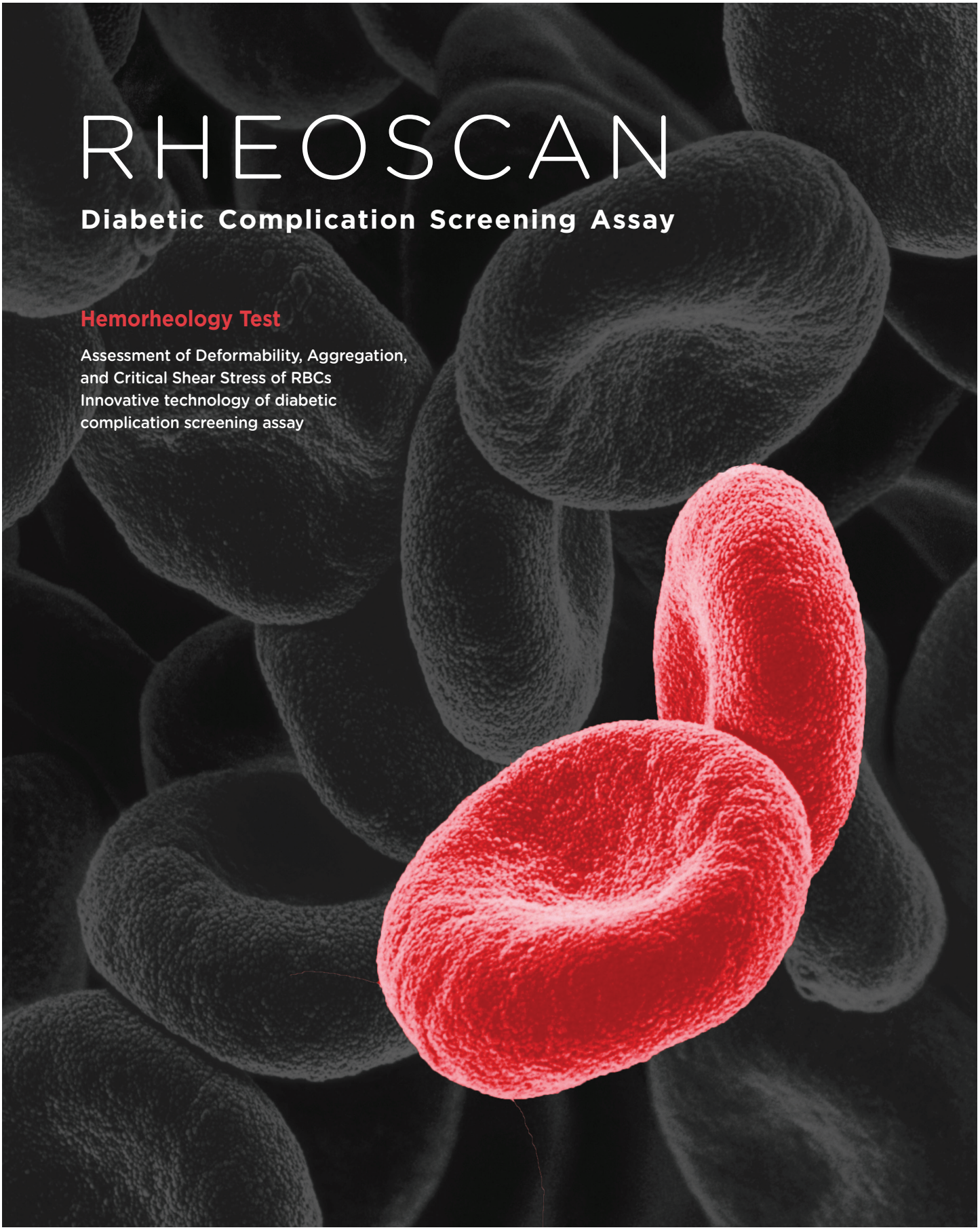
RHEOSCAN

Diabetic Complication Screening Assay

Hemorheology Test

Assessment of Deformability, Aggregation,
and Critical Shear Stress of RBCs
Innovative technology of diabetic
complication screening assay



Innovation	In Healthcare
Diagnostic	Screening device
POCT	Point of Care Technology
RheoScan	Early detection of diabetic complications

RHEO Meditech

Global impact of Diabetic Complications

Diabetes is a condition in which blood sugar is too high, which interferes with the flow of blood, causing several complications. Fatal diabetic complications, such as blindness, foot necrosis, and kidney failure, can also lead to death if not properly treated.

Diabetic Complications

Diabetic Kidney Disease (DKD)

The kidneys are blood vessels in which capillaries are intertwined. 20 ~ 40% of diabetic patients suffer from kidneys disease. Once kidney fail, dialysis or kidney transplantation is necessary.

Current diagnostic methods

Estimated Glomerular filtration rate (eGFR)
Urine Albumin to Creatinine Ratio (UACR)
First morning urinary albumin concentration
Timed urine collections for albumin excretion rates

Diabetic Retinopathy (DR)

Diabetes has a huge impact on eye health. Severe diabetes can lead to vision loss or blindness. According to one study, people with diabetes have a 20-fold increased risk of blindness compared to healthy people. Diabetic retinopathy develops in 50% of patients who have been diabetic for 10 years.

Current diagnostic methods

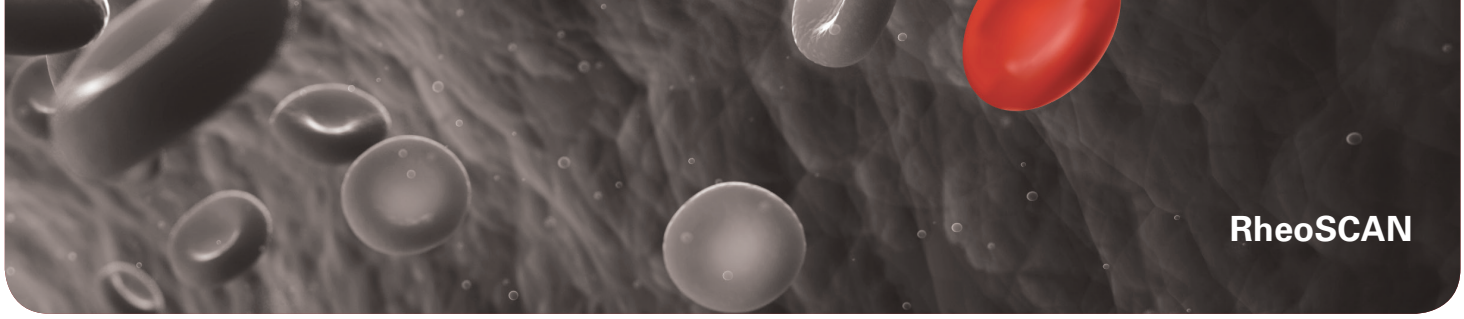
Fundus examination
Mydriatic ophthalmoscopy

Metabolic Syndrome (MetS)

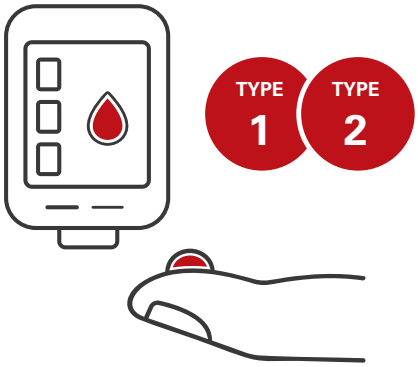
Metabolic syndrome is a set of abnormal conditions, such as increased body fat, increased blood pressure, increased blood sugar, and abnormalities in blood lipids, which increase the risk of cerebral cardiovascular disease and diabetes. People with metabolic syndrome have more than double the risk of cardiovascular disease and have a 10-fold increase in diabetes.

Current diagnostic methods

Abdominal Obesity / Hyperneutral Lipidemia / Low HDL / High Blood Pressure / Blood Sugar Disorder



It is highly Important to **screen before symptoms occur**. Early detection, timely treatment, appropriate follow-up care can reduce the risk of severe symptoms .

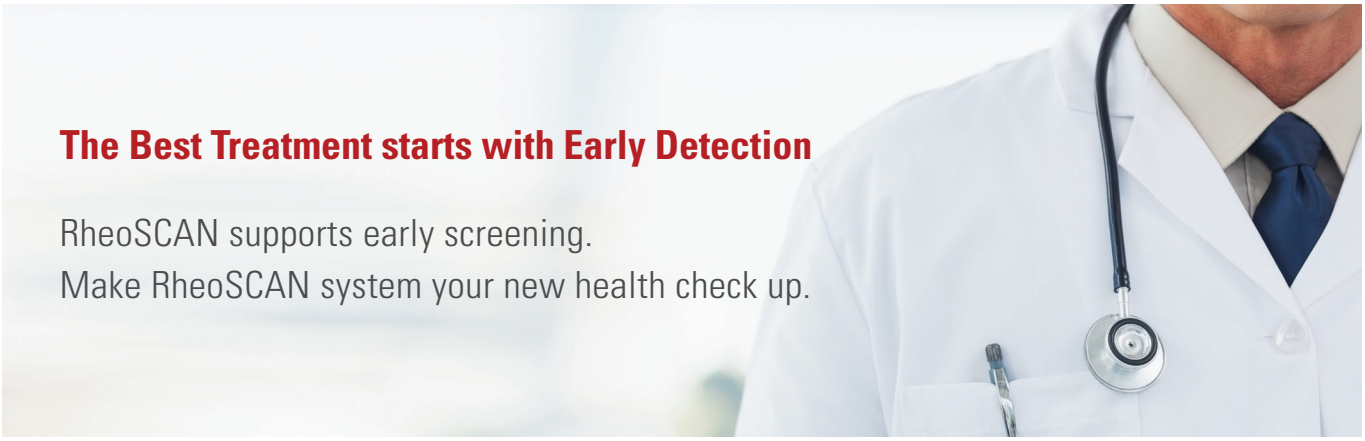


Who is at Risk?

- Anyone with diabetes mellitus

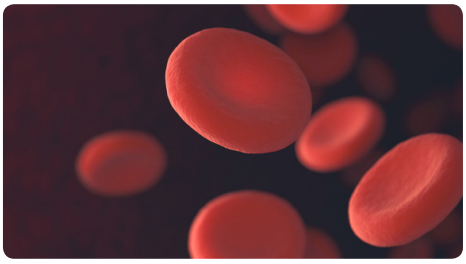
Diabetic Complication

- No early symptoms
- Losing chance to recover
- No screening test available



The Best Treatment starts with Early Detection

RheoSCAN supports early screening.
Make RheoSCAN system your new health check up.



Alteration of hemorheological properties comes first prior to diabetic complications

- RBC deformability
- RBC aggregation

RheoSCAN as a Point of Care Technology

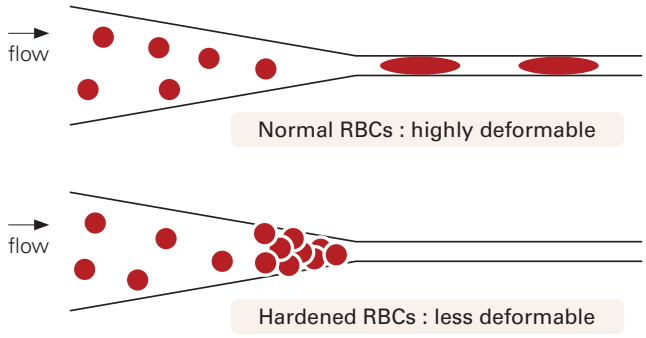
The best treatment starts with early detection

RheoScan Measures

(1) RBC deformability
(2) RBC aggregation

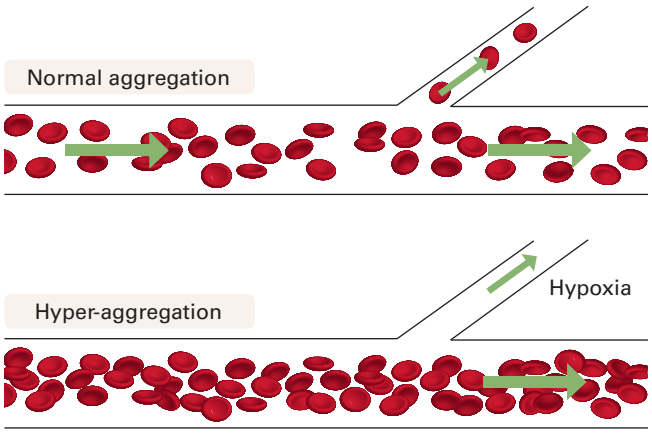
Associated Pathologies

- Diabetic Kidney Disease
- Diabetic Retinopathy
- Metabolic Syndrome



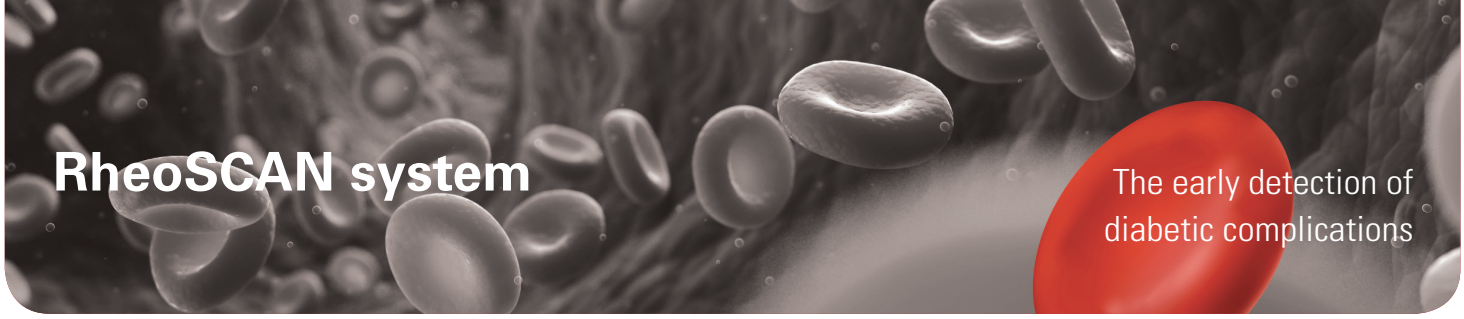
Impaired RBC Deformability leads to hypoxia

RBC **deformability** plays a critical role in blood circulation. Healthy RBCs have to pass through capillaries whose diameter is smaller than their size.
Decreased red blood cell deformability results in **hypoxia** due to decreased oxygen delivery capacity in blood vessels.



Hyper-aggregated RBCs result in vascular diseases

RBC **aggregation** is one of they key factors in determining blood flow resistance in microcirculation. Healthy red blood cells are easy to disaggregate and enter small vessels in an efficient manner, whereas hyper-aggregated red blood cells do not dis-aggregate and causes **local hypertension, vascular sclerosis, and hypoxia.**



Diabetes Mellitus

Hyperglycemia ⇢ Reduced RBC Deformability ↓

Elevated Fibrinogen ⇢ Increased RBC Aggregation ↑

Patients with DM used to have hyperglycemia and elevated fibrinogen, which leads to alterated **RBC deformability** and **aggregation.**

Diabetic Complications

Decision supporting system for precision test

RheoSCAN-D300
RheoSCAN-AnD300 ⇢ Early screening of diabetic complications

Alteration of deformability and aggregation of RBCs can be **detected with RheoScan** system at earlier stages of diabetic complications

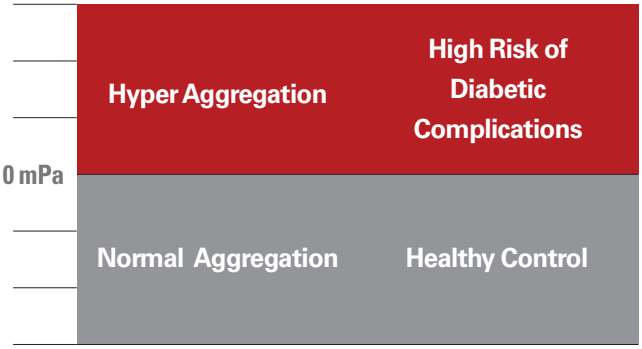
Diabetic Complication Screening Device : RheoScan

Easy Operation	Fast results	High Precision & Reliability	Small sample needed
One step pipetting One-touch operation Fully-automated	Rapid test, Instant results ① Deform. : 30 sec ② Agg. – I (CSS) : 20 sec ③ Agg. – II : 120 sec	Excellent screening Clinically approved High repeatability	Small sample of whole blood ① Deform. : 6 ㎕ ② Agg. – I (CSS) : 0.5 ㎖ ③ Agg. – II : 8 ㎕

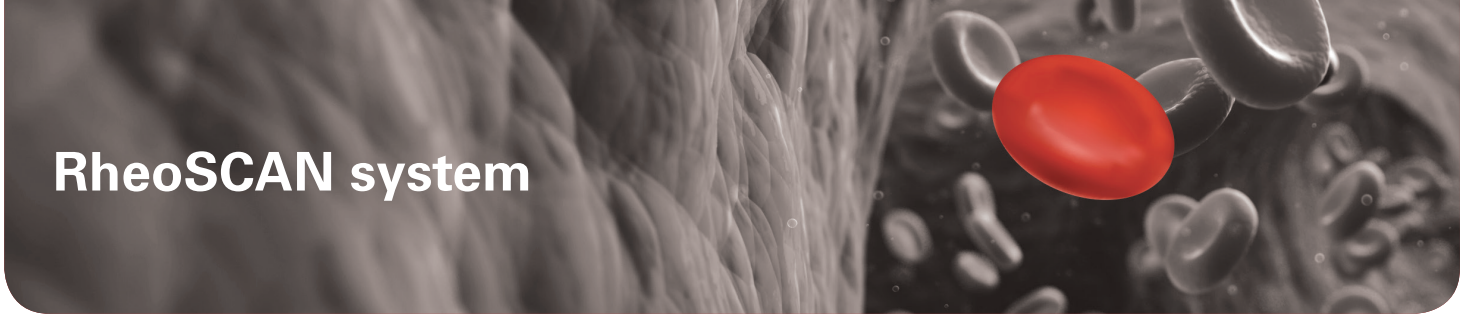
Standard comparison

	CONTROL	DIABETES
20 Pa		
8 Pa		
3 Pa		
0.3 Pa		

Deformability comparison between healthy control and diabetes group.



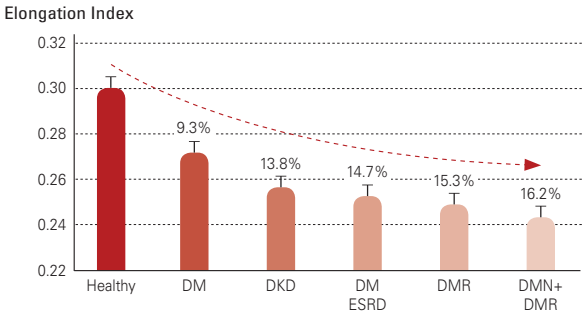
Critical Shear Stress (Aggregation – I) comparison between healthy control and diabetic / Hyper aggregation group.



RheoSCAN system

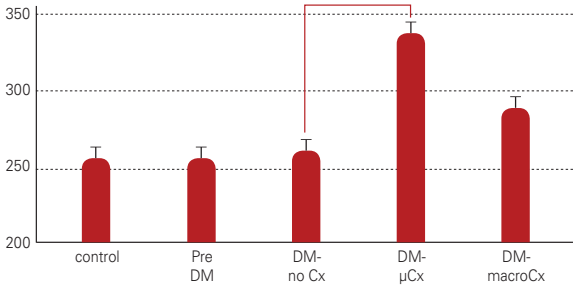
Clinical analysis

RBC Deformability



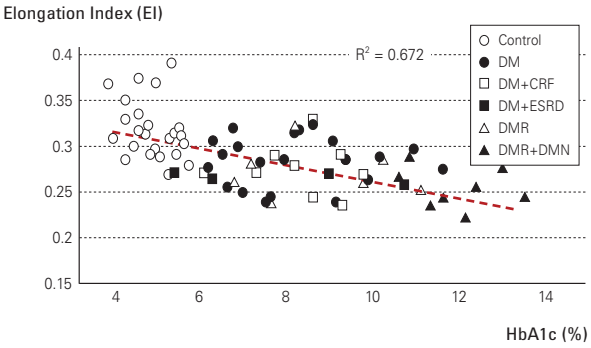
Diabetic complications have been reported to significantly decrease in RBC deformability compared to the healthy group.

RBC Aggregation



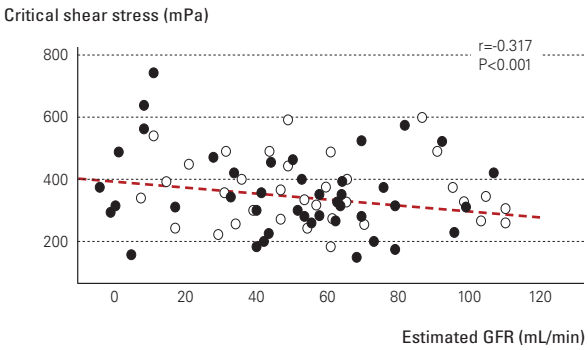
DM complication shows significantly elevated RBC aggregation compared to healthy controls and Pre-DM groups.

Deformability vs. glycated hemoglobin (HbA1c)



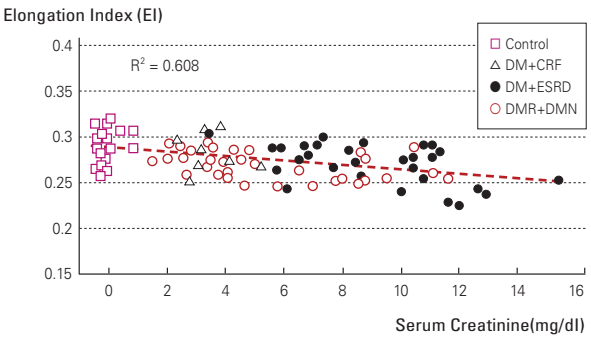
RBC deformability yields a strong correlation with glycated hemoglobin.

CSS vs. estimated GFR (eGFR)

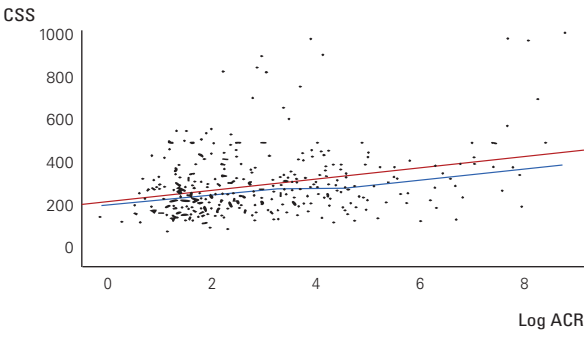


RBC aggregation also yields strong correlation with estimated GFR.

Deformability vs. glycated hemoglobin (HbA1c)

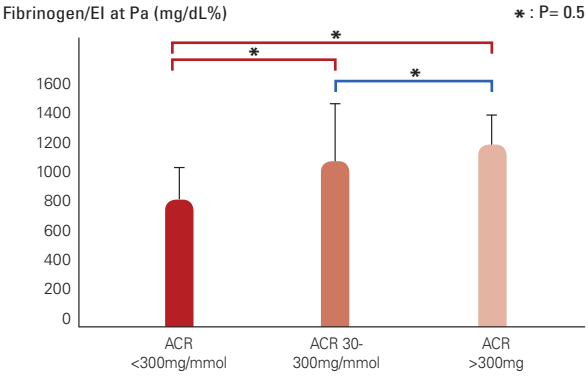


CSS vs. Albumin-to-creatinine Ratio (ACR)

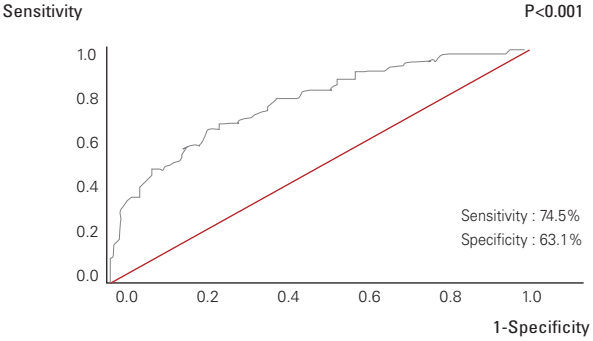


Clinical Test Results

Deformability vs. ACR-classfied DKD

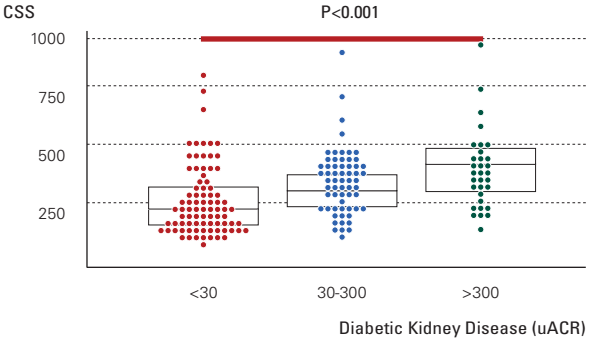


CSS vs. ACR-classfied DKD



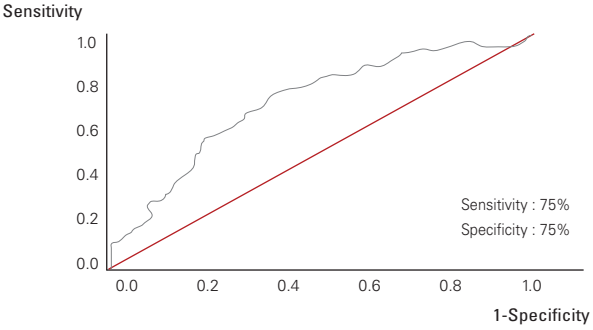
Diagnosis of DKD with Deformability

Critical shear stress (CSS)



Critical shear stress(CSS), representing RBC aggregation can identify the diabetic kidney diseases classified with urine ACR.

Diagnosis of DKD with CSS



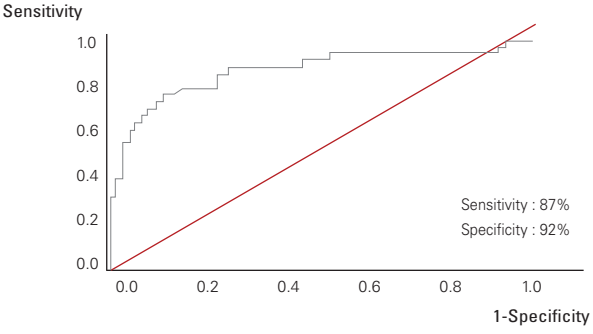
Diagnosis of Metabolic Syndrome

(1) Visceral Obseity
(2) Low HDL Cholesterol
(3) Insulin Resistance
(4) High Triglycerides
(5) Hypertension

CSS

		Systolic BP	Waist circum	HDL-C	Triglyceride	Fast glucose
CSS	*r*	.383	.419	-.459	.591	.200
	P	.000	.000	.000	.000	.049

Diagnosis of MetS with CSS



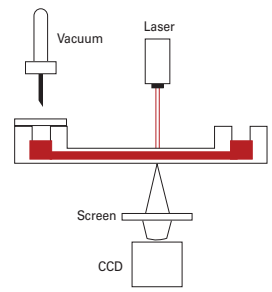
Leading-edge Technologies

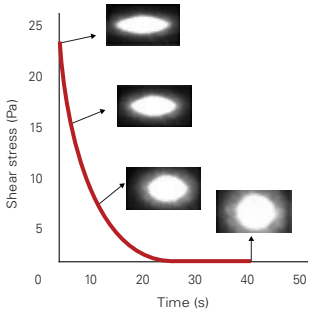
Microfluidics and laser optics meet Hemorheolgy

The Rheoscan System is an innovative technology to measure RBC deformability and aggregation with adopting leading-edge microfluidics and laser optics.

DEFORMABILITY	Microfluidics / Laser-diffractions / Image-processing
AGGREGATION - I (CSS)	Microfluidic Shearing / Light Backscattering / Data-processing
AGGREGATION - II	Microfluidic Stirring / Light Transmission / Data-processing

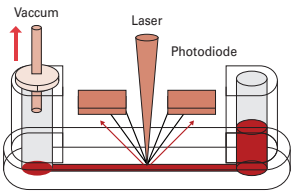
Operating Principles

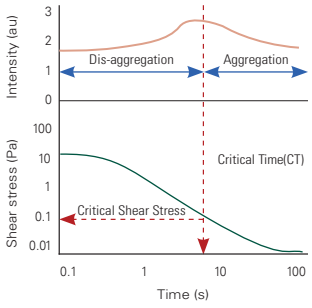




DEFORMABILITY (EI)

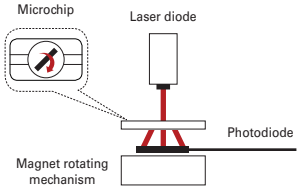
- A blood sample is driven by a vacuum pressure, which is automatically decreasing with time.
- While the sample flow through a microchannel, laser light irradiated to the blood sample forms a diffraction pattern, which is an average shape of RBCs.
- The shear stress of sample flow and diffraction patters are simultaneously recorded and analyzed.

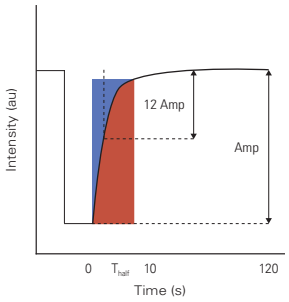




AGGREGATION - I (CSS)

- A blood sample is driven by a vacuum pressure, which is automatically decreasing with time.
- With flowing a sample, a laser irradiated to the blood sample and part of it is backscattered and collected on a optic detector.
- The flow shear stress and light intensity are simultaneously recorded and analyzed.





AGGREGATION - II (AI)

- A blood sample is sheared with a stirrer for 10 s and RBCs are completely disaggregated.
- With sudden stoppage of the stirrer, RBCs tend to aggregated, immediately.
- A transmitted light through the sample is recorded with respect to time and analyzed.

Specifications

Instrument

Model	RheoSCAN-D 300		RheoSCAN-AnD 300		
Image					
Test	Deformability	Aggregation-I (Critical Shear Stress)	Deformability	Aggregation-I (Critical Shear Stress)	Aggregation-II
Sample Volume	6㎕ whole blood, 600㎕ PVP	0.5㎖ whole blood	6㎕ whole blood, 600㎕ PVP	0.5㎖ whole blood	8㎕ whole blood
Test Time	30 s	20 s	30 s	20 s	120 s
Measuring Index	EI, SS½, EIMAX	τ_c (Critical shear stress)	EI, SS½, EI_{MAX}	τ_c (Critical shear stress)	AI, M, $t_{½}$, Amp, t_{fast}, t_{slow}
Kit/Chip	RSD-K02	RSD-K01	RSD-K02	RSD-K01	RSA-C01
Operation Mechanisms	Microfluidics, Laser Diffraction	Micro-stirring, Light Backscattering	Microfluidics, Laser Diffraction	Micro-stirring, Light Backscattering	Micro-stirring, Light Transmission

Rheoscan system must be connected to the computer to operate and the program / user manual will be provided.

Consumables

Test Kit & Chip		
RSD-K01	RSD-K02	RSA-C01
	  PVP solution (600ul)	

The test kit (RSD-K01, RSD-K02) and test chip (RSA-C01) are disposable kits consisting of a sample chamber, a micro-channel, a waste sample chamber, and a rubber cap. These test kits are made of transparent plastic, which are disposable after use. This disposability makes it possible for the Rheoscan System to be used in clinical environments. The test kits is intended for single use only.

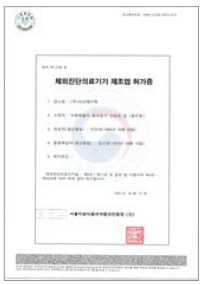
RheoMeditech Inc.

RheoMeditech Inc. is a leading manufacturer of wide range of in vitro diagnostic analyzers, test kits, and consumables. Our line of instruments and test kits are specially designed to elevate the best performance to hospitals and laboratories. RheoMeditech offers early screening and diagnostics that provide health care professionals to make better decisions. We can help people achieve better health through our early diagnosis systems with innovative technology and greater trust. The best treatment starts with early detection.

Certificate

GMP Certificate

ISO 13485 Certificate



IVD Manufacturing License

CE Certification

EC Declaration of Conformity

Certification of Free Sales (FSC)

References

References

1. Chung et al., Critical Shear Stress is Associatedwith Diabetic Kidney Disease in Patients with Type 2 Diabetes, Sci Rep. (2018) 8, 908.

2. Lee et al., Use of RBC deformability index as an early marker of diabetic nephropathy. Clinical hemorheol. microcirc., (2019) 72, 75.

3. Lee et al., Hemorheological Approach for Early Detection of Chronic Kidney Disease and Diabetic Nephropathy in Type 2 Diabetes, Diabetes Technol Ther. (2015) 17, 808.

4. Moon et al., Impaired RBC deformability is associated with diabetic retinopathy in patients with type 2 diabetes, Diabetes Metab. (2016) 42, 448.

5. Gyawali et al., Hemorheology, ankle brachial pressure index (ABPI) and toe brachial pressure index (TBPI) in metabolic syndrome. Microvasc Res. (2014) 95, 31.

6. Gyawali & Richards, Association of altered hemorheology with oxidative stress and inflammation in metabolic syndrome. Redox Rep. (2015) 20, 139.

7. Gyawali et al., The association of dyslipidemia with erythrocyte aggregation, Clinical Lipidology. (2015), 10, 129.

8. Gyawali et al., Hemorheological parameters better classify metabolic syndrome than novel cardiovascular risk factors and peripheral vascular disease marker, Clin Hemorheol Microcirc. (2016) 64, 1.

9. Gyawaliet al., Erythrocyte aggregation and metabolic syndrome, Clin Hemorheol Microcirc. (2014) 57, 73.

RHEO Meditech

2F., 32, Anam-ro, Dongdaemun-gu, Seoul, 02578, Republic of Korea
TEL +82-2-537-5111, +82-2-537-5102 **FAX** +82-2-537-5103 **E-mail** info@any-sis.com / info@rheoscan.com
Website www.any-sis.com / www.rheoscan.com