The role of peritoneal dialysis in the treatment of refractory heart failure

Alexander Kagan and Jayson Rapoport

Department of Nephrology and Hypertension, Kaplan Medical Center, Rehovot and Faculty of Medicine, Hebrew University, Jerusalem, Israel

Abstract

Heart failure (HF) refractory to conventional therapy is a major and increasing public health and financial problem. Refractory HF is associated with hyperaemia due to sodium and fluid retention, and azotaemia due to renal hypoperfusion. There is extreme renal salt and water retention and marked secondary hyperaldosteronism. In this state, the kidneys are relatively resistant to diuretic therapy, and the use of very high doses of oral or parenteral diuretics only worsens the renal hypoperfusion, making the patient more azotaemic. A logical treatment for this ‘cardiorenal syndrome’ is the use of dialysis, which is efficient in treating both the hyperaemia and azotaemia of refractory HF. Peritoneal dialysis (PD), haemodialysis or continuous venovenous haemofiltration can and have been used, but the simplest long-term treatment is PD. We present several case reports of the successful use of PD in refractory heart failure. In our opinion, chronic PD is a highly effective mode of treatment for refractory HF, and should be more widely used in this condition.

Keywords: continuous veno-venous haemofiltration; haemodialysis; peritoneal dialysis; refractory heart failure

Introduction

Heart failure (HF) is a serious problem in the 21st century. Nearly 75 million patients in the USA suffer from HF, and 50,000–200,000 of these suffer from symptomatic end-stage HF refractory to the available therapies [1–4]. Survival of patients with refractory HF is <50% at 6 months [4]. Refractory HF is thus increasingly a major public health and financial problem.

Refractory HF is usually associated with a reduction in renal function, the so-called ‘cardiorenal syndrome’ [3], and ~25% of patients hospitalized with HF have an acute reduction in glomerular filtration rate (GFR) [5,6], caused partly by low cardiac output and partly by aggressive diuretic therapy. Coronary heart disease, hypertension and diabetes are commonly associated with an increased risk for developing HF [2], and these conditions are also common causes of end-stage renal disease (ESRD) [7].

Refractory HF can be treated efficiently by acute or chronic dialysis [peritoneal dialysis (PD), haemodialysis (HD) or haemofiltration]. Unfortunately, these treatment options have not usually been discussed or recommended in recent reviews [4,8–10], except for patients with ESRD. There have, however, been a number of reports of the use of chronic PD or HD in the treatment of refractory HF [11–18].

We present here three case reports of the successful use of chronic PD in refractory HF and report five further patients. We believe that this modality should be more widely used in this condition.

Case 1: left ventricular HF and ESRD

A 17-year-old girl was admitted to our hospital in 1996 suffering from Henoch–Shoenlein purpura with renal involvement (microhaematuria, granular casts, proteinuria 2.5 g/24 h). A kidney needle biopsy showed IgA nephropathy (focal glomerulosclerosis with mesangial IgA deposition and large electron-dense deposits in a widened mesangium). Tests for hepatitis A, B and C viruses and serological tests for antinuclear antibodies, and serum levels of C3, C4, IgG, IgM and IgA were within normal limits. An echocardiogram revealed mild dilated cardiomyopathy. Despite conservative treatment, her renal function...
declined during 34 months to end-stage, and in 1998 chronic HD was begun. For a period of 32 months, despite adequate HD (average Kt/V 1.54), the dilated cardiomyopathy progressively deteriorated with a fall in left ventricular ejection fraction (LVEF) from 55 to 25% and a marked increase in pulmonary artery pressure (PAP) to 68 mmHg. During this period, she was also receiving angiotensin-converting enzyme inhibitor treatment (captopril), together with an angiotensin receptor blocker (candesartan), α-β-blocker (carvedilol), digoxin and hydralazine. Because of recurrent pulmonary oedema, a standard thrice weekly 4 h HD regime was switched to a 2.5 h daily, six times a week regime. The patient was placed on the waiting list for a combined heart and kidney transplant. In 2001, mechanical ventilation was performed for a few days due to persistent pulmonary oedema, and PD was begun. During 18 months of an adequate (weekly Kt/V 2.57) continuous ambulatory peritoneal dialysis (CAPD), using four exchanges daily (2 l of 1.5% dextrose/C2), there was a dramatic improvement in cardiac function (Figure 1), and she began to feel very well. She resumed a relationship with her boyfriend and began to seek work. There were no episodes of peritonitis during this period. In January 2003, she underwent a successful cadaver kidney transplant. Now, 22 months later, she is well (serum creatinine 1 mg/dl; LVEF 60%; PAP 25 mmHg).

Case 2: right ventricular HF and cardiorenal syndrome

A 56-year-old woman with rheumatic heart disease was admitted to the ICU in 1999 because of anasarca, ascites and dyspnoea due to refractory, predominantly right-sided HF (LVEF = 69%), severe pulmonary hypertension (PAP 88 mmHg) and pre-renal azotaemia (serum creatinine 2 mg/dl, urine volume 170 ml/24 h, urine sodium concentration 5 mEq/l). She also suffered from hyponatraemia (130 meq/l) and hyperkalaemia (7.7 mEq/l), and arterial blood pressure 90/60 mmHg. In the past, she had undergone a mitral valve replacement (Starr–Edwards) in 1971, tricuspid valve replacement in 1995, chronic atrial fibrillation and permanent pacemaker insertion. She was receiving chronic coumadin treatment, and was a candidate for combined heart and lung transplantation. A Tenckoff peritoneal catheter was inserted and standard CAPD was initiated. After a few weeks of CAPD, her status dramatically improved: anasarca, ascites and dyspnoea disappeared, body weight decreased from 53 to 47 kg. PAP decreased from 88 to 45 mmHg, but LVEF did not change significantly (65%). After a period on CAPD, she continued on automated PD using a night-time automatic cycler. During a period of 45 months on PD, there were a total of two episodes of Staphylococcus coagulase-negative peritonitis which responded rapidly to standard antibiotic therapy. She feels relatively well after 45 months of PD treatment and has been removed from the transplant list.

Case 3: biventricular HF and acute on chronic renal failure

A 76-year-old man with diagnoses of type 2 diabetes, hypothyroidism, severe coronary artery disease, myocardial infarction in 1978, coronary artery bypass grafting in 1984 and 1997 and a cardiac biventricular pacemaker was seen by a cardiologist and nephrologist. He had severe symptomatic HF, with orthopnoea and anasarca, and LVEF of 15%. He was confined to bed and needed oxygen constantly. An echocardiogram
showed severe left ventricular systolic and diastolic dysfunction with inferior, anterior, septal, apical, posterior akinesis and lateral hypokinesis of the left ventricle and moderate tricuspid regurgitation. He also had renal failure (creatinine 2.3 mg/dl). CAPD treatment was recommended. During CAPD, his well being improved and the dyspnoea and anasarca disappeared. He was able to resume working with his home computer and drive his car. The echocardiographic findings did not change significantly during CAPD, but PAP decreased from 64 to 48 mmHg. After 11 months in a stable state, his health began to deteriorate slowly. He developed intractable hypotension (80/60 mmHg), advanced renal failure (creatinine 6.7 mg/dl), severe weakness and obtunded consciousness and confusion. After 14 months of CAPD, he died without dyspnoea or peripheral oedema.

In addition to the three patients described above, there were five other patients with refractory HF treated with CAPD. The results of CAPD treatment in these patients are shown in Table 1. This group accounts for 32% of all CAPD patients treated in our department in the last 2 years.

**Table 1. Patients with refractory heart failure treated by CAPD**

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age (years)</th>
<th>Gender</th>
<th>Months on CAPD</th>
<th>Heart disease</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>M.Z. a</td>
<td>22</td>
<td>F</td>
<td>18</td>
<td>Dilated cardiomyopathy</td>
<td>Tx-kidney</td>
</tr>
<tr>
<td>Y.S.</td>
<td>28</td>
<td>M</td>
<td>45</td>
<td>Shone’s syndrome</td>
<td>Tx-kidney</td>
</tr>
<tr>
<td>B.D. a</td>
<td>63</td>
<td>M</td>
<td>18</td>
<td>Ischaemic cardiomyopathy</td>
<td>Continuing CAPD</td>
</tr>
<tr>
<td>H.M. a</td>
<td>72</td>
<td>F</td>
<td>13</td>
<td>Ischaemic cardiomyopathy</td>
<td>Continuing CAPD</td>
</tr>
<tr>
<td>F.M</td>
<td>60</td>
<td>F</td>
<td>45</td>
<td>Rheumatic heart disease</td>
<td>Continuing CAPD</td>
</tr>
<tr>
<td>O.S.</td>
<td>73</td>
<td>M</td>
<td>5</td>
<td>Ischaemic cardiomyopathy</td>
<td>Death (sepsis)</td>
</tr>
<tr>
<td>V.L.</td>
<td>67</td>
<td>M</td>
<td>6</td>
<td>Ischaemic cardiomyopathy</td>
<td>Death (peritonitis)</td>
</tr>
<tr>
<td>Y.B.</td>
<td>76</td>
<td>M</td>
<td>13</td>
<td>Ischaemic cardiomyopathy</td>
<td>Death (end-stage HF)</td>
</tr>
</tbody>
</table>

aSwitched from haemodialysis.
CAPD = continuous ambulatory peritoneal dialysis; Tx = transplant.

Discussion

Although this series is small, it is clear that PD can be an effective treatment for patients with left, right or biventricular refractory HF. PD resulted in a significant decrease in pulmonary hypertension in most of the patients and, in some, an improvement in LVEF. Three of our patients with refractory HF associated with ESRD had a dramatic improvement in cardiac function when switched from HD to CAPD, which was clearly superior to HD. Other investigators have found that PD resulted in a reduction in plasma volume and a reduction in pulmonary capillary wedge pressure [13,14]. Our results are in agreement with Mehrotra and Khanna [15], who have summarized the role of PD in the treatment of severe HF. Most of their patients had an improvement in cardiac function and a >6-fold decrease in number of hospitalizations after beginning PD. We thus heartily agree with their conclusion that PD is a suitable mode for long-term management of refractory HF.

HD and especially continuous veno-venous haemofiltration (CVVH) are two other methods of treatment for refractory HF, suitable for the short term, especially in patients with cardiorenal syndrome and acute HF [15–17]. HD is more generally available and cheaper. However, since it uses a combination of diffusion and convective ultrafiltration (UF), and is used for relatively short periods, it tends to cause acute falls in intravascular volume and severe hypotension. HD and especially continuous veno-venous haemofiltration (CVVH) are two other methods of treatment for refractory HF, suitable for the short term, especially in patients with cardiorenal syndrome and acute HF [15–17]. HD is more generally available and cheaper. However, since it uses a combination of diffusion and convective ultrafiltration (UF), and is used for relatively short periods, it tends to cause acute falls in intravascular volume and severe hypotension. [17]. Long-term UF with CVVH results in much slower fluid removal, allowing adequate intravascular refilling and preventing hypotension. It is thus better tolerated and more efficient than HD for the treatment of refractory HF. However, since it requires highly trained personnel in a hospital setting, it is more suitable for temporary treatment during the waiting period prior to a heart transplant.

PD is also associated with a slow rate of UF, and thus also is very well tolerated. Since UF is the main reason for its use in these patients, it is vital that the determinants of UF in PD are understood. These have been well described by Mehrotra and Khanna [14], and include the volume of dialysate, the osmotic agent used, the tonicity of dialysate and duration of dwell. As glucose is usually the osmotic agent used, its efficiency is much greater at the beginning of the dwell time, since the osmotic gradient is then at its greatest, and subsequently dissipates rapidly because of absorption of glucose via the peritoneum. For this reason, short, frequent exchanges are generally much more efficient for fluid removal. Thus automated PD using a cycler (APD), is extremely well suited to UF in these patients. Efficiency can also be increased by using larger volume exchanges, but these are less well tolerated by patients with refractory HF, since the large fluid volume tends to splint the diaphragm and further impair ventilation. The new osmotic agent icodextrin is of value, since its osmotic gradient is not dissipated as occurs with glucose, and it thus allows greater UF over time [19].
Peritonitis is no longer a major problem in PD patients as it was in previous years, because modern PD sets have reduced its incidence greatly [20]. Chronic PD is a demanding treatment both for the patient and for their family. The consequent high drop-out rate in PD because of patient ‘burnout’ and other social factors continues to be a major problem, and constitutes one of the major reasons for stopping the treatment.

In our opinion, chronic PD is a highly effective treatment for refractory HF, and should be considered in every case where conventional treatment fails or causes a progressive deterioration in renal function.

Conflict of interest statement. None declared.

References