Purpose: Intestinal dialysis for end-stage renal disease (ESRD) is a proposed renal replacement therapy, and studies are going on worldwide to make it practicable. We are also doing the same study in our institution and would like to share our experience in managing an anephric neonate with intestinal dialysis in the perspective of our ongoing study of intestinal dialysis since 2010. 

Patients and Methods: We did double-ended jejunostomy in an isolated loop of the jejunum keeping the main tract intact with jejunojejunal anastomosis in this anephric neonate. Following that, we started irrigation with peritoneal dialysis fluid from the 3rd postoperative day (POD) in that jejunal loop through jejunostomy.

Results: This patient had no uremic features since re-admission and showed better laboratory and clinical outcomes with combined jejunal loop and colonic dialysis for 7 days. However, the patient died on the 9th POD following severe hypoglycemia.

Conclusions: From this study, it seems intestinal dialysis, with necessary modifications done in our subsequent patients, which might be recommended for ESRD in children as well as in adults.

Keywords: Appendicostomy, end-stage renal disease, gut microbiota, intestinal dialysis, peritoneal dialysis

Introduction

Cost of hemodialysis (HD) and peritoneal dialysis (PD) is prohibitive. As a result, most people with end-stage renal disease (ESRD) cannot afford renal replacement therapies (RRTs) in our country.

Besides, chronic HD or PD is difficult options in neonates, and renal transplantation is almost impossible even in the United States that we appreciated from Prof. Kim H, Director, Pediatric Transplant Center, Boston Children’s Hospital, USA. He is also hapless regarding RRTs of the small children and is eager to know the outcome of our ongoing study on intestinal dialysis as he himself is on similar research.

We have been on intestinal dialysis for about 10 years following ethical approval on 2005 to sort out an effective and cheaper RRT. Intestinal dialysis was prompted from the concept of diarrhea therapy in renal failure to eliminate uremic toxins. Diarrhea therapy is supported by the fact that potassium, creatinine, urea, uric acid, phosphate, and other toxins and waste substances are secreted through the intestinal tract, and concentration of these solutes in general and potassium in particular become higher in the colon in ESRD.

As the surface area of 15 cm of the jejunum equals to the whole peritoneal surface, intestinal dialysis became attractive as a better alternative at low cost.

We want to share our experience of managing an anephric child with intestinal dialysis in the perspective of our ongoing study. We targeted to keep the patient nonuremic as well as to keep potassium, bicarbonate, body weight at normal level, serum creatinine within 9–10 mg/dl, and serum urea at 50–60 mg/dl.

Patients and Methods

This functionally anephric patient born with ESRD with a birth weight of 2.9 kg was passing...
On PD, he improved from acidosis, hyperkalemia, and excess body water, but improvement of blood urea nitrogen status was not possible. PD started malfunctioning with repeat blockage of exit flow even with fresh insertions, and repeat attempt of PD was kept withheld after 5 days, and parents were counseled about intestinal dialysis; however, they declined and went home with the baby. On the 14th day of life, the patient was puffy with pedal edema, and weight gain was 600 g. They returned and consented for intestinal dialysis. On admission, the patient had clear chest, normal CVs, and soft abdomen. The patient was on-demand feed at home and was passing stool frequently, with a body weight of 3.95 kg and serum creatinine of 14.8 mg/dl [Table 1] on re-admission. We started colonic wash with warm 50 ml of PD fluid twice daily.

On the 15th day of life, we did double-ended jejunostomy with an isolated loop of the jejunum and jejunoojejunal anastomosis [Figure 1]. On the 3rd postoperative day (POD), we started intestinal dialysis through the jejunal stomas at 25–30 drops/min with PD fluid for 9 h/day with inflow Foley’s catheter of 6 F and outflow with 10 F. On the 4th POD, oral feed was allowed.

The patient was on intravenous (IV) fluid at 20 ml/kg with monitoring of body weight. However, after the start of intestinal dialysis, ultrafiltrate was around 300 ml/day. Hence, an increment of IV fluid became necessary. Intestinal dialysis was continued, and biochemical parameters and body weight were recorded [Table 1].

**Table 1: Body weight and biochemical parameters**

| POD            | Body weight (kg) | Creatinine (mg/dl) | Urea (mg/dl) | Potassium (mEq/L) | HCO₃⁻ (mEq/L) | Hemoglobin (g %) | Blood glucose |
|----------------|------------------|--------------------|--------------|-------------------|--------------|-----------------|---------------|
| On re-admission at the 14th day of life | 3.95             | 14.8               | 214          | 6.2               | 20           | 11.9            | 98            |
| Day of operation | 3.95             |                    |              | 6.3               |              | 112             | 100           |
| POD-1          |                  | 3.75               | 17.8         | 274               | 6.3          | 22              | 9.9           |
| POD-2          |                  |                    |              | 14.1              | 201          | 6.1             | 100           |
| POD-3          |                  | 12.4               | 151          | 5.8               | 18           | 10.9            | 100           |
| POD-4          |                  | 10.6               | 118          | 5.6               |              | 108             | 98            |
| POD-5          |                  | 3.15               | 9.6          | 80                | 5.4          | 4.2             | 22            |
| POD-6          |                  | 9.8                | 85           |                   |              |                 |               |

**RESULTS**

The patient showed no uremic features since re-admission and was nonuremic all through the study and was doing well and tolerated oral feed. Creatinine and urea decreased toward desired level step by step, and ultrafiltrate removal was kept around 300 ml by adjusting glucose concentration in dialysate. Laboratory outcome was better [Table 1]. The patient responded well to intestinal dialysis till the 8th POD and showed improvements in parameters [Table 1].

On the 8th POD, the patient was normal during day time. However, saturation suddenly dropped at midnight, started convulsion, and collapsed. The patient was shifted on ventilator; a blood sample was sent. The patient died after 4 h. Blood examination revealed creatinine of 9.8, urea = 85, HCO₃⁻ = 22, K = 4.2, and Random blood sugar (RBS) = 10 mg/dl.

**DISCUSSION**

This anephric newborn, index patient, was enrolled as the second patient in the list following an adult patient. On that adult patient, we did appendicostomy for colonic dialysis. Following colonic dialysis, the patient was on normal serum potassium and normal serum HCO₃⁻ level with partial clearance of creatinine and urea. However, body weight went on as water removal was not possible as large gut mucosal surface is innately water absorber. Nevertheless, he was free of uremic respiratory distress which was unavoidable previously, on avoiding single HD from the regimen of thrice per week. He had no respiratory distress 12–14 days at a stretch during colonic dialysis. Hence, it seemed that uremic molecules of gut origin increase the permeability of alveoli to precipitate respiratory distress in “uremic lung.”

Recently, Kajbafzadeh et al. have shown colonic dialysis through Malone’s antegrade continence enema.
in a patient of ESRD following neurogenic bladder. Along with that, they also studied colonic dialysis on a uremic rat to innovate cheaper RRT for the children. A similar study in canine model shows optimism toward intestinal dialysis.

Our index patient had no features of uremia since admission as he was passing stool frequently and was advised for colon wash with PD fluid since admission to get rid of gut–derived–uremic, i.e., breakdown product of nitrogenous substrate by the gut microbiota.

In our first patient, colonic dialysis with PD dialysate through appendicostomy was found to be effective in alleviation of uremic symptoms, respiratory distress, and in maintaining bicarbonate, potassium level, and partial clearance of creatinine and urea. However, it was found inadequate for clearance of water and total clearance of creatinine and urea. Hence, patient was counseled for jejunal dialysis along with. However, they declined and accepted ongoing colonic dialysis along with “intermittent HD.”

Our index patient offered valuable information those happen to be useful on the next patient. The third enrolled patient with idiopathic ESRD was on HD three times per week and was on restricted fluid (500 ml/day) intake. We did a combination of the same double-ended isolated jejunal loop enterostomy for jejunal dialysis and appendicostomy for colonic dialysis in this patient [Figure 2]. Irrigation of dialysate through jejunostomy and appendicostomy made the patient happy regarding the control of uremia, bicarbonate, potassium, and the water removal (ultrafiltrate). We, from our previous observations, pioneered the combination of large and small intestinal dialysis to get utmost outcome, and we acronymed this combination as INDIA (INtestinal DIAlysis) dialysis [Figure 2] to single out from other types of intestinal dialysis. The patient was happy with INDIA dialysis, particularly for withdrawn of prohibition on drinking water as well as relief from sudden onset of respiratory distress, nausea, and vomiting. Nevertheless, urea and creatinine clearance was not adequate due to the inadequate dwell time in jejunal loop unlike jejunum of anephric neonate. Hence, he was advised for “intermittent HD” at 10-day interval. After 11 months, he was advised for detubularization of existing jejunal loop to increase volume and dwell time. The patient consented and requested to be waited for another few months, but after 2 months, he suddenly died of disequilibrium syndrome during HD.

In our index patient, we achieved an adequate clearance of creatinine and urea in intact jejunal loop without detubularization. Plausibly, some distinctive features in the neonate might be the factors for that phenomenon. Possibly weak peristalsis in the jejunum during postoperative span; thinner and vascular mucosa contributed better exchange in osmosis.

In our fourth patient, we did detubularized jejunal loop under spinal anesthesia along with appendicostomy. He showed an adequate clearance of urea, creatinine, and uremic toxins and maintained water, potassium, and bicarbonate level. He had repeated attack of hypoglycemia during postoperative and convalescence during his indoor stay. Unfortunately, after few months, he died of sudden severe hypoglycemic attack in the early morning similarly to our anephric patient. Why these severe hypoglycemia?

This is due to the absence of degradation of insulin in the kidney and the absence of compensatory gluconeogenesis from renal parenchyma. Hence, there may be severe hypoglycemia from double attack.

We comprehend the role of jejunal loop dialysis for efficacious removal of water and harmful molecules from the valuable data gathered from our patients studied. Consequently, we combined both colonic and
jejunal loop dialysis for INtesinal DIAlysis, i.e., INDIA dialysis, both for pediatric and adult population for effective and cheaper RRT. INDIA dialysis is cheaper as the solution for dialysis, i.e., dialysate, is prepared with drinking water and the same ingredients present in PD solution, i.e., glucose, sodium chloride, and sodium bicarbonate. Hence, cost of therapy is around Rs. 800–1000/month.

**Conclusions**

Eventually, we have accomplished the final effective prototype of INDIA dialysis by combining both the colonic dialysis and jejunal loop dialysis. This combination is for the first time in the scientific world of intestinal dialysis.

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**Conflicts of interest**

There are no conflicts of interest.

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