Left Ventricular Hypertrophy and LV Geometry in Chronic Dialysis Children and Adolescents

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Data from USRDS and Thai Renal Replacement Therapy revealed cardiovascular disease is a common cause of death in ESRD patients. Left ventricular hypertrophy (LVH) is one of the risk factors however there are few studies about this in chronic dialysis children. In the present study, the authors retrospectively reviewed the prevalence of LVH and variable parameters correlated with LVMI in chronic dialysis patients in Phramongkutklao Hospital. Eleven hemodialysis and three peritoneal dialysis patients, aged 12.1 ± 5 years, were included. LVH was diagnosed by calculating LVMI from echocardiographic study. Clinical and laboratory data were reviewed to compare parameters between LVH and without LVH groups. Prevalence of LVH was 57%. In the LVH group, 7 patients had eccentric LVH and 1 patient had concentric LVH. LVH patients had significantly high systolic BP (SBP), diastolic BP (DBP), index of SBP, and index of DBP. Blood pressure also had positive correlation and patients age had negative correlation with LVMI. In conclusion, high blood pressure is associated with left ventricular hypertrophy. Serial echocardiography and long term follow up should be done in this patient group to prevent cardiovascular morbidity and mortality.

Keywords: *Left ventricular hypertrophy, Left ventricular mass index, Dialysis, Children*

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Cardiovascular disease is one of the major causes of death in end stage renal disease (ESRD) either of chronic dialysis and kidney transplant patients. Data from the United States Renal Data System 2003 showed cardiovascular complication is a major cause of hospitalization and mortality in chronic dialysis patients[1]. Also in Thailand, data from the Thai Renal Replacement Therapy Registry (TRT) revealed cardiovascular disease is the most common cause of death in ESRD patients[2]. Two major risk factors for cardiovascular disease mortality include left ventricular hypertrophy (LVH) and coronary artery disease[3,4]. In adult chronic dialysis patients, prevalence of LVH was demonstrated in up to 75%[5]. Although data from TRT showed there are many dialysis centers in all parts of Thailand, however, only some dialysis centers can perform hemodialysis and peritoneal dialysis in children due to lack of experienced personnel and dialysis equipment. Most of the dialysis children were treated at university hospitals by pediatric nephrologists. In chronic renal failure children, the accumulation of uremic toxin such as urea, creatinine and parathyroid hormone can affect growth, development and myocardium function. The dialysis modalities including hemodialysis and peritoneal dialysis are the way for palliative treatment for end stage renal disease children while they are waiting for kidney transplantation. As is known, the prevalence of LVH in chronic dialysis is common in adult patients, however, there are few studies about prevalence, risk factors of LVH and left ventricular mass index (LVMI) in chronic dialysis children and adolescents. Also in Thailand, there has been no report about cardiovascular study in ESRD children before. In this retrospective study, the authors assessed LVMI in chronic hemodialysis (HD) and peritoneal dialysis (PD) children and adolescents by echocardiography to determine the prevalence of LVH and correlation between LVMI and variable parameters.

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Material and Method

Retrospective chart review for left ventricular mass index (LVMI) was performed in 14 chronic dialysis children at the Pediatric Nephrology Division, Phramongkutklao Hospital from April 2002 to March 2005. Congenital heart disease patients were excluded from the present study. LVMI was measured by two-dimension directed M-mode echocardiography according to The American Society of Echocardiography criteria[6]. LVMI ($g/m^{2.7}$) was calculated from the formula: LVMI = 0.8 x [1.04 x [(LVID + PWT + IVST)^3 -(LVID)^3]] + 0.6 g, where LVID = left ventricular internal dimension in end diastole, IVST = interventricular septal thickness in end diastole, and PWT = posterior wall thickness. Left ventricular hypertrophy (LVH) was defined as LVMI > 51 $g/m^{2.7}$. LV geometry was evaluated based on LVMI and relative wall thickness (RWT). RWT was calculated from the formula: RWT = [PWT + Septal thickness]/LVID, normal < 0.41. Concentric LVH was defined as LVH and elevated RWT. Eccentric LVH was defined as LVH and normal RWT. Normal LVMI but elevated RWT was defined as concentric remodeling. The medical records were reviewed for age, sex, dialysis modality, duration of dialysis, and underlying diseases. Clinical and laboratory data were collected on the day of echocardiographic study including systolic (SBP) and diastolic (DBP) blood pressure, index of systolic (ISBP) and (IDBP) blood pressure, hemoglobin, albumin, calcium, phosphorus, calcium phosphorus (CaxP) product, and intact parathyroid hormone (iPTH). ISBP and IDBP were calculated from SBP or DBP divided by the age-, sex-, and height-specific 90th percentile SBP or DBP. Systolic function was evaluated by ejection fraction (EF) from echocardiographic study, normal > 64%. The authors classified patients into 2 groups as LVH (LVMI > 51 $g/m^{2.7}$) and without LVH, and evaluated for significant differences between the two groups.

Statistic Analysis

The Mann-Whitney U test was used for testing the differences of mean between LVH and without LVH groups. The associations between variables were assessed by Spearman correlation analysis. A p-value < 0.05 was considered statistically significant.

Results

Fourteen patients, ages 12.1 ± 5 years (range 4-21 years), were included in the present study. Six patients were male and 8 patients were female. Eleven patients were on chronic HD and 3 patients were on chronic PD. No patients had the dialysis modalities changed since starting dialysis. The duration of dialysis was 16.1 ± 17 months (range 3-50 months). The caused of ESRD included focal segmental glomerulosclerosis (3 patients), chronic glomerulonephritis (2 patients), neurogenic bladder (2 patients), pauci immune glomerulonephritis (l patient), lupus nephritis (l patient), Drash syndrome (l patient), and unknown causes (4 patients). All patients were hypertensive and received blood pressure medication. LVH was diagnosed in 8 patients (6 HD and 2 PD patients). Concentric remodeling, concentric LVH, and eccentric LVH were

Table 1. Comparison of variables between without LVH and LVH group

Variable	Without LVH (n = 6)	LVH (n = 8)	p-value
Age (years)	15.1 ± 4	9.9 ± 5	0.07
Dialysis duration (months)	24.3 ± 27	9.9 ± 9	0.29
SBP (mmHg)	123.2 ± 9	140.9 ± 12	0.023
ISBP	1.04 ± 0.1	1.26 ± 0.1	0.005
DBP (mmHg)	74.7 ± 10	93.4 ± 9	0.004
IDBP	0.98 ± 0.1	1.30 ± 0.2	0.003
Hb (g/dl)	8.8 ± 1	8.5 ± 2	0.699
Albumin (g/dl)	3.9 ± 1	4.0 ± 0	0.948
Calcium (mg/dl)	8.8 ± 1	9.6 ± 1	0.897
Phosphorus (mg/dl)	5.8 ± 1	6.0 ± 1	0.267
CaxP product(mg^2/dl^2)	50.3 ± 7	57.3 ± 11	0.197
iPTH (ng/ml)	101.8 ± 32	345.4 ± 327	0.439
EF (%)	71.9 ± 5	62.8 ± 21	0.438

Values are mean ± SD

identified in 1, 1, and 7 patients, respectively. From the present study prevalence of LVH was 57 % and most of LVH patients had eccentric LVH. Comparison of variable parameters between LVH and without LVH groups are demonstrated in Table 1.

Statistical significant correlation between two groups were demonstrated in patients age ($r = -0.574$, $p = 0.032$), SBP ($r = 0.642$, $p = 0.013$) ISBP ($r = 0.842$, $p = 0.001$), DBP ($r = 0.708$, $p = 0.005$), and IDBP ($r = 0.754$, $p = 0.002$).

Discussion

The present study indicated that left ventricular hypertrophy and abnormal LV geometry in chronic dialysis children were common the same as in other studies[7,8]. Mitsnefes et al reported that the prevalence of LVH in chronic dialysis children was 75%[7]. Eighty percent had abnormal LV geometry: 39 % had eccentric LVH, 36% had concentric LVH, and 5% had concentric remodeling. Patients with severe LVH had significantly longer duration of renal disease prior to the start of dialysis therapy[7]. In the present study, the authors did not know about correlation between onset of renal disease and left ventricular mass because some patients were transferred to the authors center due to ESRD without a history of kidney disease duration, however, duration of dialysis did not correlate with left ventricular mass. Although the LVH patients were young and had higher blood pressure than without LVH patients, there was no correlation between patients age and blood pressure parameter (data not shown).

Several studies found a correlation between blood pressure and LVH in adults and pediatric patients with ESRD[7-9]. ISBP and IDBP are more reliable than blood pressure because they were calculated from ratio of blood pressure to 90 percentile of blood pressure for age, sex, and height. In the present study, systolic, diastolic blood pressures, ISBP, and IDBP were significantly high in LVH patients and blood pressure had positive correlation with left ventricular mass.

The role of anemia has been demonstrated as a risk of LVH in chronic dialysis adults and children[10,11]. Anemia can cause eccentric LVH from increasing left ventricular chamber and stroke volume[7]. However, the authors did not find statistical significant difference of hemoglobin in both groups.

Parathyroid hormone is uremic toxin and has negative effect on myocardium by increasing calcium influx to cardiomyocytes and leads to intermyocardiocytic fibrosis and intramyocardial arteriloes thickening[12,13]. Left ventricular hypertrophy, myocardial heart valve deposit, and congestive heart failure are common in hypercalcemic ESRD patients[14]. Hyperphosphatemia is independent risk factor for cardiovascular death[15]. High calcium phosphorus products also increase the risk for coronary calcification[16]. Currently, K/DOQI clinical practice guidelines recommend to maintain parathyroid hormone level between 200-300 ng/ml, phosphorus level less than normal range for age and calcium phosphorus products $< 55\ mg^2/dl^2$ in ESRD patients to prevent cardiovascular morbidity and mortality[16]. Calcium, phosphorus and calcium phosphorus products tended to be high in LVH group but not statistically significant. Systolic dysfunction is a risk for cardiovascular death. Although, systolic function in both groups did not have significance different, LVH patients had lower ejection fraction than without LVH patients.

The result from the present study demonstrates that prevalence of left ventricular hypertrophy is common in chronic dialysis children and adolescents, and high blood pressure is associated with left ventricular hypertrophy. Although, there is no target blood pressure recommendation for chronic dialysis children and adolescents, the authors recommend to maintain blood pressure at less than 95 percentile for age, sex, and height. Serial echocardiography and long term follow up should be done in this patient group to prevent cardiovascular morbidity and mortality.

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การศึกษาภาวะหัวใจโตในผู้ป่วยเด็กไตวายเรื้อรังที่ได้รับการรักษาโดยวิธีไดอะไลซิส

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จากการศึกษาของ USRDS และการศึกษาในประเทศไทยพบว่า ภาวะความเจ็บป่วยจากระบบไหลเวียนโลหิต เป็นสาเหตุการตายที่สำคัญของผู้ป่วยไตวายเรื้อรัง โดยภาวะหัวใจโตเป็นปัจจัยเสี่ยงที่ทำให้เกิดความผิดปกติของระบบไหลเวียนโลหิต อย่างไรก็ตามในผู้ป่วยเด็กนั้นยังมีการศึกษาถึงภาวะดังกล่าวน้อยมาก ในการศึกษาครั้งนี้ผู้วิจัยได้เก็บข้อมูลย้อนหลังเพื่อศึกษาถึงความชุกและตัวแปรที่มีผลต่อการเกิดภาวะหัวใจโตในผู้ป่วยเด็ก ไตวายเรื้อรังที่รับการรักษาที่ รพ.พระมงกุฎเกล้า ผู้ป่วยที่เข้าร่วมในการวิจัยมีจำนวน 14 ราย โดยเป็นผู้ป่วยที่ได้รับการฟอกเลือดจำนวน 11 ราย และผู้ป่วยที่ได้รับการล้างช่องท้อง 3 ราย ภาวะหัวใจโตสามารถคำนวณได้จาก Left ventricular mass index จากการศึกษาด้วย echocardiography และได้เปรียบเทียบตัวแปรต่างๆ ในผู้ป่วยที่มีภาวะ หัวใจโตและไม่มีภาวะหัวใจโต จากการศึกษาพบว่าความชุกของภาวะหัวใจโตเท่ากับ 57% โดยผู้ป่วย 7 รายเป็นหัวใจโตชนิด eccentric และ 1 รายเป็นชนิด concentric ในผู้ป่วยที่มีหัวใจโตพบว่ามีความดันโลหิต systolic, index of systolic, diastolic, index of diastolic สูงกว่ากลุ่มที่ไม่มีหัวใจโตอย่างมีนัยสำคัญ นอกจากนั้นความดันโลหิตยังมีความสัมพันธ์ในทางบวกและอายุของผู้ป่วยมีความสัมพันธ์ในทางตรงกันข้ามกับ Left ventricular mass index จากการศึกษาครั้งนี้เห็นได้ว่าภาวะหัวใจโตในผู้ป่วยเด็กไตวายเรื้อรังที่ได้รับการรักษาโดยวิธีไดอะไลซิสนั้นพบได้บ่อย แพทย์ผู้ดูแลควรควบคุมความดันโลหิตผู้ป่วยให้อยู่ในเกณฑ์ปกติ รวมทั้งตรวจ echocardiography เป็นระยะและให้การติดตามผลในระยะยาวเพื่อลดความเสี่ยงจากภาวะความเจ็บป่วยจากระบบไหลเวียนโลหิต