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Effect of radiocontrast media on kidneys of patients with renal disease

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Abstract

A prospective study was undertaken of 15 patients with impaired renal function undergoing x-ray procedures entailing the use of contrast material to see whether any deterioration in renal function resulted. Patients with diabetes or myelomatosis were excluded. Detailed observations were made during three days before and after the x-ray procedure to detect any change in factors such as fluid state, drug treatment, infection, or diet which might have affected renal function.

No significant changes occurred in endogenous creatinine and ⁵¹Cr-EDTA clearances, or in plasma creatinine and urea concentrations after the x-ray procedures. Furthermore, there was no change in urinary activity of N-acetyl-beta-D-glucosaminidase, which is a highly sensitive indicator of renal parenchymal damage.

Provided that fluid depletion and multiple x-ray procedures with radiocontrast material in rapid sequence are avoided, these procedures do not appear to affect renal function adversely, even when renal disease is advanced.

Introduction

The introduction of safer contrast materials and their use in larger doses have greatly increased the value of intravenous urography in patients with reduced renal function. High-dose urography is widely used in such patients and is generally considered to be safe provided that dehydration is avoided.¹ Acute deterioration in renal function after urography may occur in patients with myelomatosis, but other factors such as hypercalcaemia and volume depletion are probably important.² Deterioration in renal function after urography has also been reported in diabetic patients, chiefly with vascular disease and pre-existing renal impairment.³⁻⁶ Acute renal failure has also been recorded after angiography, computed tomography, and

cholecystography.⁷ With the above exceptions, early reports found little evidence that pre-existing renal disease by itself was a risk factor for urography.⁸⁻¹⁰ Later work, however, suggested that impaired renal function predisposed to radiocontrast-induced acute renal failure.^{7 11 12} If true, such reports raise the possibility that further renal damage may result from urography more commonly than is believed but may not be detected easily in the complex and unstable clinical state often present in patients with renal failure undergoing x-ray procedures. Moreover, the serum creatinine concentration—which is used in most published studies to monitor renal function—may be an unsatisfactory guide to small but important changes in renal function.¹³

We have studied renal function prospectively before and after high-dose urography or angiography in patients with chronic renal failure, taking great care to monitor all other factors that might affect renal function during the period of the radiological investigation. In addition to measuring urea and creatinine concentrations we assessed glomerular filtration rate by the clearance of ⁵¹Cr-EDTA and measured urinary N-acetyl-β-D-glucosaminidase (NAG) activity as a sensitive index of tubular damage.

Patients and method

We studied 15 patients (eight women, seven men) aged 25-70 years with varying degrees of renal failure. The underlying renal diseases (see table) were glomerulonephritis (eight patients), hypertensive nephrosclerosis (two), obstructive uropathy (two), analgesic nephropathy (one), chronic pyelonephritis (one), and scleroderma (one). High-dose intravenous urography was performed in 14 cases and selective renal angiography in one. Each patient was carefully assessed before and after the radiological study for any other factor which might have influenced renal function during this period. Particular attention was paid to fluid state including daily clinical assessment with recording of body weight, jugular venous and arterial pressures, fluid intake, and urine volume for at least three days before and after the investigation. Drugs, infections in the urinary tract or elsewhere, and changes in dietary intake were also recorded. We excluded patients in whom changes of possible significance in any of these factors occurred during the period of observation.

Fluid restriction and laxatives were carefully avoided in preparation for the x-ray procedure. For each high-dose intravenous urogram a single intravenous injection of 150 ml Conray 420 was used; 60 ml was given for the arteriogram.

During the three days before radiography blood urea and plasma

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Results of renal function tests before and after radiological investigation using contrast material

Case No	Age (years)	⁵¹ Cr-EDTA clearance (ml/min)		Creatinine clearance (ml/min)		Serum creatinine (μmol/l)		Urinary NAG (U/mmol creatinine)		Diagnosis
		Before	After	Before	After	Before	After	Before	After	
1	45	7	6	9	6	540	647	26.0	33.0	Glomerulonephritis
2	33	8	8	7	7	980	895	26.0	39.0	
3	66	6	5	4	4	853	928	25.0	31.0	Obstructive uropathy
4	35	6	6	7	8	745	741	16.0	28.0	Chronic pyelonephritis
5	68	6	7	7	5	642	675	14.0	21.0	Glomerulonephritis
6	25	5	4	5	6	1570	1435	12.5	17.0	Hypertensive nephrosclerosis
7	45	8	7	20	20	363	449	75.0	53.0	Glomerulonephritis
8	26	20	20	21	21	248	282	15.5	14.0	
9	30	45	45	74	73	78	78	4.5	9.0	
10	45	30	23	27	27	400	426	136	127	
11	70	21	19	26	23	143	141	30	38	Hypertensive nephrosclerosis
12	60	26	27	25	24	287	288	43	57	Obstructive uropathy
13	42	52	42	40		119		17.5	22	Glomerulonephritis
14	45			3	3	836	840	37	38	Analgesic nephropathy
15	60			11	11	293	296	52	80	Scleroderma
Mean ± SEM		18.5 ± 4.4 (n = 13)	16.8 ± 3.9 (n = 13)	19.0 ± 4.9 (n = 15)	17.0 ± 4.9 (n = 14)	570 ± 107 (n = 15)	580 ± 99 (n = 14)	36.0 ± 8.5 (n = 15)	41.0 ± 7.8 (n = 15)	
t		1.80 (NS)		1.67 (NS)		(0.38 (NS))		1.74 (NS)		

NAG = N-acetyl-β-D-glucosaminidase.

NS = Not significant.

Conversion: SI to traditional units—Creatinine: 1 μmol/l ≈ 0.01 mg/100 ml.

electrolyte concentrations and endogenous creatinine clearance were measured at least twice. Urinary NAG activity was determined on at least three consecutive days, including the morning of the investigation, and clearance of ⁵¹Cr-EDTA determined on the day before radiography. After radiography the clinical observations, fluid balance, and daily weight measurements were continued and blood analyses and measurement of creatinine clearance repeated on two consecutive days. Activity of NAG was measured in urine taken immediately after the x-ray procedure and on consecutive days for up to one week thereafter. Determination of ⁵¹Cr-EDTA clearance was repeated the day after the investigation.

Concentrations of creatinine and urea were estimated on a multi-channel autoanalyser (Technicon); sodium and potassium were measured by flame photometry (IL343). ⁵¹Cr-EDTA clearances were determined as described.¹⁴ For the measurement of urinary NAG activity fresh urine specimens were assayed using a fluorimetric method.¹⁵ Statistical analyses were performed with Student's *t* test. Mean values are expressed ± SEM.

Results

No obvious untoward reactions occurred during or after the investigation. The table gives the results of the renal function tests. The mean serum creatinine concentration was 570 ± 107 μmol/l (6.4 ± 1.2 mg/100 ml) before the x-ray procedures and 580 ± 99 μmol/l (6.6 ± 1.1 mg/100 ml) afterwards. The corresponding mean creatinine clearances were 19.0 ± 4.9 and 17.0 ± 4.9 ml/min, and mean ⁵¹Cr-EDTA clearances 18.5 ± 4.4 and 16.8 ± 3.9 ml/min. None of these changes was statistically significant. Urinary NAG activity also showed no significant change, the mean values being 36.0 ± 8.5 units before and 41.0 ± 7.8 units after radiography.

Two patients were excluded retrospectively: one developed septicaemia, and renal function deteriorated; and in the other fluid depletion occurred due to vomiting, but renal function showed no change.

Discussion

Large doses of radiological contrast media had no significant effect on renal function in these patients. Risk factors for urography reportedly include diabetes, myelomatosis, dehydration, advanced age, hyperuricaemia, multiple radiocontrast procedures within a short time, prior renal insufficiency, and renal vascular disease.⁷⁻¹² All our patients had reduced renal function, five were aged 60 or over, and eight were hypertensive. Diabetes and myelomatosis were excluded, and great care was taken to avoid dehydration. None had received radiocontrast material for at least three days before the study. No significant change in glomerular filtration rate was detected, and no change occurred in urinary activity of NAG, which is particularly sensitive as an indicator of renal tubular damage.^{16,17}

Our findings are reassuring, since loss of urography and other

x-ray procedures entailing the use of contrast media in patients with renal impairment would be a serious restriction in nephrology. None the less, it seems advisable not to give doses of radiocontrast materials in rapid sequence, and every precaution should be taken to avoid dehydration. The significance of other risk factors present should be considered against the likely benefit to the patient of the proposed x-ray procedure. With these precautions our results suggest that renal failure need not preclude the use of large doses of radiocontrast media.

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