The clinical status of end-stage renal disease in children:a single center analysis

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Abstract: End-stage renal disease (ESRD) is chronic renal failure which needs hemodialysis (HD) or kidney transplantation treatment. The maintenance HD has become mature and the pediatric patients gradually increased in recent years. We investigated the causes of ESRD and the clinical manifestation of patients before HD in our hospital from January 2000 to December 2010. A total of 86 patients were included, the average age of patients was 10.15±2.92 years. According to our analysis, calcium and phosphorus metabolic disorders and secondary hyperparathyroidism should be paid high attention in ESRD children, and kidney transplantation should be applied widely to treat ESRD.

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Key words: end-stage renal disease; hemodialysis; kidney transplantation.

1.Introduction

End-stage renal disease (ESRD) is the chronic and persistent renal dysfunction disease caused by a variety of kidney disease, which develops to irreversible ESRD, it is the end-stage of chronic renal failure (CRF). This disease threatens seriously to children's physical and mental health and has a poor prognosis, however, the application of hemodialysis (HD) help many children with ESRD return to society. In recent 10 years, with the maturation of HD technology, the enhancement of people's living standards and a sound health care system, the maintenance HD pediatric patients increases every year. Our study analyzes the pathogeny and clinical features of ESRD children who received HD treatment in our hospital in last 11 years, to understand the clinical status of ESRD children before HD began, the pathogeny of ESRD and the proportion of follow-up kidney transplantation.

2.Materials and methods

2.1 Study objects

Total 86 patients of blood purification center of our hospital who received HD treatment are brought into our study from January 2000 to December 2010, including 44 males and 42 females, the age of patients was 2.5-15.0 years (the average age was 10.15±2.92 years). The age of patients was less than 3 years in one case (1.16%), 3 to 5 years in 4 cases (4.65%), 6 to 10 years in 33 cases (38.37%), more than 10 years in 48 cases (55.81%).

2.2 Methods

Retrospective analyzing the causes of ESRD, the clinical manifestation before HD, the proportion of complicated hypertension, the hemoglobin (Hb) contents before HD, blood biochemistry (serum potassium, calcium, phosphorus, alkaline phosphatase, urea nitrogen, creatinine), parathyroid hormone (PTH) contents and the increased proportion of atrioventricular in echocardiographic in all children. Telephone follow-up of 69 children patients with the current situation and treatment.

2.3 Statistical analysis

Data are expressed as means ± standard deviation ($\bar{x}$ ±s) and were analyzed by SPSS 17.0 software.

3 Results

3.1 Etiology

In the 86 cases, the onset time was 3 days to 12 years, the average course before ESRD diagnosed was 27.69±40.09 months. In 15 cases, the etiology was unclear, because the patients were diagnosed with ESRD the first examination, the shortest history was only 3 days. In 71 cases (82.56%), 29 ESRD patients (33.72%) was because of congenital kidney disease (congenital renal dysplasia, renal cystic disease) and urinary tract malformations, 39 cases (44.19%) was caused by acquired renal disease. Distribution of etiology is shown in Table 1.

Table 1. The etiology analysis of 86 children patients with CRF

Etiology	Number of cases (n)	Percentage (%)
Congenital	29	33.72
Acquired	38	44.19
Chronic glomerulonephritis	20	23.16
Nephritic syndrome	11	12.79
IgAN	2	2.32
Systemic lupus erythematosus	1	1.16
Hemolytic uremic syndrome	1	1.16
Anaphylactoid purpura nephritis	1	1.16
Rapidly progressive glomerulonephritis	1	1.16
Surgical postoperative	1	1.16
ANCA related vasculitis	2	2.32
Goodpasture syndrome	1	1.16
Chronic tubulointerstitial nephritis	1	1.16
Unexplained	15	17.44

3.2 ESRD treatment time structure

The HD patients (86 cases) accounted for 0.66% hospitalized children in department of Nephrology (13051 cases) in the same period. 13 cases in 2010 (13/1316=0.99%), 13 cases in 2009 (13/1307=0.99%), 13 cases in 2008 (13/1209=1.07%), 8 cases in 2007 (8/1257=0.64%), 8 cases in 2006 (8/1422=0.56%), 10 cases in 2005 (10/1379=0.72%), 10 cases in 2004 (10/1265=0.79%), 4 cases in 2003 (4/859=0.46%), 5 cases in 2002 (5/901=0.55%), one case in 2001 (1/742=0.13%), one case in 2000 (1/1394=0.07%).

3.3 Analysis of clinical characteristics

3.3.1 Clinical manifestation

ESRD of different causes has similar clinical manifestations, including pallor, hypodynamia, anorexia, nausea, dizziness headache, convulsion and development retardation. 49 patients suffered from high blood pressure, blood pressure was 130/85 mmHg-250/160 mmHg (1 mmHg=0.133 Kpa), systolic blood pressure 145±21 mmHg and diastolic blood pressure was 99±16 mmHg. The details are in Table 2.

Table 2. Statistics of clinical manifestations in 86 children

Item	Number of cases (n)	Percentage (%)
Anemia	82	95.35
Hypodynamia	70	81.40
Anorexia, nausea	56	65.12
Edema	51	59.30
Hypertension	49	56.98
Development retardation	36	41.86
Dizziness headache	25	29.07
Convulsion	20	23.26

3.3.2 Laboratory examination

The hemoglobin of 86 children was 32-125 g/L (69.80±20.22 g/L), 82 children (95.35%) have varying degrees of anemia, mild anemia in 12 cases (13.95%), moderate anemia in 40 cases (46.51%) and severe anemia in 30 cases (34.88%). The serum potassium of all patients was 2.74-8.35 mmol/L (4.56±1.16 mmol/L), it was less than 3.5 mmol/L in 18 cases (20.93%), more than 5.5 mmol/L in 16 cases (18.60%), and in normal range in 52 cases (62.34%); creatinine was 200-2359 μmol/L (1006.96±418.72 μmol/L); urea nitrogen was 9.9-106 mmol/L (44.93±20.02 mmol/L); blood calcium was 0.86-2.48 mmol/L (1.64±0.41 mmol/L), hypocalcemia (<2.1 mmol/L) appeared in 74 cases of 86 (86.05%); serum phosphorus was 1.0-5.3 mmol/L (2.58±0.93 mmol/L), hyperphosphatemia was detected in 61 cases of 79 (77.22%); alkaline phosphatase was 36-885 IU/L (236.48±206.90 IU/L) in 72 cases; 47 children performed the PTH examination, PTH was 29.1-2500 pg/ml (847.06±658.89 pg/ml), it was more than 300 pg/ml in 37 cases; echocardiographic examination of 68 children showed normal in 22 cases, mild enlargement of left atrioventricular in 17 cases, moderate enlargement in 14 cases, severe enlargement in 14 cases, pericardial effusion in 14 cases.

3.3.3 Renal biopsy

19 children with acquired renal disease performed renal biopsy, and the results showed proliferative sclerosing or sclerosing glomerulonephritis in 10 cases (52.63%), focal segmental glomerular sclerosis in 4 cases (21.05%), IgA nephropathy in 2 cases (10.53%), fiber crescentic glomerulonephritis in one case (5.26%), membranous nephropathy in one case (5.26%), chronic tubulointerstitial nephritis in one case (5.26%).

3.4 Blood purification

86 patients underwent HD treatment, dialysis time was one day to six years. Maintenance dialysis was more than one month in 63 cases, 2-3 times a week, 3-4 hours each time; vascular access includes femoral vein

in 74 cases, internal jugular vein in 11 cases, arteriovenous fistula in one case (HD has begun outside the hospital). No one patient performed atreriovenous fistulation before HD started. 41 patients who had a successful atreriovenous fistulation continued maintenance HD after HD started, one patient were treated with semi-permanent jugular vein catheter. Seven patients performed intermittently hemodiafiltration and hemoperfusion therapy when they underwent HD.

3.5 Prognosis and follow-up

23 cases were lost in 86 cases (one case was lost which was not included after renal transplantation); 63 cases were followed up, among them 26 patients died (41.27%), 19 patients underwent maintenance HD treatment until now, the average time was 25.26±24.17 months; HD was replaced by peritoneal dialysis in 3 cases (one patient died of peritoneal infection); one patient stopped dialysis and took oral drugs; 14 patients performed kidney transplantation: 10 patients live well, the longest kidney transplantation was nearly six years, the average time was 46.12±31.34 months; 3 patients died after transplantation, one was lost.

4. Discussion

ESRD is one of the important life-threatening disease in children, there are few reports in China. In this study, the ESRD dialysis children accounted for 0.66% hospitalized children in the same period. Due to diversification of lifestyle, improvement of disease prevention and cure and people's living standards, reform of health care system, HD patients increased significantly in recent years, it increased from 0.07% hospitalized patients in 2000 to 1% hospitalized patients nearly 2 years in the Department of Nephrology at the same period.

The main cause of ESRD was acquired glomerulopathy (44.19%), chronic glomerulonephritis occupied first place (23.26%). Congenital anomalies accounted for 33.72%, 48.2% of cause of ESRD was acquired glomerular diseases and 31.2% was congenital urinary tract anomalies according to Poland's reports [Ziółkowska et al., 2009], and the statistics of North American Pediatric Renal Transplant Cooperative Research showed that 40% CRF was caused by congenital malformations [Seikaly et al.,2003]. In our study, the average age of children was 10.15±2.92 years when HD started, which was earlier than 11.10±2.25 years in Jordan [Sacca and Hazza 2006] and 12.1 years in the United States [Annual Data Report Pediatric ESRD 2006]. Our data showed the etiology of ESRD was unknown in 15 cases, it had not monitored urine routine, renal function before and it was diagnosed ESRD the first examination, the shortest history was 3 days; therefore, Chinese children should have urine routine test, blood biochemical test and monitor renal function which are beneficial to early diagnosis, they also should treat and protect residual kidney function in early period, which could delay the development of renal failure to ESRD. It suggests that the screening, management and follow-up of chronic kidney disease need to standardize and strengthen.

ESRD children lack of specific clinical manifestations, it is often multiple system involvement, and the most common was blood system and digestive system symptoms. A significant feature between children with ESRD and adults is growth retardation and delayed puberty. In this study, growth retardation accounted for 41.86%, we also lack of the follow-up data after application of renal replacement therapy. The reason of hypertension in ESRD children are complicated, mainly due to sodium and water load, although taking antihypertensive drugs, hypertension is still the risk factor of ESRD children occur cardiovascular complications and die of cardiovascular diseases [Mitsnefes and Stablein 2005;Parekh et al.,2002]. The rate of hypertension is 56.98% in ESRD children in our study. As erythropoietin (EPO) synthesis deficiency, erythrocyte lifetime shorten, bone marrow suppression and lack of nutritional factors (especially iron), anemia occurred easily in ESRD children, our data confirm that 95.35% ESRD children have anemia, 34.88% are severe anemia. Calcium and phosphorus metabolic disorders and secondary hyperparathyroidism are one of the common metabolic disorders in chronic renal failure patients, which could easily cause a further loss of residual renal function, cardiovascular system, blood system, endocrine system and bone damage, all of these have been concerned. Compared to *Rahman*'s report [Rahman et al.,2005], the blood calcium (6.58±1.65 mg/dL) of our group was close to 6.49±0.77mg/dL which was reported before, the rate of hypocalcemia (<2.1 mmol/L) was 86.05%; serum phosphorus was 8.00±2.88 mg/dL, which was significantly higher than the reported 6.52±1.09 mg/dL, the rate of hyperphosphatemia was 77.22%; the PTH of 37/47 cases (78.72%) was more than 300 pg/ml, which was significantly higher than the foreign reported 130.66±58.74 pg/ml. It suggested that calcium and phosphorus metabolic disorders and secondary hyperparathyroidism should be paid high attention.

Cardiovascular disease is a common complication of ESRD, and it is the second death factor in ESRD patients. The progress of left ventricular hypertrophy is related to hypertension, hyperparathyroidism, anemia and other factors [Mitsnefes 2005]. Our data showed that 66.18% patients (45/68 cases) had left atrioventricular increase by ultrasonic cardiography, 20.59% patients (14/68 cases) had complicated pericardial effusion. We should pay more attention to cardiovascular function in children with ESRD.

Multi-center study has confirmed that 82% children had left ventricular hypertrophy when dialysis began [Mitsnefes et al.,2009].

Fadrowski [2009] reported that when 1284 children began HD, 89.2% children used vascular catheter, 8.1% possessed arteriovenous internal leakage or vascular graft, 41% used arteriovenous internal leakage or vascular graft in maintenance HD, 59% used central venous catheter as a vascular access. No patient established vascular access before dialysis, which suggested that our CRF patients lack of system management.

The treatment of ESRD patients depend on economic conditions and health care resources, 90% ESRD patients can perform renal replacement therapy, including dialysis and kidney transplantation in developed countries. *McDonald* [2004] followed up 1634 children and adolescents with renal replacement therapy 9.7 years, 10 and 20 years long-term survival rate had reached 79% and 66%, the mortality rate was 30 times than people without ESRD disease, the risk factors were younger age receiving renal replacement therapy (the mortality within one year is 4 times than that between 15 to 19 years) and dialysis (the mortality of dialysis is 4 times than that of kidney transplantation). The best treatment for ESRD children is renal replacement therapy, especially kidney transplantation, and the survival rate could be improved significantly compared to dialysis. However, this couldn't happen in most developing countries. In China, renal replacement therapy started after 1997, the rates of kidney transplantation are lower than other countries, such as 66% in the United States [Sacca and Hazza 2006], 30% in Jordan [Seikaly et al.,2006]; however, renal replacement therapy has been rapid development in recent years. In the 63 cases in our study, 19 cases had maintenance HD, 14 cases performed kidney transplantation which accounted for 16.28%, the longest survival was 6 years. With the improvement of surgical techniques, improvement of tissue compatibility and the application of new immunosuppressant, kidney transplantation has become the most important method to treat ESRD patients.

There were few reports about ESRD in China, the long-term survival needs further follow-up, and it is urgent to establish a registration system for Chinese ESRD children.

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