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EVALUATION OF RENAL FUNCTIONS IN CHILDREN WITH CONGENITAL HEART DISEASE BEFORE AND AFTER CARDIAC ANGIOGRAPHY*

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SUMMARY: Noyan A, Küçükosmanoğlu O, Yıldızbaş D, Özbarlas N, Anarat A, Anarat R. (Departments of Pediatric Nephrology and Cardiology, Çukurova University Faculty of Medicine, Adana, Turkey). Evaluation of renal functions in children with congenital heart disease before and after cardiac angiography. Turk J Pediatr 1998; 40: 97-101.

Radiocontrast nephrotoxicity, which has increased in incidence with widespread use of radiological methods in medicine, is a serious complication of radiocontrast materials. In this study, we have prospectively investigated whether children with cyanotic congenital heart disease are at risk for radiocontrast nephrotoxicity with the use of a nonionic low osmolar contrast agent. Thirty-five children (17 cyanotic and 18 acyanotic patients) who underwent diagnostic cardiac catheterization were subjects of the study. The age range was from five days to 13 years. The volume of contrast material was 3.11 ± 1.37 ml/kg in cyanotic patients and 2.67 ± 0.86 ml/kg in acyanotic patients. Blood samples and timed urine samples were taken from all patients 24 hours before and 48 hours after cardiac catheterization. Blood urea nitrogen, creatinine, sodium, and phosphorus in serum, and creatinine and N-acetyl-β-D-glucosamine in urine were analyzed. There was not a statistically significant difference between the values before and after angiography. As a result, we could find no evidence of radiocontrast nephrotoxicity with the use of a nonionic contrast agent in cyanotic and acyanotic patients who underwent cardiac angiography. *Key words: cardiac angiography, radiocontrast nephrotoxicity.*

Radiocontrast nephrotoxicity (RCN), a serious complication of radiocontrast materials, has increased in incidence with widespread use of radiological methods in medicine. While the incidence of radiocontrast nephrotoxicity in adults with no risk factors is given as 47 percent, in cases with diabetes or preexistent kidney disease, this incidence rises to 90 percent[1]. Although radiocontrast investigations are employed frequently as diagnostic tools in pediatrics, we do

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not have adequate knowledge about the incidence of RCN in children. In this study, we have prospectively investigated whether children with cyanotic congenital heart disease (CHD) are at risk for RCN by comparing the glomerular and tubular functions in children with cyanotic and acyanotic CHD before and after cardiac angiography.

Material and Methods

The subjects of this study were 35 children who underwent cardiac catheterization in the Pediatric Cardiology Department of Çukurova University Faculty of Medicine between March and June 1996 as a result of various congenital heart diseases. Seventeen children (8 girls, 9 boys) had cyanotic and 18 (9 girls, 9 boys) had acyanotic congenital heart disease. The age range of the cyanotic patients was 5 days to 14 years (mean 4.23 ± 4.61 years) and of acyanotic patients was 1.5 to 13 years (mean 5.44 ± 3.04 years) (Table I). Cardiac catheterization and angiography were performed using standard techniques. Lopamidol was used for angiography. The volume of contrast material was 3.11 ± 1.37 ml/kg in cyanotic patients and 2.67 ± 0.86 ml/kg in acyanotic patients. Procedure duration was less than 30 minutes for all patients.

Table I: Comparison of Clinical Variables of the Cyanotic and Acyanotic Patients

	Cyanotic (n = 17)	Acyanotic (n = 18)
Age (year, mean ± SD)	4.23 ± 4.61	5.44 ± 3.04
Male (%)	53	50
Contrast material volume (ml/kg)	3.11 ± 1.37	2.67 ± 0.86
Mean Htc (%)	50.3 ± 5.7	36.3 ± 3.2
Diagnosis	10 Tetralogy of Fallot	7 Ventricular septal defects
	3 Double outlet right ventricle	5 Atrial septal defects
	4 Transposition of great arteries	3 Pulmonary stenoses
		1 Patent ductus arteriosus
		1 Atrioventricular septal defect
		1 Rheumatic heart disease

Laboratory methods: Blood samples and timed urine samples were taken from all patients 24 hours before and 48 hours after cardiac catheterization. Urea nitrogen, creatinine, sodium, phosphorus and calcium in serum and creatinine in urine were analyzed with Cobas Mira autoanalyzer. N-acetyl-β-D-glucosamine (NAG) in urine was measured by spectrophotometric absorption of 3-cresolsulfophthalein sodium at 580 nm. The Wilcoxon test was used to test the significance between values before and after angiography within the same group and correlation was calculated according to the Pearson equation. Values are expressed as mean ± SD and p value ≤ 0.05 was considered significant.

Results

Comparison of laboratory parameters before and after cardiac angiography in the cyanotic and acyanotic groups is shown in Table II. The NAG values of the cyanotic group before and after cardiac angiography were 3.29 ± 1.95 U/day and 3.37 ± 1.56 U/day, respectively ($p > 0.05$). The NAG values of the acyanotic group before and after the procedure were 2.88 ± 1.17 U/day and 3.09 ± 1.68 U/day, respectively ($p > 0.05$). The fractional excretion of sodium (FeNa) values of the cyanotic group before and after angiography were 0.91 ± 0.67 and 0.87 ± 0.84, respectively ($p > 0.05$) and of the acyanotic group were 1.01 ± 0.76 and 1.02 ± 0.65, respectively ($p > 0.05$). Creatinine clearance (CrCle) values before angiography were 89.1 ± 3.11 ml/min/1.73 m^2 in the cyanotic group and 74.22 ± 5.86 ml/min/1.73 m^2 in the acyanotic group. The values after angiography were found to be 90.69 ± 3.24 ml/min/1.73 m^2 and 78.12 ± 5.07 ml/min/1.73 m^2, respectively. There was not a statistically significant difference between the values of the two groups.

Table II: Comparison of Laboratory Parameters Before and After Cardiac Angiography in Cyanotic and Acyanotic Groups

	Cyanotic Group (n = 17)			Acyanotic Group (n = 18)		
	Before	After	P	Before	After	P
NAG	3.29 ± 1.95	3.37 ± 1.56	p > 0.05	2.88 ± 1.17	3.09 ± 1.68	p > 0.05
FeNa	0.91 ± 0.67	0.87 ± 0.84	p > 0.05	1.01 ± 0.76	1.02 ± 0.65	p > 0.05
CrCle	89.1 ± 3.11	90.69 ± 3.24	p > 0.05	74.22 ± 5.86	78.12 ± 5.07	p > 0.05
SCr	0.51 ± 0.14	0.53 ± 0.16	p > 0.05	049 ± 0.14	0.53 ± 0.14	p > 0.05
BUN	15.31 ± 7.18	12.41 ± 3.11	p > 0.05	13.98 ± 4.77	14.61 ± 5.17	p > 0.05
TRP	0.90 ± 0.04	0.93 ± 0.05	p > 0.05	0.90 ± 0.04	0.91 ± 0.04	p > 0.05
SCa	9.7 ± 61	10.01 ± 0.98	p > 0.05	9.5 ± 0.97	10.04 ± 0.96	p > 0.05

NAG (U/day) : N acetylglucosaminidase.
FeNa : Fraetional excretion of sodium.
CrCle (ml/min/1.73 m^2) : Creatinine clearance.
SCr (mg/dl) : Serum creatinine.
BUN (mg/dl) : Blood urea nitrogen.
TRP : Tubular reabsorption of phosphorus.
SCa (mg/dl) : Serum calcium.

Tubular reabsorption of phosphorus (TRP) values of the cyanotic group before and after angiography were 0.90 ± 0.04 and 0.93 ± 0.05, respectively. The same values for the acyanotic group were 0.90 ± 0.04 and 0.91 ± 0.04, respectively. There was also no statistically significant difference between the TRP values before and after the angiography ($p > 0.05$). The serum Ca^{++} (SCa) values of both groups before and after angiography showed no statistically significant difference ($p > 0.05$). The Ca^{++} values of the cyanotic group were 9.70 ± 0.61 mg/dl and 10.01 ± 0.98 mg/dl and of the acyanotic group were 9.50 ± 0.97 mg/dl

10.04 ± 0.96 mg/dl, respectively. There was no correlation observed between the dosage of the radiocontrast material and NAG and serum creatinine differences of the groups before and after angiography.

Discussion

Cardiac catheterization and angiography carry certain risks of morbidity and mortality[2]. One of the risks associated with this procedure is nephrotoxicity. Since an adequate definition of RCN does not exist, reports of its incidence in adults vary from study to study[3-7]. The incidence of RCN in children is even less well documented. However, one fact known for certain is that in the presence of risk factors (such as renal insufficiency, diabetes mellitus, hypertension, congestive heart failure etc.) the incidence of RCN increases significantly. The relationship of glomerular abnormalities to cyanotic CHD has long been recognized[8, 9]. Studies of autopsy material have revealed various glomerular changes in cyanotic CHD[8, 10]. A number of speculative mechanisms have been proposed, including hypoxia, polycythemia, chronic hypercapnia, increased pressure in the right side of the cardiac circuit and increased postglomerular resistance[8]. The true mechanism of these abnormalities is not known. In this study we have investigated whether children with cyanotic or acyanotic CHD constitute a risk group for RCN. NAG is a lysosomal enzyme which is found in renal tubular cells and its activity in urine increases markedly in case of renal damage[11]. Even though glomerular and tubular parameters are useful in diagnosing RCN, NAG may be an important criterion for early diagnosis as in renal transplant patients and certain drug nephrotoxicities[11, 12]. However, as was the case in other studies, we also could not determine significant differences betweenn NAG values before and after cardiac catheterization in conjunction with use of low osmolality agents[13, 14]. In some studies done on RCN, one indicator has been an increase in serum creatinine of greater than 50 percent from baseline values[7]. In this study, no increase to this extent was observed in either group. In addition, no significant difference in creatinine clearance was observed in either group. Controversy exists regarding whether the dose of contrast media administration is related to the development of RCN[10]. In our study, we could not find a correlation between the dosage of the contrast material and NAG and serum creatinine differences of the groups before and after angiography.

As a result, we could not find any evidence of RCN with the use of iopamidol in pediatric cyanotic and acyanotic patients who underwent cardiac angiography. However, in evaluating this result, it should be kept in mind that the volume of contrast material given to the patients in our study was not the maximum dose. We can say that cardiac angiography using not-too-high volumes of nonionized low osmolar contrast material is rather safe, in terms of nephrotoxicity, for children with acyanotic and cyanotic CHD.

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