The Effect of Hemodiafiltration Versus Hemodialysis on Anemia
in Patients on regular hemodialysis

Emad Allam Mohamed
*Department of Internal Medicine and Nephrology, Faculty of Medicine for boys, Al-Azhar University, Cairo, Egypt.*

Ahmed Farag Abdelkader
*Department of Internal Medicine and Nephrology, Faculty of Medicine for boys, Al-Azhar University, Cairo, Egypt.*

Amr Ahmed Rizk
*Department of Clinical pathology, Faculty of Medicine for boys, Al-Azhar University, Cairo, Egypt.*

Ahmed Qayed Ibrahim Galhom
*Department of Internal Medicine and Nephrology, Faculty of Medicine for boys, Al-Azhar University, Cairo, Egypt.*

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The Effect of Hemodiafiltration Versus Hemodialysis on Anemia in Patients on Regular Hemodialysis

Emad Allam Mohamed a, Ahmed Farag Abdelkader a, Amr Ahmed Rizk b, Ahmed Qayed Ibrahim Galhom a,*

a Department of Internal Medicine and Nephrology, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt
b Department of Clinical Pathology, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt

Abstract

Background: Convective dialysis consists of hemodiafiltration, hemofiltration, and biofiltration devoid of acetate. Hemodialysis (HD) eliminates solutes and water through diffusion over a semipermeable membrane. Hemofiltration (HF) increases transmembrane pressure to increase solvent drag, whereas hemodiafiltration (HDF) combines HF and HD. More than 90% of CKD studied cases with eGFRs below thirty mL/min developed renal anemia. Due to restricted red blood cell transfusions, hemoglobin levels of approximately seven g/dL were clinically acceptable for cure of renal anemia. In practice, there is substantial inter-patient variability, & subset of dialysis studied cases may need greater ESA dose.

Aim: To evaluate and compare between the role of Hemodiafiltration and Hemodialysis on Anemia in Patients on regular hemodialysis.

Subject and methods: This prospective observational study, include 80 patients was selected from attendee of nephrology dialysis units of National Institute of Nephrology and Urology and Al-Azhar hospitals.

Results: There was no statistically significant variation among groups in terms of dialysis characteristics. No statistically significant variation was found among groups in terms of cure doses.

Conclusion: Long-term HDF therapy for twelve months was linked to significant improvements in anaemia & nutritional status.

Keywords: Anemia, Hemodiafiltration, Hemodialysis

1. Introduction

Dialysis or kidney transplant are used to eliminate toxins & fluid from people who have significant renal function loss. Dialysis eliminates waste materials and fluid from the body by filtering them over membrane in dialysis machine (for hemodialysis) (for peritoneal dialysis).1 Toxins that accumulate in body when kidneys fail come in a variety of sizes, and bigger molecules are eliminated less effectively by regular hemodialysis.2

Newer dialysis types ‘push’ water through dialysis membrane, allowing undesired molecules to be removed more efficiently.3 Greater molecules are removed more effectively, & dialysis fluid has less contaminants, suggesting that convective dialysis has the potential to enhance how studied cases feel & survive on dialysis.1 Hemodiafiltration, hemofiltration, & acetate free biofiltration are three kinds of convective dialysis treatment.5

Diffusion, removal of solutes & water throughout semipermeable membrane down concentration gradient, is used in standard hemodialysis. Hemofiltration, convection modality, uses enhanced transmembrane pressure to improve clearance across solvent drag, while hemodiafiltration combines HD & HF.6

Erythropoiesis is controlled by erythropoietin, which is generated in stromal cells near kidney's proximal renal tubule. Renal anaemia is most common complication in chronic kidney disease studied cases & is caused by relative lack of endogenous
3. Results

Table 1.

Table 1. Patient characteristics (N = 80).

<table>
<thead>
<tr>
<th>Variable</th>
<th>HDF (N = 40)</th>
<th>HD (N = 40)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td></td>
<td></td>
<td>0.446*</td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>39.5 ± 6.5</td>
<td>38.5 ± 6.1</td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>30–50</td>
<td>30–49</td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td>0.496b</td>
</tr>
<tr>
<td>Female</td>
<td>15 (37.5%)</td>
<td>18 (45%)</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>25 (62.5%)</td>
<td>22 (55%)</td>
<td></td>
</tr>
<tr>
<td>Primary Renal Pathology</td>
<td></td>
<td></td>
<td>0.900c</td>
</tr>
<tr>
<td>Diabetic Nephropathy</td>
<td>19 (47.5%)</td>
<td>18 (45%)</td>
<td></td>
</tr>
<tr>
<td>Hypertensive Nephropathy</td>
<td>11 (27.5%)</td>
<td>11 (27.5%)</td>
<td></td>
</tr>
<tr>
<td>Glomerulonephritis</td>
<td>8 (20%)</td>
<td>10 (25%)</td>
<td></td>
</tr>
<tr>
<td>ADPKD</td>
<td>2 (5%)</td>
<td>1 (2.5%)</td>
<td></td>
</tr>
<tr>
<td>Duration of Dialysis (months)</td>
<td></td>
<td></td>
<td>0.206*</td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>5.9 ± 1.8</td>
<td>6.5 ± 1.9</td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>3–9</td>
<td>3–9</td>
<td></td>
</tr>
<tr>
<td>Associated Comorbidities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diabetes Mellitus</td>
<td>19 (47.5%)</td>
<td>18 (45%)</td>
<td>0.823b</td>
</tr>
<tr>
<td>Cardiac Disease</td>
<td>7 (17.5%)</td>
<td>9 (22.5%)</td>
<td>0.576b</td>
</tr>
<tr>
<td>Cerebrovascular Disease</td>
<td>6 (15%)</td>
<td>7 (17.5%)</td>
<td>0.762b</td>
</tr>
</tbody>
</table>

* Independent sample t-test.
  b x² test.
Hemodialysis on Anemia in studied cases on regular hemodialysis.

This prospective observational study was conducted in nephrology dialysis units of National Institute of Nephrology and Urology and Al-Azhar hospitals. This research was conducted on 80 ESRD studied cases in Hemodialysis. All studied cases were separated into two groups: group A: 40 HDF studied cases with anemia Hb < 10 g% and group B: 40 HD patients with anemia Hb < 10 g%.

Regarding demographic data of tested groups, we showed that there was no statistically significant variation among HD & HDF groups regarding years old, sex, primary renal pathology, duration of dialysis, and associated comorbidities.

As regard Primary Renal Pathology, we found that in HDF group, 19 (47.5%) patients had diabetic nephropathy, 11 (27.5%) had hypertensive nephropathy, 8 (20%) had GN, and two (5%) had ADPKD. In HD group, 18 (45%) patients had diabetic nephropathy, 11 (27.5%) had hypertensive nephropathy, 10 (25%) had GN, and one (2.5%) had ADPKD. No statistically significant variation was shown among groups regarding primary renal pathology \((\chi^2 \text{ test}, P = 0.900)\).

Also, as regard Associated Comorbidities, we found that in HDF group, 19 (47.5%) patients were diabetic, 7 (17.5%) had cardiac disease, and 6 (15%) had cerebrovascular disease. In HD group, 18 (45%) patients were diabetic, 9 (22.5%) had cardiac disease, and 7 (17.5%) had cerebrovascular disease. No statistically significant variation was shown among groups regarding primary renal pathology \((\chi^2 \text{ test}, P > 0.05)\).

In line with the present study Kashgary et al., who enrolled 164 studied cases in HD group & 77 studied cases in HDF group, this study reported that there were no statistically significant variations

### Table 2. Dialysis characteristics (N = 80).

<table>
<thead>
<tr>
<th></th>
<th>HDF (N = 40)</th>
<th>HD (N = 40)</th>
<th>(P) value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Session Length (hours)</td>
<td></td>
<td></td>
<td>0.978</td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>3.7 ± 0.4</td>
<td>3.7 ± 0.3</td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>3–4.5</td>
<td>2.9–4.6</td>
<td></td>
</tr>
<tr>
<td>Urea Reduction Ratio</td>
<td></td>
<td></td>
<td>0.994</td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>72.5 ± 4.7</td>
<td>72.6 ± 4.6</td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>65–80</td>
<td>65–80</td>
<td></td>
</tr>
<tr>
<td>Kt/V</td>
<td></td>
<td></td>
<td>0.969</td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>1.5 ± 0.3</td>
<td>1.4 ± 0.2</td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>1–1.9</td>
<td>0.9–2.0</td>
<td></td>
</tr>
<tr>
<td>Blood Flow Rate (ml/min)</td>
<td></td>
<td></td>
<td>0.776</td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>266 ± 9.6</td>
<td>267 ± 10.7</td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>250–280</td>
<td>246–284</td>
<td></td>
</tr>
<tr>
<td>Predilution</td>
<td>5 (12.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Convolution Volume (L)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>20.3 ± 6.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>10–30</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Independent sample t-test.
among HD & HDF groups regarding age, gender, primary renal pathology, duration of dialysis, and associated comorbidities. The most common comorbidities were hypertension followed by diabetes.

As well, Ibrahim et al.,\(^8\) compared twenty studied cases on low flux dialyzer, twenty studied cases on high flux dialyzer, and 20 patients on hemodiafiltration. The study reported that the studied groups were similar as regard demographic data and baseline characteristics. About 33.3% were hypertensive (HTN), 21.7% had chronic glomerulonephritis, 20% were of unknown cause, 13.3% had obstructive uropathy and 11.7% had polycystic kidney disease and no history of diabetes.

As regard the characteristics of the dialysis process between groups. The mean session length was 3.7 ± 0.4 h in HDF group and 3.7 ± 0.3 h in HD group. Mean URR was 72.5 ± 4.7 in HDF group & 72.6 ± 4.6 in HD group. Mean Kt/V was 1.5 ± 0.3 in HDF group & 1.4 ± 0.2 in HD group. Mean blood flow rate was 266 ± 9.6 ml/min in HDF group & 267 ± 10.7 ml/min in HD group. No statistically significant variation was shown among groups regarding characteristics of dialysis (Independent sample \(t\)-test, \(P > 0.05\)). In the HDF group, predilution was performed in five (12.5%) patients. The mean convection volume was 20.3 ± 6.2 L, ranging between 10 and 30 L.

In agreement with our study Kashgary et al.,\(^17\) discovered that there was statistically significant variation among tested groups as regard characteristics of dialysis (including Session Length, Urea Reduction Ratio, Kt/V and Dialysis Access).

Furthermore, Smith et al.,\(^19\) enrolled 50 studied cases in HD group & 50 studied cases in HDF group, study described that there was statistically significant variation between the tested groups as regard characteristics of dialysis (including Session Length, Urea Reduction Ratio, Kt/V and Blood Flow Rate. In the HDF group, predilution was performed in 4 (9.1%) patients. mean convection volume was 20.6 ± 4.6 L.

Regarding the anemia treatment doses in both groups and anemia lab parameters, we found that the mean ESA dose was 187 ± 75.4 IU/kg/week in HDF group, and 186 ± 75.4 IU/kg/week in HD group. mean IV iron dose was 5.4 ± 2.4 mg/day in the HDF and 5.3 ± 2.5 mg/day in the HD groups. No statistically significant variation was shown among groups in terms of treatment doses (Independent sample \(t\)-test, \(P > 0.05\)).

In agreement with the current study Lee et al.,\(^15\) revealed that there was no statistically significant variation among groups in terms of anemia treatment doses.

In current research, in HDF group, the baseline values were 8.4 ± 0.7 g/dl, 9.6 ± 3.3 ng/ml and 11.2 ± 4.4% for hemoglobin, ferritin and TSAT, respectively. In the HD group, the baseline values were 8.2 ± 1.0 g/dl, 9.5 ± 3.2 ng/ml, and 11.0 ± 4.4% for hemoglobin, ferritin, and TSAT, respectively. No statistically significant variation was shown among groups regarding baseline anemia parameters (Independent sample \(t\)-test, \(P > 0.05\)).

After 12 months, the anemia parameters were significantly different between groups in favor for HDF (Independent sample \(t\)-test, \(P < 0.05\)). The mean Hgb was 11.1 ± 0.6 g/dl in HDF group, & 10.4 ± 0.2 g/dl in HD group. Mean ferritin has been 37.8 ± 8.1 ng/ml in HDF group, & 29.7 ± 8.1 ng/ml in HD group. Mean TSAT was 32.3 ± 7.1% in HDF group, & 23.6 ± 7.2% in the HD group.

Furthermore, Ibrahim et al.,\(^8\) revealed that statistically significant increase in hemoglobin level, platelets number and serum albumin level and highly significant increase in HDL (High density lipoprotein) in hemodiafiltration group when compared to high flux and low flux dialysis groups.

Also, Georgatzakou et al.,\(^21\) described that mean Hb was non significantly increased after therapy in HD group, however it was significantly increased in HDF group after treatment.

As well, Hamzagic et al.,\(^23\) revealed that HDF have significantly higher positive impact on anemia parameters when compared to HD treatment.

However, Kashgary et al.,\(^17\) described that there was no significant variation in post treatment anemia parameters, the same results were reported by Smith et al.,\(^19\) in adults and Galal & Hesham,\(^22\) in pediatrics. This was in disagreement with our results may be due to the differences in sample size and inclusion criteria as well as the differences in study settings.

In the current study, at baseline, the albumin was 3.6 ± 0.2 and 3.5 ± 0.4 g/dl in HDF & HD groups. Mean baseline serum calcium was 8.1 ± 0.4 & 8.2 ± 0.4 mg/dl in HDF & HD groups. Mean baseline serum phosphorus was 4.9 ± 0.3 and 5.1 ± 0.4 mg/dl in HDF & HD groups, respectively. Mean baseline intact PTH was 309 ± 130 and 308 ± 130 pg/ml in HDF & HD groups, respectively. No statistically significant variation was found among groups in terms of baseline laboratory measurements (Independent sample \(t\)-test, \(P > 0.05\)).

After 12 months post-treatment, the HDF group was related to significantly greater levels of albumin, calcium, phosphorus, & intact PTH (Independent sample \(t\)-test, \(P < 0.05\)). The mean albumin level increased to 4 ± 0.3 and 3.4 ± 0.2 mg/dl in HDF & HD groups, respectively. Mean calcium level increased to 8.3 ± 0.4 & 7.9 ± 0.5 mg/dl in HDF &
HD groups, respectively. Mean phosphorus level increased to 6.2 ± 0.4 and 5.9 ± 0.4 mg/dl in HDF & HD groups, respectively. Mean intact PTH increased to 442 ± 154 and 350 ± 183 pg/ml in HDF & HD groups, respectively.

Similarly, current study Ibrahim et al., reported that the HDF group was related to significantly greater levels of albumin, calcium, phosphorus, & intact PTH (Independent sample t-test, \( P < 0.05 \)).

Also, Smith et al., reported that Serum albumin levels (3.2 vs. 3.3 g/dl for HDF & HD, respectively; \( P = 0.001 \)) & chloride levels (101 vs 100 mEq/L for HDF & HD, respectively; \( P = 0.02 \)) differed by small but statistically significant amount.

However, Pedrini et al., revealed that there were no clear variations in clinical parameters’ albumin, calcium, phosphate & parathyroid hormone were observed in HD and HDF groups over time. Also, Galal & Hesham, revealed that showed no significant difference in albumin levels in HDF studied cases compared to HD patients 3.519 ± 0.3391 versus 3.350 ± 0.48±0.219 (\( P = 0.219 \)). This was in disagreement with our results may be due to the differences in sample size and inclusion criteria as well as the differences in study settings.

The current study discovered that albumin level was nonsignificantly increased in HDF group however decreased in HD group, however, Albumin level reduction with HDF was reported by several authors (Stefansson et al.,, Tomo et al.,), however without having clear clinical impact. Combarnous et al., tested albumin removal with pre-dilutional HDF, most likely due to interaction with polymer surface of the dialysis membrane. Albumin loss during HDF seemed to have no acute effect on plasma albumin.

4.1. Conclusion

Current HDF methods & equipment can effectively deliver high-volume convective treatment to most studied cases & assure clinical performance related to better results. High-volume HDF can be easily & safely implemented in variety of settings, resulting in increased uremic solute clearance. Numerous studies have shown advancements in intermediate, studied case-reported, & clinical results when compared to standard HD. Long-term HDF therapy for twelve months was related to significant improvements in anaemia & nutritional status.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

Authorship

All authors have a substantial contribution to the article.

Conflicts of interest

There are no conflicts of interest.

References


