'TORAY'

Innovation by Chemistry

Hollow Fiber Dialyzer

TORAY FILTRYZER™ NF series

New PMMA membrane

The membrane having the property of protein adsorption and suppressing structural change of adsorbed proteins

Design concept of a new PMMA membrane

PMMA has an adsorption property of several kinds of proteins. As the one of the reasons for the occurrence of coagulation during hemodialysis, it is considered that platelets are activated by adhesion on membrane surface because of recognizing protein structure which was changed by adsorption on membrane (Fig.1 a).
In TORAY FILTRYZER™ NF (NF), we aimed at suppressing platelet adhesion on membrane surface by preventing proteins adsorbed on membrane from structural changes (Fig.1 b).

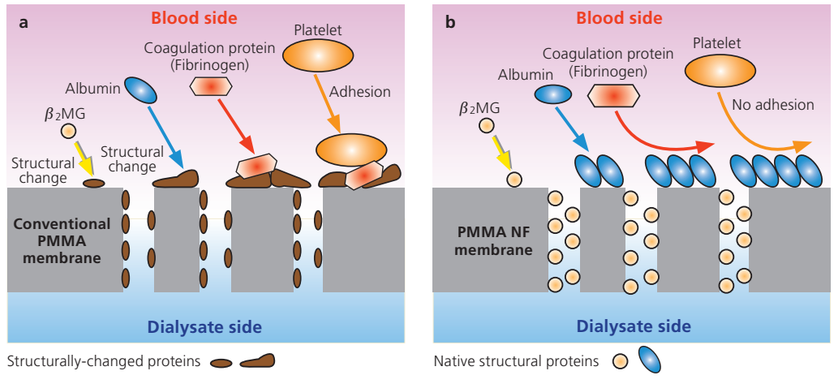

Fig.1 Schema of the protein adsorption mechanism on the PMMA membrane[1)]

Structural change of adsorbed proteins

Structural change of albumin adsorbed on membrane was analyzed by using "Attenuated total reflection Fourier transform infrared spectroscopy (ATR-FTIR)". Peak of amide bond of albumin adsorbed on NF membrane was closer to that of native albumin than that on conventional PMMA membrane (Fig.2).

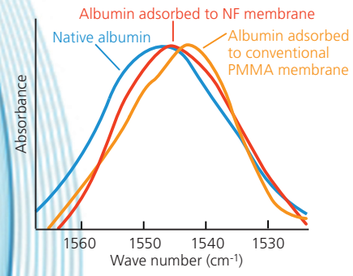

Fig.2 ATR-FTIR spectra of albumin adsorbed on the NF and conventional PMMA membranes, and native human serum albumin[1)]

Improvement of anti-thrombogenecity

Platelet adhesion on the NF membrane surface was lower than the conventional PMMA membrane (Fig.3).
The amounts of fibrinogen adsorbed on the NF membrane were lower than the conventional PMMA membrane (Fig.4).

Suppression of platelet adhesion on membrane

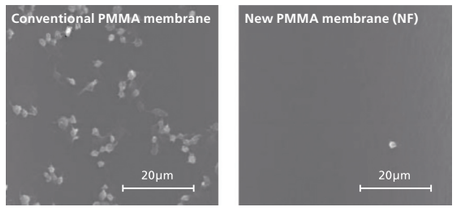

Fig.3 Platelet adsorption on membrane surface in vitro[2)]
(SEM image obtained from in vitro investigation using human blood.)

Suppression of fibrinogen adsorption on membrane

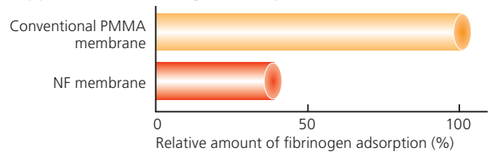

Fig.4 Adsorption amounts of fibrinogen[2) #)]

Membrane structure suitable for protein adsorption

PMMA membrane has a homogenous structure with uniform pore size from inside to outside (Fig.5). The whole membrane plays roles of both the separating layer for solutes and the adsorption for proteins.

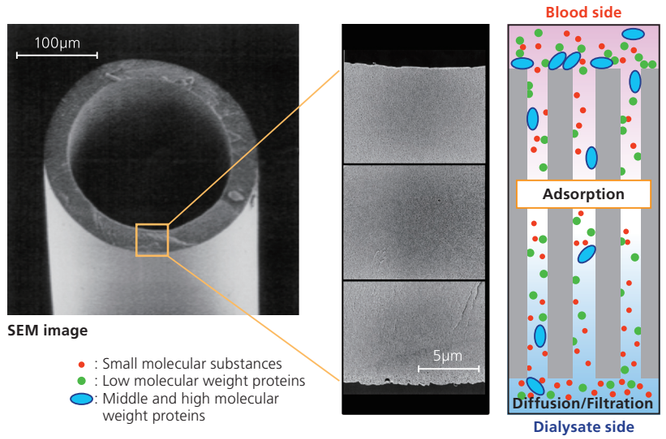

Fig.5 Image of PMMA membrane obtained by scanning electronic microscopy (SEM) and schematic diagram of solutes removal in PMMA[3)]

The PMMA-specific adsorption property

It is confirmed that platelet adhesion is suppressed in NF while adsorption performance in NF is almost equal to conventional PMMA (Fig. 6, 7).

Protein adsorption

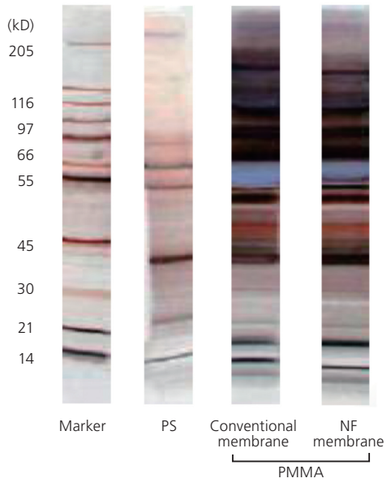

Fig.6 Electrophoretic patterns of proteins adsorbed by membrane[2) #)]

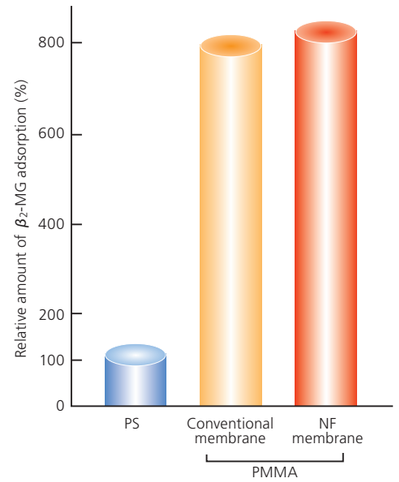

Fig.7 Adsorption amounts of β_2-microglobulin[2) #)]

1) Oshihara W et al., Contrib Nephrol. 2017:189:230-236.
2) Takahashi H et al., Kidney and Dialysis (suppl.) High Performance Membrane '13 2013:75:230-236.
3) Sugaya H et al., Kidney and Dialysis (suppl.) High Performance Membrane '06 2006:61:19-23.
#: Results were obtained from in vitro investigation using human plasma

Performance *(in vitro)*

Type		NF-1.3H	NF-1.6H	NF-1.8H	NF-2.1H
Effective surface area (m^2)		1.3	1.6	1.8	2.1
Clearance (mL/min)[1)]					
Q_B=200mL/min					
	Urea	186	190	192	193
	Creatinine	170	176	178	182
	Phosphate	161	168	172	176
	Vitamin B_{12}	110	119	124	132
	Inulin	56	68	75	81
Q_B=300mL/min					
	Urea	239	250	257	264
	Creatinine	204	220	228	238
	Phosphate	187	203	212	223
	Vitamin B_{12}	119	134	140	152
	Inulin	59	77	77	87
Q_B=400mL/min					
	Urea	279	293	304	312
	Creatinine	234	248	260	271
	Phosphate	207	220	236	251
	Vitamin B_{12}	128	141	154	165
	Inulin	62	75	82	83
KoA[2)]		707	824	916	1,027
UFR (Ultrafiltration coefficient) (mL/hr/mmHg)[3)]		36	43	48	55

1) Aqueous solution, Q_D: 500±10mL/min, Q_F: 10±2mL/min, Temp.: 37±1°C.
2) KoA was calculated by clearanece for Urea at Q_B=300 mL/min.
3) UFR was measured by using bovine blood at a TMP of 50 mmHg in accordance with ISO 8637.

Specifications

Housing material		Polystyrene
Fibers	Material	Polymethylmethacrylate (PMMA)
	Inner diameter (μm)	200
	Membrane thickness (μm)	30
Potting material		Polyurethane
Sterilization		Gamma-ray Irradiation
Maximum TMP (kPa (mmHg))		66 (500)
Range of blood flow rates (mL/min)		100 – 400
Maximum dialysate flow (mL/min)		1000

TORAY

CE 0123

Manufacturer:
Toray Industries, Inc.
1-1, Nihonbashi-Muromachi 2-chome,
Chuo-ku, Tokyo 103-8666, JAPAN

Exporter:
Toray Medical Co., Ltd.
4-1, Nihonbashi-Honcho 2-chome,
Chuo-ku, Tokyo 103-0023, JAPAN

EC REP
Toray International Italy S.r.l.
Via Mecenate 86, 20138 Milan, ITALY

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