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A new generation of cellulose triacetate suitable for online haemodiafiltration☆

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ABSTRACT

Background: Online haemodiafiltration (OL-HDF) is currently the most effective dialysis technique that also improves survival. To date, high permeability membranes with low albumin loss, such as polysulfone, polyamide and polyacrylonitrile membranes have been the most widely used. However, the initially restricted use of cellulose triacetate (CTA) membranes in OL-HDF has expanded. The aim of the study was to ascertain whether the latest generation asymmetric CTA membranes are more effective in obtaining high convective transport.

Patients and methods: A total of 16 patients (10 males and 6 females) undergoing OL-HDF were studied. Each patient underwent 4 different sessions, with haemodialysis or OL-HDF, and/or with CTA or asymmetric CTA 1.9 m^2 membranes. Each session was assigned in a randomised order. Serum levels of urea, creatinine, β_2-microglobulin, myoglobin, prolactin, α_1-microglobulin, α_1-acid glycoprotein and albumin where measured at the beginning and end of each session to obtain the reduction rate. The loss of solutes and albumin was quantified from the dialysate.

Results: A significantly greater replacement volume in OL-HDF (32.1 ± 3.1 *vs.* 19.7 ± 4.5 l, $p < 0.001$) was obtained by using asymmetrical CTA membranes compared to conventional CTA membranes. Regarding uraemic toxin removal, both membranes obtained similar results for small molecules, whereas asymmetric CTA membranes achieved better results for large molecules, increasing the reduction ratio by 29% for β_2-microglobulin, 27.7% for myoglobin, 19.5% for prolactin, 49% for α_1-microglobulin and double for α_1-acid glycoprotein ($p < 0.01$ in all situations). The loss of albumin was less than 2 g for all treatment sessions.

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Conclusion: Latest-generation asymmetric CTA have proven to be effective in attaining OL-HDF objectives without increased albumin loss.

Una nueva generación de triacetato de celulosa adecuado para hemodiafiltración *on-line*

Palabras clave:
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Hemodiafiltración *on-line*
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Volumen convectivo

RESUMEN

Antecedentes: La hemodiafiltración *on-line* (HDF-OL) es actualmente la técnica de hemodiálisis (HD) más efectiva y aumenta la supervivencia. Hasta el momento presente las membranas de alta permeabilidad con baja pérdida de albúmina como las de polisulfona, poliamida y poliacrilonitrilo son las más utilizadas. Las membranas de triacetato de celulosa (TAC), limitadas inicialmente para su uso en HDF-OL, han evolucionado. El objetivo del estudio fue determinar si las membranas de nueva generación de TAC asimétrico (TACA) son más adecuadas para realizar alto transporte convectivo.

Pacientes y métodos: Se estudiaron 16 pacientes, 10 hombres y 6 mujeres, en programa de HDF-OL. A cada paciente se le realizaron 4 sesiones diferentes, con HD o HDF-OL, o con filtros de TAC o TACA de 1,9 m^2, aleatorizando el orden. En cada sesión se determinaron concentración de urea, creatinina, β_2-microglobulina, mioglobina, prolactina, α_1-microglobulina, α_1-glicoproteína ácida y albúmina en suero al inicio y al final de cada sesión, para calcular el porcentaje de reducción. Así mismo, se cuantificó la pérdida de solutos y albúmina en el líquido de diálisis.

Resultados: Con las membranas de TACA se consiguió un volumen de sustitución en HDF-OL significativamente superior a las membranas de TAC clásicas (32,1 ± 3,1 vs. 19,7 ± 4,5 L; $p < 0{,}001$). En términos de depuración, la eliminación de moléculas pequeñas fue similar con ambas membranas, pero, en moléculas grandes, con HDF-OL la depuración fue mayor con TACA. En HDF-OL, el porcentaje de reducción de la β_2-microglobulina se incrementó un 29%, un 27,7% la mioglobina, un 19,5% la prolactina, un 49% la α_1-microglobulina, y se duplicó la α_1-glicoproteína ácida ($p < 0{,}01$ en todas las situaciones). La pérdida de albúmina fue inferior a 2 g en todas las situaciones de estudio.

Conclusión: Las membranas de TAC de nueva generación han demostrado ser eficaces para alcanzar los objetivos de HDF-OL, sin que haya una mayor pérdida de albúmina.

Introduction

The number of patients receiving on-line haemodiafiltration (HDF) has increased in recent years because randomised clinical trial in prevalent patients[1] have shown increased survival. Afterwards, various meta-analyses have confirmed a reduction in cardiovascular and overall mortality.[2,3] Secondary analyses of studies looking at mortality as the main variable[1,4,5] observed an association between convective volume and survival; so a minimum convective volume of 21 l per session[6] is being recommended. The main limiting factors to achieve high convective volumes are blood flow (Qb), time and the dialyser.

The pharmaceutical industry, in line with the technological advances made in haemodilaysis (HD) monitors, has developed improved dialysers able to achieve greater clearance capacity with a better adaptation to highly convective treatments. In fact, not all dialysers are appropriate to perform this type of treatment.

In a previous study[7] of 11 dialysers evaluated for on-line HDF treatment, only cellulose triacetate (CTA) membranes and polymethyl methacrylate (PMMA) demonstrated to be less appropriate for on-line HDF with less β_2-microglobulin (β_2-m) clearance and limited capability to reach a suitable convective volume with elevated transmembrane pressure. Recently, Potier et al.[8] published the use of 19 dialysers for on-line HDF; they observed that in seven of them, albumin loss per session was excessive. Therefore, the use of these dialysers for highly convective techniques is questioned.

Synthetic dialysers made of polysulfone (polyethersulfone, helixone) polyamide and polyacrylonitrile have been used most frequently in the past few years in HD and also in on-line HDF. However, in recent years, intolerance reactions (low blood pressure, desaturation) to synthetic dialysers have been observed in a small percentage of patients.[9,10] This is a reason by which cellulose dialysers, such as CTA, have been reintroduced as an alternative to the dialysers previously mentioned. Initial CTA dialysers presented a low ultrafiltration coefficient, and therefore there are limitations of their use