Reversal of protein losing enteropathy with prednisone in adults with modified Fontan operations: long term palliation or bridge to cardiac transplantation?

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Abstract
Protein losing enteropathy (PLE), defined as severe loss of serum protein into the intestine, occurs in 4–13% of patients after the Fontan procedure and carries a dismal prognosis with a five year survival between 46% and 59%. Chronically raised systemic venous pressure is thought to be responsible for the development of PLE in these patients, with perhaps superimposed immunological or inflammatory factors. The success rate of contemporary medical, transcatheter, and surgical treatments attempting to reduce systemic venous pressure ranges from 19% to 40%. Prednisone treatment for PLE has been tried, with variable success rates reported in children. The effect of prednisone in adult patients with PLE after the Fontan procedure is largely unknown. Two cases of PLE in adults (a 39 year old woman and a 25 year old man) after modified Fontan procedure who responded dramatically to oral prednisone treatment are reported, suggesting that a trial of this “non-invasive” treatment should be considered as long term palliation or bridge to cardiac transplantation.

Case 1
A 39 year old woman with tricuspid and pulmonary atresia had undergone a modified Fontan procedure (right atrium to pulmonary artery connection) at 28 years old. At the age of 38, she presented with generalised oedema and ascites. Laboratory tests revealed normal liver and kidney function, albumin 22 g/l (normal 38–50), total protein 41 g/l (normal 64–83), lymphocyte count 0.4 bil/l (normal 1.5–4.0), and α₁ antitrypsin clearance of 354 ml/day (normal < 22). Transthoracic echocardiography showed mild systemic ventricular dysfunction with moderate atroventricular valve regurgitation and a widely patent Fontan connection. Contrast saline study injected from the right arm showed evidence of a venovenous fistula from rapid appearance of bubbles into the left atrium. Cardiac catheterisation revealed a mean right atrial pressure of 17 mm Hg without any Fontan pathway obstruction, and an oxygen saturation of 92% in air. A low fat, high protein, medium chain triglyceride diet along with albumin infusions and large doses of diuretics and angiotensin converting enzyme inhibitors had no clinical benefit. An atrial fenestration was considered but not done because of the presence of venovenous anastomoses allowing for some degree of right to left shunting. The patient was...
started on a trial of subcutaneous octreotide treatment (120 µg twice a day for two weeks followed by 240 µg twice a day for two weeks and 480 µg twice a day for eight weeks). Because of the lack of clinical improvement and the patient’s discomfort at the site of injection, octreotide was discontinued after 10 weeks.

Prednisone, 60 mg daily (1 mg/kg), was initiated. Response to treatment was dramatic. Within 11 days, the patient had lost 9 kg, with complete disappearance of generalised oedema and ascites. At that time, albumin concentration had risen to 30 g/l and total protein to 40 g/l. Intestinal biopsy was suggested but declined. The patient reportedly had not felt better for a long time. Unfortunately, one month after initiation of prednisone (while still taking 40 mg daily) she felt dizzy and had a cardiac arrest from which she could not be resuscitated. The presumed cause of death was arrhythmias. Symptomatic recurrent atrial tachyarrhythmia had previously been documented in this patient. Unfortunately, there was no postmortem examination.

Case 2
A 25 year old man with tricuspid and pulmonary atresia had undergone a modified Fontan procedure (right atrium to pulmonary artery connection) at the age of 14. In 1998, at the age of 25, the patient presented with generalised oedema and ascites. Laboratory tests showed normal liver and kidney function, albumin 22 g/l, total protein 45 g/l, lymphocyte concentration (40 g/l), total protein (59 g/l), and α1 antitrypsin stool clearance (2 ml/day) were all normal. The patient is currently on a tapering dose of prednisone without any clinical or laboratory evidence of recurrence.

Discussion
High central venous pressure has been suggested as the principal cause of PLE, impeding thoracic lymphatic drainage with consequent intestinal lymphangiectasia and protein leak. However, autoimmune and inflammatory processes have also been postulated as possible pathogenic factors. Indeed, PLE has been described in association with autoimmune diseases such as lupus erythematosus, sarcoidosis, and allergic gastroenteropathy. Furthermore, immune deposits have been found in the intestinal capillary walls of patients with PLE with a dramatic response to corticosteroid treatment. Cases of PLE after the Fontan procedure in the presence of low central venous pressure have also been described. Some authors have shown high mean right atrial pressure to be a predisposing risk factor in the development of PLE. However, this has been refuted by others. All this would suggest a perhaps more complex and multifactorial cause of PLE than was first anticipated.

Mertens et al report on a contemporary series of patients with PLE in which the overall medical success rate in treating PLE was 25%, the transcatheter success rate 40%, and the surgical success rate 19% with an associated mortality of 50%. Because of the grave prognosis and low success rate of present treatments, alternatives focusing not only on an increased hydrostatic pressure as the cause of PLE but on other potential contributing factors such as immunological or inflammatory mechanisms seem justified.

Corticosteroid treatment for PLE after Fontan procedure has been reported so far in 30 patients, most of them children with no case reports of adults. Long term remission with prednisone has been achieved in 10 of 30 patients, partial benefit has been seen in 11 with no benefit in nine. Dosages range from 2 mg/kg/day of oral prednisone or the equivalent dosage administered as methylprednisolone intravenously in children, to 25–60 mg of oral prednisone twice a day in adolescent patients, with a slow tapering regimen over five to six months. Of the 21 patients responding to prednisone, nine patients had relapses on stopping the medication, necessitating a return to higher doses and a slower tapering regimen, and five patients could not be completely weaned off treatment.

The mechanism of action of corticosteroids in the treatment of PLE is unclear. Prednisone has been shown to produce resolution of intestinal lymphangiectasia in patients with biopsy proven PLE after Fontan procedures leading some to postulate that corticosteroids may have a stabilising effect on intestinal capillary and lymphatic membranes or lead to a reduction in lymphatic tissue volume.
Whether it does so through its anti-inflammatory properties or its cellular anabolic effect is unknown.

The close temporal relation of initiation of prednisone treatment and the clinical resolution of PLE in our two adult patients strongly suggest that prednisone was responsible for the improvements. The delay between dramatic clinical response and laboratory normalization in our patients, and described by others, supports a membrane stabilizing effect of prednisone leading to a rapid stop of protein leakage from the gut and the peripheral vasculature, with quick disappearance of oedema followed by a slower normalization of albumin and protein concentrations as they are being gradually replenished through normal protein synthesis. Whether prednisone is more likely to work in cases of PLE without central venous hypertension remains to be determined.

Our limited experience suggests that prednisone is effective in adult patients with PLE, even in those with raised central venous pressure. Given the potential morbidity of cyanosis and the risk of paradoxical emboli associated with transcatheter or surgical atrial fenestration, and the high reported surgical mortality of Fontan conversion or take down, a trial of prednisone should be considered in adult patients with PLE, either as a long term palliation or a bridge to cardiac transplantation.