Editorial

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What is the final destination of hemodialysis membrane?

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Hemodialysis (HD) is the treatment modality for end-stage renal disease used by the largest number of patients globally. The initial scientific descriptions of these procedures trace back to the 19th century and were pioneered by the Scottish chemist Thomas Graham, often referred to as the "Father of Dialysis." In the spring of 1960, Scribner implanted a shunt in an American, Clyde Shields, in Seattle. Shields became the first chronic HD patient, and the dialysis treatments allowed him to live an additional 11 years before dying of cardiac disease. Subsequently, membrane material, membrane hole size, and dialysis machines underwent continuous improvement and industrial-scale production, with a significant milestone being the development of the first hollow-fiber dialyzer in 1964. Notably, advancements in dialysis membranes have led to improvements in membrane pore size and the utilization of new materials, including synthetic plastics.

In 2002, efforts were made to ascertain whether the dialysis dose or the pore size of the dialysis membrane held greater significance for dialysis patients. The conclusion drawn was that high-flux dialysis was associated with a decreased mortality rate in prevalent HD patients but not in incident HD patients [1]. Nevertheless, researchers believed that enhancing dialysis dosage and improving dialysis membranes would prove beneficial for patients.

A 2012 Cochrane systematic review also suggested that high flux may be superior to low flux concerning cardiovascular mortality, although further research was deemed necessary [2]. In the 2015 Kidney Disease Outcomes Quality Initiative HD guidelines, high-flux dialysis membranes were recommended but were not definitively considered superior to low-flux membranes [3]. Until then, no evidence was found to believe that enlarging the dialysis membrane hole was unconditionally advantageous to the patient. Subsequent research focused on online hemodiafiltration, a technique differing from traditional dialysis mechanisms, and its widespread adoption in acute kidney injury. Studies demonstrated the necessity for dialysis membranes capable of selectively removing uremic substances.

The development of the medium cut-off (MCO) dialyzer aimed to alter the removal rate by leveraging the molecular weight characteristics of uremic substances [4]. Expanded HD using MCO dialyzers represents an innovation enhancing the efficacy of HD. This process is anticipated to facilitate increased removal of uremic toxins without significantly inducing hypoalbuminemia, employing the high-retention onset membrane (Fig. 1) [5].

The CONVINCE trial reported a lower mortality rate associated with high-volume hemodiafiltration compared to high-flux dialyzers. However, as the trial likely selected pa-

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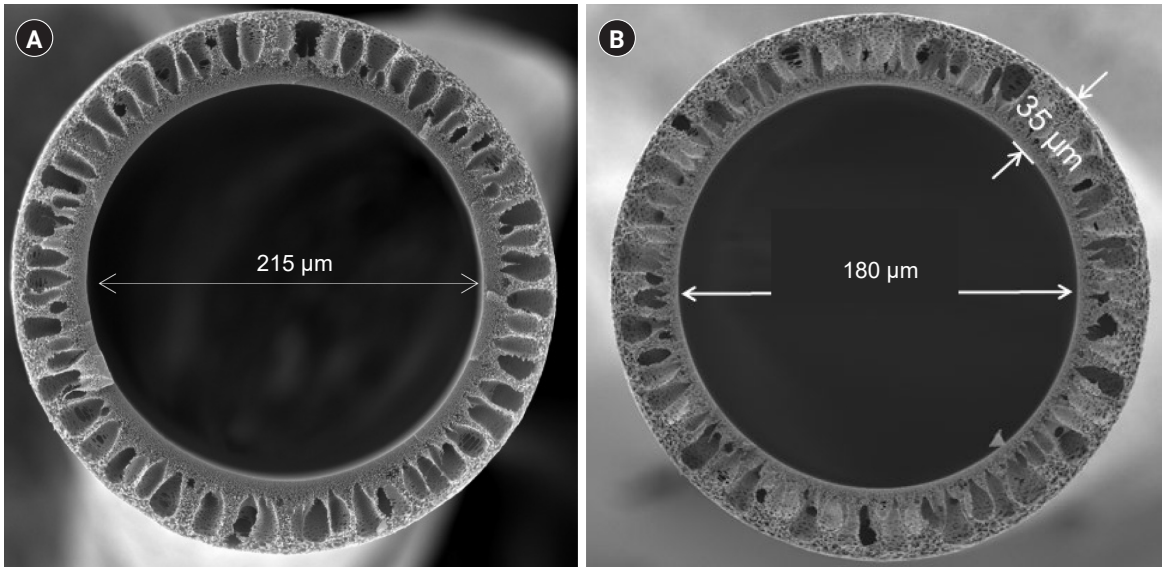

Figure 1. Inner fiber diameter of two dialysis membranes. (A) High-flux membrane type. (B) Medium cut-off membrane type. Smaller fiber diameter to enhance internal filtration quantitatively.

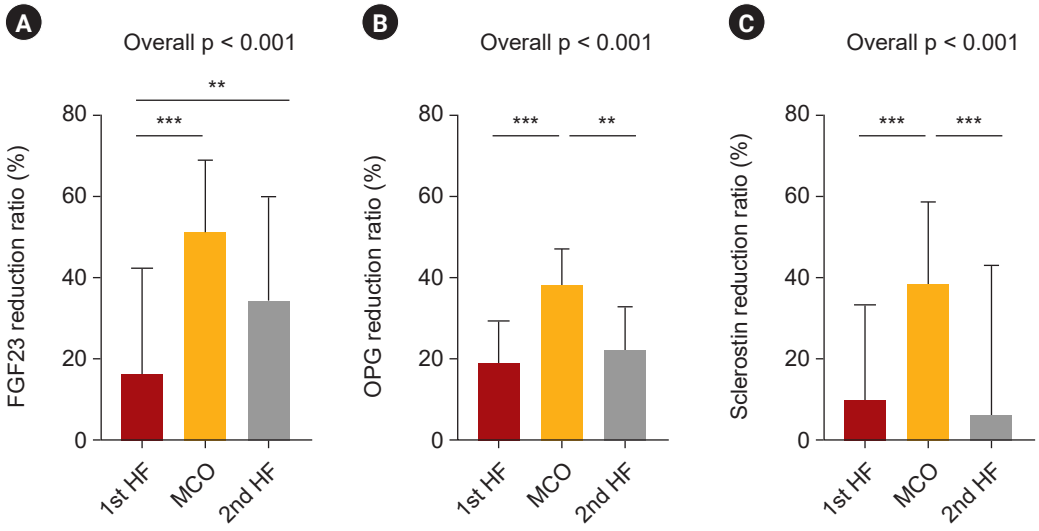

Figure 2. Reduction ratios of the large middle molecules according to the treatment modalities. The reduction ratios of (A) fibroblast growth factor 23 (FGF23), (B) osteoprotegerin (OPG), and (C) sclerostin were significantly higher with the medium cut-off (MCO) dialyzer than with the high-flux (HF) dialyzer.
**p < 0.01, ***p < 0.001.
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tients capable of achieving a convection volume of 23 L or more, utilizing an MCO dialysis machine may present advantages in treatment policy application if clinical results prove favorable [6]. MCO dialysis membranes exhibit a higher removal rate of large middle molecules compared to hemodiafiltration without necessitating a large convection volume or high blood flow velocity, thus proving advantageous for elderly HD patients with poor vascular access [7].

Various studies have been published demonstrating the effectiveness of extended HD therapy using MCO dialyzers.

Previous studies have reported a higher reduction rate of inflammatory markers (tumor necrosis factor alpha, lambda free-light-chains, etc.) in MCO compared to high flux, and further evidence suggests an increased reduction rate of osteoprotegerin and sclerostin, associated with vascular calcification, compared to high flux (Fig. 2) [8–10]. Overcoming limitations such as albumin reduction and alleviating the progression of vascular calcification could lead to heightened expectations for improved cardiovascular disease incidence and mortality in patients through the use of MCO dialyzer instead of high-flow hemodiafiltration. Large-scale randomized controlled trials in the future, including high-volume hemodiafiltration, will further elucidate treatment options for patients with end-stage kidney disease.

Conflicts of interest

The author has no conflicts of interest to declare.

Data sharing statement

The data presented in this study are available from the corresponding author upon reasonable request.

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