosterone on kidney function was previously demonstrated by Goel who reported a significant delay in the progression of chronic kidney disease in patients who received testosterone replacement. The treated men had a 24% decreased risk of end stage renal disease and 25% decreased risk of death [27].

Some reports indicate that testosterone increases the biological activity of erythropoietin, alters iron metabolism and stimulates red blood cell production thus increasing
hemoglobin level [28]. This can explain our observation of the direct and strong correlation between serum testosterone and red cell count, hematocrit and haemoglobin level (p=0.043, 0.046, 0.01 respectively).

The relation between atherosclerotic and cardiovascular diseases and white blood cell count was evoked by several authors. Judith [29] demonstrated inverse correlation between total testosterone and total WBC count in males 40 to 78 years of age who did not have history of coronary artery disease. We found the same correlation in our study population. These results support a link between hormonal status and low-grade inflammation and consequently the higher risk to atherosclerotic cardiovascular disease.

RDW has shown its significance as a predictive and risk factor for cardiovascular and overall mortality in the general population and in various conditions such as obesity, malignancies, and chronic kidney diseases [30]. In our study it is inversely associated with testosterone level (p=0.028)

Conclusion

Erectile dysfunction in diabetic patients is strongly associated with peripheral neuropathy, not serum total testosterone level, so sexual history should not be missed in diabetic patient having PDN. This dysfunction can be also easily predicted by the uncontrolled diabetic state and simple CBC. Achieving target HbA1c in diabetic patients is of utmost significance to avoid ED. Requesting simple inexpensive CBC can significantly reflect the presence of an underlying complication such as ED with its widely known association with coronary atherosclerosis. Erectile dysfunction in diabetic patients is multifactorial as shown by its association with variable clinical and laboratory parameters. We believe that management of diabetes is an art that can has its effect on improving patient’s health and quality of life by simple basic and cost-effective clinical practice.

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