Exacerbation of Renal Dysfunction Following Contrast Media Study in Diabetic Patients

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It has been generally assumed that contrast media used for excretory urography are safe even in the presence of renal insufficiency. Recently, however, several reports of acute oliguric renal failure have been documented in diabetic patients after excretory urography. We also have experienced three cases of acute renal failure following contrast media study in diabetic patients. For the purpose of investigating the effect of contrast media on renal function, we examined serum creatinine, BUN, K^+ levels and urine volume before and after intravenous pyelography (IVP), drip-infusion pyelography (DIP) or angiography in twenty diabetic patients. As controls, twenty patients with non-diabetic renal diseases were selected. From this study, it is concluded that contrast media study had better be avoided in diabetic patients providing with renal disturbance (creatinine level more than 3.0 mg/dl) and severe retinopathy.

Key Words: Contrast media; diabetic patient; acute renal failure; serum creatinine level; retinopathy;

The utilization of contrast media is increasing in diagnostic radiology as technical advances permit their wider application. Intravenous pyelography is an important investigational procedure in patients with renal problems and is generally regarded as safe, even in patients with renal disturbances¹⁻⁴⁾. In recent years, however, there have been several reports describing the occurrence of acute renal failure following infusion urography in patients with diabetes mellitus⁵⁻⁷⁾. And, the utilization of large doses of angiographic or cholecystographic media has also been associated in some cases with transient renal failure¹⁾.

Recently, in our diabetic clinic we have experienced three cases of acute renal failure following angiography, drip-infusion pyelography (DIP) or computerized tomography (CT) with contrast media. We, therefore,

investigated the changes of renal function before and after these studies in diabetic patients, comparing them with patients with non-diabetic renal diseases.

CASE PRESENTATION

Case 1: A 50 year-old male was admitted to our hospital on March 26, 1976, complaining of diabetic gangren in the left leg. Although diabetes mellitus was first diagnosed in 1965, he was not under treatment and the diabetic gangren had gotten worse. On admission, his serum creatinine level was 2.5 mg/dl and blood urea nitrogen (BUN) was 24 mg/dl. His daily urine volume was 1600-2000 ml/day and protein excretion averaged 6.6 g/day, and the grade of diabetic retinopathy was Scott IV. On April 21, angiography with Angiografin (Meglumine-Amidotrizoate) of the left femoral artery for excluding other obstructive arterial

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diseases was performed without any resulting hypotension, rash or other acute reactions. After this study, the patient developed severe oliguria persisting for 4 days and his serum creatinine level rose to 10.0 mg/dl and BUN to 72 mg/dl on the fourth day. With the administration of 100mg furosemide, his urine volume increased gradually and after 2 weeks, the serum creatinine decreased to 2.4 mg/dl and BUN to 34 mg/dl (Fig. 1).

Case 2: A 72 year-old female was admitted on April 12, 1977 for the purpose of controlling diabetes mellitus. Since the diagnosis of diabetes mellitus in 1963, she had been treated as an outpatient and on admission her fasting blood sugar (FBS) was 606 mg/dl, her serum creatinine level was 5.1 mg/dl and BUN was 70 mg/dl. Her daily urine volume was 1200-1500 ml/day and protein excretion was 3.9 g/day. The grade of diabetic retinopathy was Scott IIb.

After admission, FBS became stable ranging 120-130 mg/dl with insulin therapy. As plain abdominal X-ray showed atrophy of the both kidneys, DIP was performed on June, 6. After the study, the patient became severely oliguric and both serum creatinine and BUN increased. Although a large dose of furosemide and mannitol was administered, the serum BUN level elevated to 97 mg/dl, creatinine to 8.1 mg/dl and K⁺ to 7.8 mEq/L, and she finally died because of heart failure (Fig. 2).

Case 3: A 57 year-old female was admitted to our diabetic clinic, complaining of visible disturbance and leg edema. Although she was first diagnosed as having diabetes mellitus ten years ago and had been controlled it with oral hypoglycemic agents, she has not received therapy for the past few years. After stopping the therapy, she experienced bleeding of the optic fundus

Fig. 1. Clinical course (case 1).

Fig. 2. Clinical course (case 2).

twice. On admission, she had retinopathy with the grade of Scott V. As EEG showed slow wave in the parietooccipital region, a brain CT with contrast media was performed. After this study, she developed anuria and the next day her serum creatinine level rose to 3.8 mg/dl and BUN to 54 mg/dl. Despite the administration of 500 mg furosemide, spontaneous urination did not appear and hemodialysis was performed after 30 hours. After a few times of hemodialysis were performed, spontaneous urination occurred and her renal function returned to the former level (Fig. 3).

PATIENT AND METHOD

In the present study, twenty adult-onset diabetic patients ranging in age from 46 to 76 years (mean, 63 years) were selected. Their serum creatinine, BUN, K^+ and urine volume were examined the day before and the day after angiography, DIP or IVP. As controls, twenty patients with non-

diabetic renal diseases comparable to the diabetic patients in age, most of whom had chronic nephritis, were selected. Their blood samples were tested for serum creatinine by Jaffe's method, BUN by urease method and K^+ by flame ionization spectrometry.

RESULTS

Defining the exacerbation of renal dysfunction as an increase in serum creatinine level greater than 1.0 mg/dl, regardless their serum creatinine level before the study, in the group of diabetic patients exacerbation of renal dysfunction was never experienced. However, in the cases in which serum creatinine level was greater than 3.0 mg/dl before the study, there were three cases in which serum creatinine showed an increase of more than 0.5 mg/dl but less than 1.0 mg/dl (Table 1). On the other hand, in the group of patients with non-diabetic renal diseases, there was

Fig. 3. Clinical course (case 3)

Table 1. Changes of serum creatinine, BUN, K⁺ level and urine volume before and after contrast media studies in diabetic patients.

Name	Age	Sex	Duration of Diabetes (yr.)	Study	BUN mg/dl before after	Creatinine mg/dl before after	K mEq/L before after	Urine Volume ml/day before after	Retinopathy (Scott)
A K	66	F	20	DIP	18 17	1.6 1.5	4.4 4.5	1900 1300	II
N O	76	F	3	IVP	25 26	1.2 1.2	3.9 4.1	800 700	Ia
K K	72	F	2	IVP	13 16	0.9 1.1	4.0 3.9	1300 1400	Ib
M W	56	F	15	DIP	14 16	0.7 0.8	4.2 4.2	1000 1400	Ia
K K	64	M	1	Angio-graphy	34 44	3.1 3.6	5.2 4.9	1800 2000	IIIa
K H	62	F	13	DIP	12 15	0.9 1.0	3.7 4.0	1400 1400	(-)
S U	62	M	5	Angio-graphy	18 19	1.6 1.6	5.3 5.4	1200 1600	(-)
H A	71	F	20	IVP	23 18	0.9 0.8	4.8 5.1	1300 1400	II
K K	57	M	8	IVP	19 20	1.1 1.2	4.7 4.8	3100 3050	Ia
Y S	71	F	8	DIP	16 17	0.9 1.0	3.8 4.1	1700 2000	Ib
T I	58	F	Unknown	IVP	30 35	3.1 3.6	4.1 4.1	1200 1000	IIIa
N O	61	M	1	DIP	33 48	2.6 3.0	4.8 5.6	1800 1500	Ib
N O	64	M	12	DIP	40 48	4.9 5.5	4.5 5.4	2200 1700	IIIb
K K	67	M	10	IVP	23 25	1.2 1.4	5.1 4.9	3200 1700	(-)
H U	51	F	11	IVP	14 16	0.7 0.8	4.0 4.1	2200 1200	Ia
Y O	71	M	12	DIP	21 21	1.3 1.2	4.1 4.0	1600 1400	(-)
T K	69	M	28	DIP	14 16	0.7 0.9	4.9 4.0	1600 1900	Ib
A F	60	M	9	Angio-graphy	11 12	0.8 0.8	4.1 3.9	1000 2600	(-)
H S	68	M	7	IVP	17 11	0.9 1.1	3.4 4.1	2400 1900	(-)
T K	46	F	2	IVP	21 25	2.1 2.3	4.2 4.3	2300 2000	(-)
Case1	50	M	11	Angio-graphy	24 50	2.5 8.5	6.2 5.2	1500 700	IV
Case2	72	F	14	DIP	73 74	5.0 5.4	6.8 6.0	1400 200	IIIb
Case3	57	F	10	CT	42 54	1.7 3.8	4.8 5.4	1200 0	V

Table 2. Changes of serum creatinine, BUN, K⁺ level and urine volume before and after contrast media studies in patients with non-diabetic renal diseases.

Name	Age	Sex	Duration of Renal Disease (yr.)	Study	BUN mg/dl		Creatinine mg/dl		K mEq/L		Urine Volume ml/day	
					before	after	before	after	before	after	before	after
	62	F	5	DIP	15	17	0.7	0.8	4.8	4.9	1220	1500
	65	F	2	DIP	20	18	0.9	1.1	4.3	4.4	800	1000
	43	M	2	IVP	34	32	2.4	2.4	5.4	5.5	1600	1300
	52	M	2	IVP	18	17	1.6	1.5	4.8	4.7	1600	1300
	55	M	Unknown	DIP	32	25	1.4	1.4	4.9	5.0	1200	1600
	63	M	4	DIP	44	54	3.6	3.8	4.5	4.5	1600	1400
	70	F	Unknown	IVP	24	23	1.2	1.1	4.3	4.6	1900	1900
	40	M	30	IVP	14	16	1.3	1.3	4.1	4.8	1200	1100
	73	F	2	IVP	30	30	2.1	2.2	4.2	4.2	1300	1600
	68	M	10	Angio-graphy	63	65	2.6	2.8	4.3	4.6	1500	1900
	47	M	3	IVP	21	28	2.1	1.8	4.4	4.2	1800	1600
	46	M	2	DIP	22	23	2.1	2.5	4.4	4.6	1200	1800
	61	F	2	IVP	24	20	0.9	0.6	4.1	4.3	2000	1600
	52	F	7	IVP	28	21	1.9	1.2	4.5	4.8	1200	950
	48	F	10	IVP	15	15	0.7	0.8	3.9	3.6	1400	1200
	59	F	7	IVP	44	47	3.0	3.1	4.0	4.1	700	800
	48	M	7	IVP	14	14	1.2	1.4	4.3	3.9	1200	1000
	42	F	2	IVP	17	19	1.1	1.1	4.3	4.4	600	800
	42	F	2	IVP	52	53	4.5	4.4	5.4	4.9	2200	1800
	47	F	1	DIP	15	18	1.0	1.2	4.6	4.7	3000	2600

no remarkable change in serum creatinine level (Table 2).

DISCUSSION

Contrast media for excretory urography are generally considered safe even in the presence of renal insufficiency^{1~4}). However, it has been reported that acute renal failure is possible after intravenous pyelography in diabetic patients especially with renal disturbance^{5~7}). Harkonen et al. investigated the changes in severity of renal insufficiency before and after DIP in diabetic patients in which the serum creatinine level was more than 2.0 mg/dl. Their study suggested that those most severely affected were patients with juvenile onset diabetes (less than 40 years) suffering from severe renal failure (creatinine over 5.0 mg/dl). In our study of the patients with non-diabetic renal diseases, no remarkable changes in serum creatinine, BUN, K⁺ level or urine volume were found regardless of the serum creatinine level before study. In the diabetic patients, on the other hand, notable changes in serum creatinine levels (elevation of more

than 0.5 mg/dl) were found in the three cases whose original serum creatinine levels were greater than 3.0 mg/dl. These patients had complication of retinopathy (Scott IIIa, IIIb, IV). All three patients presented in the text also had serum creatinine levels greater than 3.0 mg/dl before the study and moreover had severe retinopathy (Scott IV, IIIb, V).

Several hypotheses have been reported regarding the mechanism of contrast media-induced renal failure. The dose of contrast media does not seem to be a significant risk factor⁸). Red blood cell sludging and slowing of capillary flow can be induced by iodinate contrast media. If this is enhanced by superimposed dehydration, precipitation of contrast media with urinary mucoprotein in the renal tubules may theoretically occur. This precipitation of protein casts in the renal tubules may be the basis for the acute oliguria produced by the contrast media⁹). The unique feature of vascular disease in diabetes mellitus is micro-angiopathy. Diabetic glomerulosclerosis is the most significant renal lesion of diabetics

and begins as a diffuse thickening of the glomerular capillary basement membrane⁹⁾. The obstruction of the glomerular capillary has a great effect on blood flow. Therefore, diabetic patients, especially those with severe microangiopathy, tend to experience a disturbance of the blood flow in the arterioles and glomerular capillary. And, increased platelet aggregation may also contribute to the disturbance of blood flow in diabetics⁹⁾. Because of deteriorate immunity, the diabetic patient tends to have bacterial infection of the urinary tract. This also may be one of the causes of the disturbance of blood flow in the renal medulla. However, the exact mechanism of renal dysfunction in diabetic patients after intravenous pyelography remains unknown.

The present study shows that in diabetic patients with both renal disturbance (creatinine level more than 3.0 mg/dl) and severe retinopathy, contrast media study involves the high possibility of resulting in acute renal failure. Nevertheless, these studies are of great value in discovering malignant lesion, urinary tract obstruction and renal papillary necrosis. Therefore, after undergoing contrast studies, diabetic patients especially those with renal disturbance and severe retinopathy should be

closely monitored for urine volume, renal function and complications associated with oliguric renal failure.

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