Hemorheologic assessment for screening diabetic nephropathy in type 2 diabetes

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Background and Aim

Hemorheologic alterations or changes in blood viscosity have been suggested to play a role in the pathogenesis of diabetic microvascular complications. We measured various hemorheologic parameters in type 2 diabetes patients and assessed their possible role as a diagnostic tool for diabetic nephropathy.

Methods

Four hundred-seventy patients with type 2 diabetes were included in this study. Hemorheologic parameters, including erythrocyte deformability, elongation index (EI), critical shear stress (CSS), and aggregation index (AI) were measured using microfluidic hemorheometer. Various metabolic parameters were assessed from fasting blood samples and urinary albumin to creatinine ratio was used to assess diabetic nephropathy.

Results

Table 1. Clinical characteristics and hemorheologic parameters of subjects according to urinary ACR group

	ACR group			P-value
	<30 n=375	30 ~ 300 n=55	>300 n=40	
AGE (years)	55.48 (10.31)	59.18 (10.81)	61.53 (9.30)	0.000
BMI (kg/m²)	24.20 (2.98)	24.18 (3.41)	26.01 (4.10)	0.002
SBP (mmHg)	121.63 (8.87)	121.83 (11.99)	132.09 (12.98)	0.000
DBP (mmHg)	73.58 (5.90)	73.01 (8.94)	77.85 (7.47)	0.001
HbA1c (%)	6.31 (1.34)	8.29 (1.81)	8.22 (1.62)	0.000
BUN (mg/dL)	14.74 (7.29)	19.17 (10.41)	28.12 (11.08)	0.000
Cr (mg/dL)	0.77 (0.25)	0.98 (0.55)	1.57 (0.71)	0.000
eGFR (ml/min/m²)	84.74 (10.33)	73.96 (21.00)	49.95 (22.49)	0.000
TC (mg/dL)	190.89 (41.32)	176.26 (38.61)	179.60 (49.82)	0.022
TG (mg/dL)	131.14 (76.45)	177.10 (112.29)	140.72 (72.48)	0.000
LDL-C (mg/dL)	116.21 (33.67)	97.38 (37.11)	101.40 (37.95)	0.000
HDL-C (mg/dL)	50.30 (13.10)	42.87 (10.08)	43.80 (11.73)	0.000
ESR (mm/h)	14.72 (12.57)	27.40 (22.35)	40.52 (23.59)	0.000
Fibrinogen (mg/dL)	271.23 (56.19)	313.28 (78.68)	334.20 (81.34)	0.000
EI at 1.5 Pa (%)	0.2180 (0.0608)	0.2148 (0.0425)	0.2160 (0.0182)	0.913
EI at 3 Pa (%)	0.3215 (0.0180)	0.3181 (0.0186)	0.3161 (0.0150)	0.102
EI max (%)	0.5575 (0.1863)	0.5616 (0.0129)	0.5599 (0.0138)	0.238
Critical time (sec)	8.90 (3.55)	7.93 (3.11)	6.53 (1.36)	0.000
Critical shear stress (Pa)	261.82 (129.97)	308.90 (170.12)	345.88 (154.41)	0.000
AI (%)	40.41 (9.36)	42.05 (9.50)	41.09 (7.92)	0.454
Fibrinogen/3EI (mg/dL%)	811.73 (245.70)	967.99 (273.47)	1060.69 (268.75)	0.000
CSS/3EI (Pa/%)	788.18 (454.75)	985.92 (615.56)	1106.44 (531.97)	0.000
Fibrinogen/CSS (mg/dLPa)	788.18 (454.75)	985.92 (615.56)	1106.44 (531.97)	0.000

Data are means ± SD
Abb: BMI, body mass index; SBP, systolic blood pressure; DBP, diastolic blood pressure; HbA1c, hemoglobin A1c; BUN, Blood urea nitrogen; Cr, creatinine; eGFR, estimated glomerular filtration rate; TC, total cholesterol; TG, triglyceride; LDL-C, low-density lipoprotein cholesterol; HDL-C, high-density lipoprotein cholesterol; ESR, erythrocyte sedimentation rate; EI, elongation index; AI, aggregation index; 3EI, EI at 3 Pa; CSS, critical shear stress

Results

Table 2. Hemorheologic parameters of subjects according to eGFR group

	CKD stage				P-value
	Group IV (eGFR<30)	Group III (30≤eGFR<60)	Group II (60≤eGFR<90)	Group I (eGFR>90)	
	n=10	n=48	n=142	n=260	
Fibrinogen (mg/dL)	357.80 (77.52)	311.98 (66.00)	284.26 (65.60)	271.43 (60.34)	0.000
EI at 1.5 Pa (%)	0.2106 (0.0172)	0.2110 (0.0517)	0.2198 (0.0303)	0.2177 (0.0678)	0.790
EI at 3 Pa (%)	0.3106 (0.0169)	0.3169 (0.0153)	0.3190 (0.0182)	0.3226 (0.0181)	0.021
Critical shear Stress (Pa)	323.08 (82.48)	287.53 (144.46)	274.75 (162.83)	270.10 (125.92)	0.571
CSS/3EI (Pa/%)	1043.23 (272.76)	908.50 (459.26)	849.13 (558.13)	811.53 (463.59)	0.289
Fibrinogen/3EI (mg/dL%)	1040.89 (430.22)	987.86 (221.59)	862.61 (262.95)	808.86 (254.72)	0.000
Critical time (sec)	5.66 (0.88)	8.71 (6.27)	8.90 (3.09)	8.51 (2.87)	0.024

Data are means ± SD
Abb: EI, elongation index; AI, aggregation index; 3EI, EI at 3 Pa; CSS, critical shear stress

Table 3. Multiple regression analysis for urinary ACR

Independent variable	Urine ACR				
	B	SE	β	T	P-value
Constant	-225.55	513.09		-0.44	0.660
Age	-5.143	3.690	-0.61	-1.394	0.164
ESR	9.327	2.946	0.182	3.166	0.002
Hct	-33.493	9.900	-0.175	-3.383	0.001
BMI	45.864	12.103	0.166	3.789	0.000
HbA1c	76.623	24.261	0.142	3.158	0.002
Fibrinogen/3EI	0.347	0.171	0.101	2.026	0.043

Abb: B, unstandardized regression coefficient; β, standardized β; ESR, erythrocyte sedimentation rate; Hct, hematocrit; BMI, Body mass index; HbA1c, hemoglobin A1c; 3EI, EI at 3 Pa

Figure 1. ROC curve between Fibrinogen/3EI and microalbuminuria

Conclusion

Fibrinogen/EI is a sensitive parameter measured via point-of-care testing for screening diabetic nephropathy in patients with type 2 diabetes.