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Optimisation of dialysate flow in on-line hemodiafiltration☆

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ABSTRACT

Introduction: Currently, on-line hemodiafiltration (OL-HDF) is the most effective technique. Several randomised studies and meta-analyses have shown a reduced mortality and a direct association with convective volume has been reported. At present, it has not been established if an increased dialysate flow (Qd) shows in improved results in terms of convective and depurative efficiency. We aim at assessing the effects of Qd variations on convective volume and its depurative capacity in patients on OL-HDF.

Material and methods: A total of 59 patients (45 men and 14 women) from a OL-HDF programme in which a monitor 5008 Cordiax with auto-substitution was used, were enrolled. Patients were assessed in 5 sessions with post-dilutional OL-HDF, using helixone-based dialyzers, with only Qd being changed (300, 400, 500, 600 and 700 mL/min). Serum levels of urea (60 Da), creatinine (113 Da), β_2-microglobulin (11,800 Da), myoglobin (17,200 Da) and α_1-microglobulin (33,000 Da) were measured at the beginning and at the end of each session, in order to estimate the percent reduction of such solutes.

Results: An increased dialysate volume per session was observed, from 117.9 ± 6.4 L with Qd 300 mL/min to 232.4 ± 12 L with Qd 700 mL/min. No changes were found in replacement volume or convective volume. Regarding diffusion, Qd increase was associated to a significantly increased dialysis dose, with an increased Kt from 68 ± 6.9 L with Qd 300 mL/min to 75.5 ± 7.3 L with Qd 700 mL/min ($P < 0.001$), and a gradually increased percent reduction in urea associated to increased Qd with significantly lower levels being found with Qd 300 mL/min. No changes were found in other measured substances.

Conclusion: Qd variations in OL-HDF do not change convective volume. A higher Qd was associated to a slightly increased urea clearance with no change being observed for medium and large molecules. Qd optimisation to the minimal level assuring an adequate dialysis dose and allowing water and dialysate use to be rationalised should be recommended.

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Optimización del flujo del líquido de diálisis en la hemodiafiltración *on-line*

Palabras clave:
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Volumen convectivo

RESUMEN

Introducción: La hemodiafiltración on-line (HDF-OL) es actualmente la técnica más efectiva. Varios estudios aleatorizados y metaanálisis han observado una reducción de la mortalidad, con una asociación en relación directa con el volumen convectivo. En el momento presente no está bien establecido si el aumento del flujo del líquido de diálisis (Qd) puede suponer mejores resultados en términos de eficacia convectiva y depurativa. El objetivo del estudio fue valorar, en pacientes en tratamiento con HDF-OL, el efecto de la variación del Qd sobre el volumen convectivo y su capacidad depurativa.

Material y métodos: Se incluyeron 59 pacientes, 45 varones y 14 mujeres que se encontraban en programa de HDF-OL con monitor 5008 Cordiax con autosustitución. Cada paciente fue analizado en 5 sesiones con HDF-OL posdilucional, con dializadores de helixona, en las que solo se varió el Qd (300, 400, 500, 600 y 700 ml/min). En cada sesión se determinaron concentración de urea (60 Da), creatinina (113 Da), β_2-microglobulina (11.800 Da), mioglobina (17.200 Da) y α_1-microglobulina (33.000 Da) en suero al inicio y al final de cada sesión, para calcular el porcentaje de reducción de estos solutos.

Resultados: Se objetivó un aumento de litros de Qd por sesión, desde 117,9 ± 6,4 L con Qd de 300 ml/min hasta 232,4 ± 12 L con Qd 700 ml/min. No se determinaron cambios en el volumen de sustitución ni en el volumen convectivo. En términos de difusión, el incremento del Qd mostró un aumento significativo de la dosis de diálisis, con un aumento de Kt de 68 ± 6,9 L con Qd 300 ml/min hasta 75,5 ± 7,3 L con Qd 700 ml/min ($p < 0{,}001$), y un aumento progresivo del porcentaje de reducción de urea con el incremento del Qd, que era significativamente inferior con Qd 300 ml/min. No se objetivaron cambios en el resto de moléculas estudiadas.

Conclusión: La variación del Qd en HDF-OL no modifica el volumen convectivo. Un mayor Qd mostró un discreto incremento de la depuración de la urea, sin variaciones en las medianas ni en las grandes moléculas. Es recomendable optimizar el Qd al mínimo posible que garantice una adecuada dosis de diálisis y permita racionalizar el consumo de agua y concentrado de diálisis.

Introduction

National[1] and international[2] clinical practice guidelines recommend to provide at least a minimum dose of haemodialysis as determined by a Kt/V of 1.3 and a urea reduction ratio of 70%. Diffusive clearance is related to blood flow (Qb), dialysate flow (Qd), and the mass transfer-area coefficient (KoA). In one in vitro study, Leypoldt et al.[3] showed that an increase in Qd from 500 mL/min to 800 mL/min conferred a 14% increase in urea KoA, due to improved distribution of dialysate and reduced mass transfer resistance across the membrane. These results were subsequently demonstrated in clinical practice, with a 5.7%[4] increase in KoA and an 8.5% increase in K and Kt/V when Qd was changed from 500 mL/min to 750 mL/min.[5] Through modifications in the manufacturing of dialyzers, the pharmaceutical industry has improved dialysate distribution in capillaries.[6–8] It has been observed that an increase in Qd to beyond 600 mL/min does not correlate with better dialysis outcomes, as determined by Kt/V[9] or clearance of molecules such as phosphorus and β_2-microglobulin.[10]

Haemodiafiltration is a dialysis technique that combines diffusion and convection, both processes having similar clearance capacities. Post-dilution on-line HDF (OL-HDF) has been demonstrated to improve intradialysis tolerance[11], increase survival[12] and more recently, several meta-analyses have confirmed reduced overall and cardiovascular mortality.[12–15] Secondary analyses of the studies using death as a primary endpoint[11,14,15] observed an association between convective volume and survival. Therefore, a minimum convective volume of 23 L per session was recommended until more conclusive scientific evidence became available.[16,17]

Initially, OL-HDF was performed with a Qd of 800 mL/min, because some of the dialysate was used as substitution solution.[18,19] Later, newer monitors were able to differentiate dialysate destined for diffusion (usually 500 mL/min) from that destined for substitution (60–150 mL/min).[20] Now, with the aim of optimising the dialysate to the requirements of the dialyser, the 5008 monitors have a Qd autoflow system with an adjustable Qd/Qb ratio. The initial default setting recommended by the monitor for this factor was 1.2.[21] This recommendation has subsequently been changed to a factor of 1.0 if Qb is equal to or greater than 400 mL/min, or 1.2 if Qb is less than 400 mL/min.

To assess and optimise the choice of dialysate, the aim of this study was to evaluate the effects of changes in Qd on the