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Original Research Article

Serum high sensitivity C reactive protein levels in patients with diabetic retinopathy: a cross sectional study

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ABSTRACT

Background: Diabetic retinopathy (DR) is one of the major visual morbidities associated with diabetes. This study determined the levels of serum high-sensitivity C-reactive protein (hs-CRP) in patients with DR and to correlate the estimated levels of serum hs-CRP with the severity of DR and other coexisting factors.
Methods: This was a cross-sectional study conducted between March 2009 and August 2010 and included patients with type 2 diabetes mellitus (T2DM) with or without DR. A detailed fundus evaluation was performed using direct and indirect ophthalmoscopy. The retinopathies were observed and documented in accordance with the Kanski's system of classification as background DR (BDR), pre-proliferative DR (PPDR), and proliferative DR (PDR). Laboratory investigations determined the levels of fasting blood glucose (FBG), postprandial blood glucose (PPBG), glycosylated hemoglobin, urine albumin excretion, and serum hs-CRP levels.
Results: In total, 80 patients with T2DM were included (DR group, n=40 [BDR, n=22; PDR, n=11; PPDR, n=7]; control group, n=40). Highest serum hs-CRP levels were found in PDR group (6.68 mg/L), followed by PPDR and BDR group (3.2 mg/L and 1.56 mg/L, respectively). The PDR group showed the longest duration of diabetes (16 years), highest FBG (221.8 mg/dL) and HbA1c (6.68 mg/L). The incidence of albuminuria and maculopathy was higher in PDR group (72.7% and 54.54%, respectively). A significant association of hs-CRP levels with DR in patients with T2DM was observed. A significantly (<0.005) positive correlation of hs-CRP was also observed with age, duration of disease, FBG, PPBG, and HbA1c.
Conclusions: Patients with severe grades of retinopathy had significantly higher hs-CRP levels than patients with the milder grades.

Keywords: Diabetes, Fundus, Glycemic control, Kanski's system, Proliferative

INTRODUCTION

Diabetes mellitus is one of the leading causes of mortality and morbidity owing to its complications, and it adds significant financial burden on both society and the healthcare system. Diabetic retinopathy (DR) is one of the major visual morbidities associated with diabetes that further leads to maculopathy and retinal neovascularization.[1] Patients with untreated diabetes are 25 times more likely to become blind due to DR and macular edema as compared to those without diabetes.[2] Patients with DR may not present any symptoms until very late stage; hence, patients with diabetes need to keep a regular check and screen for ocular diseases. According to the Union Health Ministry's survey (2015-2019), the incidence of DR was 16.9% while the incidence of sight-threatening DR was 3.6%.[3]

The exact sequence of events in the pathogenesis of DR is yet to be investigated while some studies propose microvascular occlusion, oxidative stress, inflammation and abnormal metabolic pathways to be critical contributors.[4,5] Familial influence and genetic predisposition are other associated factors responsible for DR.[6,7] Inflammation is a prime factor in DR progression; hence, therapeutic approaches like corticosteroids and anti-vascular endothelial growth factor are found effective in slowing the progression of DR.[8,9] It is mainly classified as non-proliferative DR (NPDR) and proliferative DR (PDR) depending upon the presence of neovascularization, which is further subdivided into mild, moderate, and severe stages. The management of DR is successfully achieved via a combination therapeutic approach, such as glucose monitoring, laser therapy, and vitrectomy. Glycemic control plays an important role in the management of DR; however, despite this, few patients may still develop DR and some may be spared.[10]

High-sensitivity C-reactive protein (hs-CRP), a measure of inflammation, is elevated in patients with diabetes and those with macro vascular complications. Therefore, it is considered to be a marker for cardiovascular and arterial diseases. Diabetes and hypertension are strongly associated with inflammation and vascular dysfunction and are considered to be the major risk factors for retinal disorders. The serum hs-CRP levels are positively associated with the severity of retinopathy.[10]

There is limited information on the association between serum hs-CRP levels and DR and most of the results are inconclusive. This paper presents the results of a study that evaluated the serum hs-CRP levels in patients with DR. This study also evaluated the correlation of serum hs-CRP levels with the severity of DR and other coexisting factors including duration of diabetes and metabolic control of diabetes.

METHODS

This was a cross-sectional single-center study conducted between March 2009 and August 2010 at the Department of General Medicine, Pushpagiri Medical College, Thiruvalla, Kerala, India. The study protocol was approved by the Institutional Ethics Committee, and the study was conducted in accordance with the ethical principles that have their origin in the Declaration of Helsinki. Written informed consent was obtained from each participant before any study related procedure.

Patients of either sex aged more than 18 years with a confirmed diagnosis of type 2 diabetes mellitus (T2DM) were included in this study. Patients who were on medications or those with conditions known to affect C-reactive protein (CRP) levels (angiotensin-converting enzyme inhibitors, nonsteroidal anti-inflammatory drugs, statins, aspirin, other concomitant infections, pregnancy), patients with ocular media opacity in both eyes that may interfere with detailed examination of the fundus, and patients with other degenerative lesions of the fundus were excluded from the study.

Following data related to diabetes was collected: age of onset, duration, nature, and effect of treatment received. A general physical examination was performed followed by a complete ophthalmic examination. A detailed fundus evaluation was performed using direct and indirect ophthalmoscopy. The retinopathies were observed and documented in accordance with the Kanski's system of classification as background diabetic retinopathy (BDR), pre-proliferative diabetic retinopathy (PPDR), and proliferative diabetic retinopathy (PDR).

In patients with asymmetric fundus findings, the eye with a more severe grade of DR was taken into consideration. Laboratory investigation was performed to determine the levels of fasting blood glucose (FBG), postprandial blood glucose (PPBG), glycosylated hemoglobin (HbA1c), and urine albumin excretion. Estimation of serum hs-CRP levels was done in vitro using flex reagent cartridge on the dimension clinical chemistry system.

Categorical variables were expressed as frequencies and percentages, numerical variables as mean (standard deviation). Association between the parametric variables was evaluated using the Chi-square test. A comparison of data between the groups was performed using the student t-test. A p value of <0.01 was considered as statistically significant.

RESULTS

A total of 80 patients were included in the study (DR group, n=40 and without DR (control group), n=40). The patients from DR group (n=40) were further classified into 3 groups according to the stage of DR: BDR (n=22, 55%), PPDR (n=7, 17.50%), and PDR (n=11, 27.50%). The mean age of the patients in BDR, PPDR, PDR, and control group were 56.32, 65.14, 66.73, and 62.05 years, respectively. In all the groups, the number of women was higher than the number of men (Table 1).

There was a significant difference in the duration of diabetes in all grades of retinopathy and control group. The PDR group had the longest duration of diabetes (16 years); however, the control group had the shortest duration of diabetes (9.37 years). The FBG was highest in the PDR (221.82 mg/dL) group and lowest in the control group (128.87 mg/dL). The mean levels of PPBG were higher in the PDR group (328.73 mg/dL) and lower in the control group (192.50 mg/dL). The mean HbA1c value was highest in the PDR group (10.84 mmol/mol), followed by PPDR and BDR group (9.34 mmol/mol and 8.96 mmol/mol, respectively). The highest mean serum hs-CRP levels were found in the PDR group (6.68 mg/L), followed by the PPDR and BDR groups (3.2 mg/L and 1.56 mg/L, respectively). The incidence of albuminuria and maculopathy was higher in the PDR group (72.72% and 54.54%, respectively) (Table 1).

Table 1: Group wise distribution of the study population.

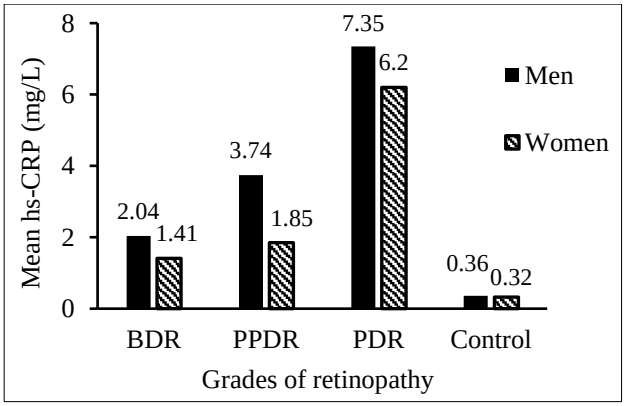
Parameters	BDR (n=22)	PPDR (n=7)	PDR (n=11)	Control (n=40)	p value
Age (years)	56.32 (7.64)	65.14 (8.23)	66.73 (5.73)	62.05 (0.53)	<0.05[a], 0.01[c], >0.05[b, d-f]
Sex, n (%) Men	13 (59.09)	4 (57.14)	5 (45.45)	14 (35.00)	0.152
Frequency of grades, n (%)	22 (55.00)	7 (17.50)	11 (27.50)	-	-
Duration of diabetes (years)	10.32 (2.00)	14.71 (0.75)	16 (2.00)	9.37 (2.57)	<0.001[a,c,f], <0.05[d,e], 1.00[b]
Fasting blood sugar (mg/dL)	153.82 (36.39)	194.86 (23.64)	221.82 (24.18)	128.87 (27.04)	<0.001[a, e, f],0.011[c], <0.05[d], 0.63[b]
Post prandial blood sugar(mg/dL)	255.09 (53.95)	287.71 (51.91)	328.73 (21.15)	192.50 (54.23)	<0.001[a, e, f], <0.05[d], 0.86[c], 0.59[b]
HbA1c (mmol/mol)	8.96 (1.06)	9.34 (1.23)	10.84 (1.11)	7.49 (0.80)	<0.001[a, d-f], <0.05[b], 1.0[c]
Serum hs-CRP (mg/L)	1.56 (1.10)	3.2 (1.47)	6.68 (1.73)	0.34 (0.34)	<0.001[a-f]
Albuminuria (mg/mmol), n (%)	3 (13.63)	3 (42.85)	8 (72.72)	2 (5.00)	<0.001
Maculopathy, n (%)	2 (9.09)	2 (28.57)	6 (54.54)	-	<0.001

Data shown as mean (SD), unless otherwise specified. BDR, background diabetic retinopathy; HbA1c, glycosylated haemoglobin; hs-CRP, high-sensitivity C-reactive protein; PDR, proliferative diabetic retinopathy; PPDR, pre proliferative diabetic retinopathy.
[a] BDR vs. PDR; [b] PPDR vs. PDR, [c] BDR vs. PPDR; [d] BDR vs. Control; [e] PPDR vs. Control; [f] PDR vs. Control.

Table 2: Relationship between hs-CRP and other parameters in both groups.

Parameters		DR (n=40)	Control (n=40)
Age (years)	<49	2/0.75 (0.21)	6/0.15 (0.08)
	50-64	24/2.91 (2.41)	14/0.22 (0.09)
	>65	14/4.20 (2.78)	20/0.47 (0.43)
p value		0.12	0.03
Duration of diabetes (years)	<10	8/1.81 (1.6)	26/0.19 (0.1)
	10-14	17/2.04 (1.88)	11/0.41 (0.23)
	>15	15/5.40 (2.32)	3/1.26 (0.50)
p value		<0.001	<0.001
HbA1c (mmol/mol)	≤7	1/0.6	12/0.26 (0.14)
	>7	39/3.32 (2.58)	28/0.37 (0.39)
p value		0.14	0.35

Data shown as n/mean (SD), unless otherwise specified.
DR, diabetic retinopathy; HbA1c, glycosylated hemoglobin; hs-CRP, high-sensitivity C-reactive protein; SD, standard deviation. ≤7, well controlled group; >7, poorly controlled group.



BDR, background diabetic retinopathy; hs-CRP, high-sensitivity C-reactive protein; PDR, proliferative diabetic retinopathy; PPDR, pre-proliferative diabetic retinopathy.

Figure 1: Relation of mean hs-CRP with gender and grades of retinopathy.

Figure 1 shows the association of mean hs-CRP with gender and grades of retinopathy. The mean hs-CRP levels were comparable between men and women; however, a significantly increasing trend was observed in hs-CRP levels with the advancement of DR stage (BDR<PPDR<PDR). Majority of patients with DR had poor glycemic control (n=39) as compared to the patients without DR (p<0.05).

Elevated hs-CRP level was associated with increase in age and duration of diabetes in the DR and control groups. The mean hs-CRP level in well-controlled patients (HbA1c ≤7) was 0.6 and 0.26 in DR and control groups, respectively, while in the poorly controlled group (HbA1c >7), it was 3.32 and 0.37, respectively (Table 2).

In the DR group, patients with maculopathy (n=10) had significantly higher mean (SD) hs-CRP level (4.66 [2.49]

mg/L) as compared to patients without maculopathy. A significantly positive correlation of hs-CRP levels was observed with age, duration of disease, FBG, PPBG, and HbA1c (Table 3).

Table 3: Correlation coefficient of hs-CRP with other parameters.

Parameters	Correlation coefficient	p value
Age (years)	0.33	0.002
Duration of diabetes (years)	0.57	<0.001
Fasting blood glucose (mg/dL)	0.55	<0.001
Post prandial blood glucose (mg/dL)	0.38	0.001
HbA1c (mmol/mol)	0.58	<0.001

HbA1c, glycosylated hemoglobin; hs-CRP, high-sensitivity C-reactive protein.

The number of patients with albuminuria were highest in the PDR group (72.72%). The highest hs-CRP levels (6.46 mg/L) and the lowest hs-CRP levels (1.1 mg/L) were observed in the control group (Table 4).

Table 4: Relationship between hs-CRP levels and albuminuria in different grades of retinopathy.

Grades of retinopathy	Number of patients with albuminuria (%)	hs-CRP
BDR	3 (13.63)	2.16 (1.58)
PPDR	3 (42.85)	3.65 (2.05)
PDR	8 (72.72)	6.46 (1.89)
Control	2 (5.00)	1.1 (0.98)

Data shown as mean (SD), unless otherwise specified. BDR, background diabetic retinopathy; hs-CRP, high-sensitivity C-reactive protein; PDR, proliferative diabetic retinopathy; PPDR, pre-proliferative diabetic retinopathy; SD, standard deviation.

DISCUSSION

In this study, the fundii of 40 patients were examined and categorized based on their grade of retinopathy as per the Kanski system of classification. The grades of diabetic retinopathies of these patients and their mean serum hs-CRP levels were compared with various parameters such as patient age, gender, diabetic age, and glycemic control. The results depict a significant association of hs-CRP levels with DR in patients with T2DM. Glycemic control, age, and HbA1c levels ($p<0.05$) were significantly associated with hs-CRP levels in patients with DR. Advanced stages of DR showed a trend of increase in hs-CRP level and albuminuria, suggesting hs-CRP to be a vital indicator of retinal and chronic inflammatory diseases considering that its production upsurges in response to any infection, injury, or autoimmune inflammatory diseases.

Advanced stage of DR is associated with an increased cardiovascular event independent of other risk factors.[1] Studies have also reported hs-CRP levels to be a potent predictor of impending cardiovascular diseases and diabetic nephropathy.[11] Few studies have demonstrated the association of hs-CRP with the severity of DR; however, the results vary.[12] Findings from this study are in accordance with an Indian study conducted by Gopinath et al, who demonstrated the co-relation of inflammatory process and metabolic control in the pathogenesis of DR and diabetic macular edema as indicated by CRP and HbA1c.[13]

A similar study was conducted by Peng et al, in Chinese patients with T2DM (N=1018) and it revealed that not only CRP but also its genetic variants are associated with DR. The mean age of patients with and without DR was 62.48 and 67.37 years, BMI of 24 kg/m^2 and duration of diabetes >10 years. Furthermore, this study showed that women predominated in both the groups, and there was no grouping of patients according to the stages of DR, while the present study showed majority of women without DR.[10]

A systematic review and meta-analysis by Song et al. on a series of 3679 patients from 22 studies revealed a potential relationship between CRP level and DR and showed higher blood CRP levels in patients with DR than those without DR.[14] The present study demonstrated that hs-CRP levels in patients with PDR was higher compared with patients with NPDR and PPDR, which is consistent with the findings of Chen et al, and Jia et al, suggesting a positive association of hs-CRP with the severity of DR.[15,16]

Several studies have referred to hs-CRP instead of CRP. In fact, hs-CRP is CRP that is detected using immunoassay methods to increase the sensitivity for CRP quantification in acute phase responses.[17]

Blum et al, conducted a study in a series of 73 patients with diabetes, of which 25 patients showed NPDR stage and 23 patients showed PDR stage. The hs-CRP levels were higher in patients with diabetes than the control group. However, they concluded that patients with diabetes but without retinopathy and those with NPDR had high levels of inflammatory and angiogenic markers, which decreased in patients with PDR. Studies in patients with DR have examined several clinical parameters in NPDR and PDR stage of retinopathy; however, none of the studies looked at the PPDR stage that was investigated in the present study.

Metabolic parameters such as age, duration of diabetes, glycemic control and HbA1c are indicators of manifestation and progression of DR. Duration of disease, insulin resistance, and genetic factors are unalterable components of metabolic control, while improved glycemic control and blood pressure with reduced HbA1c are proven to be efficacious in reducing the levels of hs-CRP resulting in slowing of DR progression.[18] This study showed a positive correlation of

age and HbA1c ($p<0.05$) with serum hs-CRP levels, which was in accordance with the report of Gopinath et al and Bertin et al.[13,19] Previous research suggests a significant correlation of hs-CRP with metabolic syndrome; however, it is unclear whether controlled metabolic components will reduce hs-CRP levels.[20,21]

Albuminuria is another sensitive marker of severity of DR. The present study showed a positive association of albuminuria with PDR that was in accordance with the results obtained by Rani et al, and Boelter et al.[22,23] The present study showed a high prevalence of PDR than BDR and PPDR, and the results suggested longer duration of diabetes and albuminuria to be strong predictors of DR.[24]

Occurrence of maculopathy was high in the PDR group (54.5%) as compared to the BDR (9.1%) and NPDR (28.6) groups and was found to be absent in control group, while a study conducted by Zander et al. showed that 56% patients in the PDR group maculopathy.[25] Furthermore, literature reports that long duration of diabetes jeopardizes the development of maculopathy in DR.

Previous studies advocate that early diagnosis of T2DM along with a significant control of blood glucose and blood pressure have probably greatly decreased the prevalence of BDR but not in case of sight-threatening PDR. The prevalence of retinopathy is significantly higher in individuals who develop diabetes, even within 3 years of diagnosis.[26] Systolic blood pressure and HbA1c were higher at baseline in the patients who had retinopathy compared with those without retinopathy. On the basis of clinical evidences, it is observed that blood pressure and diabetes frequently coexist resulting in more severe DR; hence, it is recommended that control of blood pressure in patients with T2DM is an important preventive measure for visual loss due to DR.[27,28] In the present study, systolic and diastolic blood pressure between the groups was not taken into consideration. Although a positive association was observed with serum hs-CRP levels and the grades of retinopathy, the question remains whether raised hs-CRP level is a cause or just an effect of chronic endothelial damage. Studies with larger sample size are required to clearly delineate the role of serum hs-CRP in the causation of microvascular complications of diabetes.

This study was limited by small sample size due to inclusion of patients from a single center; hence, the caution must be taken when generalizing these results. A larger sample size at multiple centers with inclusion of various age and ethnic groups may have depicted different trends.

CONCLUSION

This study revealed that patients with severe grades of retinopathy had significantly higher levels of serum hs-CRP compared to the patients with milder grades. A significant association was observed between duration of diabetes, poor glycemic control, HbA1c levels, and albuminuria at different stages of DR.

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REFERENCES

1. Targher G, Bertolini L, Zenari L, Lippi G, Pichiri I, Zoppini G, et al. Diabetic retinopathy is associated with an increased incidence of cardiovascular events in Type 2 diabetic patients. Diabet Med. 2008; 25:45-50.
2. Holekamp N. Overview of diabetic macular edema. Am J Manag Care. 2016;22:S284-91.
3. Prevalence of diabetic retinopathy in India is 16.9%: Survey. Available at: https://www.aninews.in/news/health/prevalence-of-diabetic-retinopathy-in-india-is-169-survey20191010175050/. Accessed 26th December 2019.
4. Vainas T, Stassen F, Graff R, Twiss E, Herngreen S, Welton R, et al. C-reactive protein in peripheral arterial disease: relation to severity of the disease and to future cardiovascular events. J Vasc Surg. 2005;42:243-51.
5. Navarro J, Mora C. Role of inflammation in diabetic complications. Nephrol Dial Transplant. 2005;20: 2601-4.
6. Arar NH, Freedman BI, Adler SG, Iyengar SK, Chew EY, Davis MD, et al. Heritability of the severity of diabetic retinopathy: the FIND-Eye study. Invest Ophthalmol Vis Sci. 2008;49:3839-45.
7. Ng DP. Human genetics of diabetic retinopathy: current perspectives. J Ophthalmol. 2010; 2010:172593.
8. Heng LZ, Comyn O, Peto T, Tadros C, Ng E, Sivaprasad S, et al. Diabetic retinopathy: pathogenesis, clinical grading, management and future developments. Diabet Med. 2013;30:640-50.
9. Rangasamy S, McGuire PG, Das A. Diabetic retinopathy and inflammation: novel therapeutic targets. Middle East Afr J Ophthalmol. 2012;19:52-9.
10. Peng D, Wang J, Zhang R, Tang S, Jiang F, Chen M, et al. C-reactive protein genetic variant is associated with diabetic retinopathy in Chinese patients with type 2 diabetes. BMC Endocr Disord. 2015; 2(15):8.
11. Hayashino Y, Mashitani T, Tsujii S, Ishii H, Diabetes Distress and Care Registry at Tenri Study

Group. Serum high-sensitivity C-reactive protein levels are associated with high risk of development, not progression, of diabetic nephropathy among Japanese type 2 diabetic patients: a prospective cohort study (Diabetes Distress and Care Registry at Tenri [DDCRT7]). Diabetes Care. 2014;37:2947-52.
12. Tsunoda K, Arita M, Yukawa M, Ueyama M, Furuta M, Nakagawa T, et al. Retinopathy and hypertension affect serum high-sensitivity C-reactive protein levels in type 2 diabetic patients. J Diabetes Complica. 2005;19:123-7.
13. Gopinath G, Kakkanatt V, Bisto AA, Mathai MT. Correlation of C-reactive protein and glycosylated hemoglobin on severity of diabetic macular edema. Kerala J Ophthalmol. 2019;31:131-7.
14. Song J, Chen S, Liu X, Duan H, Kong J, Li Z. Relationship between C-Reactive protein level and diabetic retinopathy: a systematic review and meta-analysis. PLoS ONE. 2015;10:e0144406.
15. Chen YS. Contents changes and correlations between homocysteine and cystatin C in patients with diabetic retinopathy in type 2 diabetes mellitus. Int J Ophthalmol. 2010;10:2107-10.
16. Jia ZT, Liu CY, Li H. Changes of the concentration of serum ischemia modified albumin and high sensitivity C-reactive protein in type 2 diabetic patients with retinopathy]. Zhonghua Yan Ke Za Zhi. 2009;45:805-8.
17. Pepys MB, Hirschfield GM. C-reactive protein: a critical update. J Clin Invest. 2003;111:1805-12.
18. Fong DS, Aiello LP, Ferris FL Klein R. Diabetic retinopathy. Diabetes Care. 2004;27:2540-53.
19. Bertin E, Nguyen P, Guenounou M, Durlach V, Potron G, Leutenegger M. Plasma levels of tumor necrosis factor-alpha (TNF-alpha) are essentially dependent on visceral fat amount in type 2 diabetic patients. Diabetes Metab. 2000;26:178-82.
20. Engelsen D, Koekkoek P, Gorter K, Donk M, Salome P, Rutten G. High-sensitivity C-reactive protein to detect metabolic syndrome in a centrally obese population: a cross-sectional analysis. Cardiovasc Diabetol. 2012;11:25.
21. Chuengsamarn S, Rattanamongkolgul S, Sittithumcharee G, Jirawatnotai S. Association of serum high-sensitivity C-reactive protein with metabolic control and diabetic chronic vascular complications in patients with type 2 diabetes. Diabetes Metab Syndr. 2017;11:103-8.
22. Rani PK, Raman R, Gupta A, Pal SS, Kulothungan V, Sharma T. Albuminuria and diabetic retinopathy in type 2 diabetes mellitus Sankara Nethralaya diabetic retinopathy epidemiology and molecular genetic study (SN-DREAMS, report 12). Diabetol Metab Syndr. 2011;3:9.
23. Boelter MC, Gross JL, Canani LH, Costa LA, Lisboa HR, Três GS, et al. Proliferative diabetic retinopathy is associated with microalbuminuria in patients with type 2 diabetes. Braz J Med Biol Res. 2006;39:1033-9.
24. Ra H, Yoo JH, Ban WH, Song HC, Lee SS, Kim SR, et al. Predictors for diabetic retinopathy in normoalbuminuric people with type 2 diabetes mellitus. Diabetol Metab Syndr. 2012;4:29.
25. Zander E, Herfurth S, Bohl B, Heinke P, Herrmann U, Kohnert K, et al. Maculopathy in patients with diabetes mellitus type 1 and type 2: associations with risk factors. B J Ophthalmol. 2000;84:871-6.
26. Diabetes Prevention Program Research Group. The prevalence of retinopathy in impaired glucose tolerance and recent-onset diabetes in the Diabetes Prevention Program. Diabet Med. 2007;24:137-44.
27. Tomić M, Ljubić S, Kaštelan S, Gverović Antunica A, Jazbec A, Poljičanin T. Inflammation, haemostatic disturbance, and obesity: possible link to pathogenesis of diabetic retinopathy in type 2 diabetes. Mediators Inflamm. 2013;2013:818671.
28. Blum A, Socea D, Ben-Shushan RS, Keinan-Boker L, Naftali M, Segol G, et al. A decrease in VEGF and inflammatory markers is associated with diabetic proliferative retinopathy. Eur Cytokine Netw. 2012;23:158-62.

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