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Does prophylactic haemodialysis protect kidney function after angiography?

Martin Tepel

Medizinische Klinik Nephrologie, Charité Campus Benjamin Franklin, Berlin, Germany

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What was known about prophylactic haemodialysis after radiocontrast administration?

On the one hand, it is well known that radiocontrast media can effectively be reduced by haemodialysis [1]. On the other hand, several prospective randomized studies clearly demonstrated that prophylactic haemodialysis after the administration of radiocontrast media did not prevent contrast-induced nephropathy and did not improve outcome of patients with chronic kidney disease. Lehnert *et al.* performed a study in 30 patients with chronic renal failure receiving radiocontrast. Mean baseline serum creatinine concentration was 2.4 mg/dL (212 μmol/L). Patients were randomly assigned to receive either a haemodialysis procedure for 3 h, started as soon as possible after the administration of radiocontrast or a conservative treatment. Contrast-induced nephropathy was not significantly different between the two groups [2]. Vogt *et al.* performed a randomized trial to test whether radiocontrast nephropathy can be avoided by prophylactic haemodialysis immediately after the administration of radiocontrast in patients with baseline serum creatinine concentrations >2.3 mg/dL (>200 μmol/L). In the haemodialysis group serum creatinine decreased at Day 1, peaked at Day 4 and returned to baseline at Day 6, whereas in the control group no significant changes of serum creatinine concentrations could be observed. Eight patients in the haemodialysis group and three patients in the control group required additional haemodialysis treatments. Therefore, Vogt *et al.* concluded that the strategy of performing haemodialysis immediately after the administration of low-osmolality radiocontrast media did not diminish the rate of complications, and prophylactic haemodialysis after radiocontrast media in patients with renal insufficiency is potentially harmful [3]. In a prospective, randomized, controlled trial Frank *et al.* tested the effect of a 4-h online haemodialysis during radiocontrast application in patients with advanced chronic renal failure. Mean baseline creatinine clearance was 18 mL/min. In that study no difference between creatinine clearance at 1 and 8 weeks after angiography between the haemodialysis group ($n = 7$) and the control group ($n = 10$) could be observed. Furthermore, two patients developed end-stage renal disease and requested permanent dialysis during follow-up in each group [4]. Finally, Reinecke *et al.* reported that haemodialysis after the administration of radiocontrast neither prevented contrast-induced nephropathy nor did it provide any evidence for an outcome benefit. In their large study, mean baseline glomerular filtration rates were 49 mL/min/1.73 m^2 in the haemodialysis group ($n = 138$) and 47 mL/min/1.73 m^2 ($n = 140$) in the control group [5]. From all these studies it had been concluded that prophylactic haemodialysis after radiocontrast administration does not make sense.

What do novel studies add to our knowledge on prophylactic haemodialysis or haemofiltration?

Lee *et al.* recently presented a prospective, randomized trial indicating that prophylactic haemodialysis might be useful in patients with severely impaired renal function [6]. Within 3 years they included 82 patients with a mean baseline creatinine clearance of 13 mL/min/1.73 m^2 that were routinely scheduled for coronary angiography or coronary intervention. Patients were treated with normal saline at 1 mL/kg/h for 6 h before and 12 h after radiocontrast administration and randomized to receive haemodialysis for 4 h as soon as possible after angiography or control treatment. Four days after angiography, serum creatinine concentrations were lower in the haemodialysis group compared to the control group. Out of 42 patients, 1 patient (2%) in the haemodialysis group but 14 (35%) out of 40 patients in the control group required temporary haemodialysis after coronary angiography. Temporary haemodialysis was started 1–13 days after the angiography because of oliguria for >48 h or serum potassium >6 mmol/L. Furthermore, none of the 42 patients in the haemodialysis group, but 5 (13%) out of 40 patients in the control group, required maintenance haemodialysis after discharge from the hospital ($P < 0.05$).

The results of that trial are quite remarkable. First, the interpretation of serum creatinine concentrations obtained 4 days after angiography seems difficult, in particular when 35% of patients in the control group required temporary haemodialysis as well, which might have been started as

Correspondence and offprint requests to: Martin Tepel, Charité Campus Benjamin Franklin, Med. Klinik Nephrologie, Hindenburgdamm 30, 12200 Berlin, Germany. Fax: +49-30-8445-4235;
Email: Martin.Tepel@charite.de

Table 1. Recommendations for the prevention of contrast-induced nephropathy

1. All patients receiving radiocontrast media should be evaluated for their risk of radiocontrast-induced nephropathy. Patients with chronic renal failure, diabetes mellitus, congestive heart failure, older age, hypotension and anaemia are at particular risk
2. All patients receiving radiocontrast media should be in optimal volume status at the time of exposure to radiocontrast. Consider oral hydration in all patients. Periprocedural hydration, preferably with intravenous administration of 0.9% isotonic saline or an isotonic sodium bicarbonate solution, should be given in high-risk patients
3. Low osmolality and iso-osmolar radiocontrast media are recommended for all patients. The lowest possible amount of radiocontrast media should be used
4. Pharmacologic prophylaxis is still controversial, although several prospective trials documented the beneficial effects of *N*-acetylcysteine, which also shows low cost and low side-effect profile
5. In patients with chronic kidney disease stage 5 (glomerular filtration rate <15 mL/min/1.73 m^2), but not yet on maintenance dialysis, postprocedural haemodialysis for 4 h as soon as possible after angiography or coronary intervention or haemofiltration in the intensive care unit should be considered

early as 1 day after the angiography. However, it should be noted that Lee *et al.* compared serum creatinine levels between the haemodialysis group and the control group 4 days after radiocontrast administration because creatinine levels are necessarily lowered after haemodialysis. Vogt *et al.* previously showed that in the haemodialysis group serum creatinine decreased after 24 h and peaked after 4 days [3]. Hence, under these study conditions measurements of serum creatinine 4 days after radiocontrast administration appear reasonable. In the study by Vogt *et al.* these data were from patients who did not require subsequent haemodialysis. It is unclear whether the data on serum creatinine concentrations at Day 4 reported by Lee *et al.* were solely derived from patients who did not require subsequent haemodialysis. Anyway, in patients with advanced chronic kidney disease parameters including the requirement of temporary haemodialysis after radiocontrast administration or the requirement of maintenance haemodialysis after discharge are probably more important outcome measures.

Second, the number of patients requiring temporary haemodialysis after the angiography and the number of patients requiring maintenance haemodialysis after discharge is very high, indicating that the trial included patients with advanced chronic kidney disease. There are only very few studies that investigated the effects of radiocontrast media in patients with baseline creatinine clearance <20 mL/min/1.73 m^2. The results reported by Lee *et al.* are in contrast to the results of the small study by Frank *et al.*, who did not observe any difference between the haemodialysis group and the control group [4]. Third, unfortunately the control group did not receive *N*-acetylcysteine nor bicarbonate, which both had been shown to significantly reduce contrast-induced nephropathy [7,8]. Besides these limitations, this large prospective randomized study by Lee *et al.* may help to clarify the needs for treatment of those patients with advanced chronic kidney disease (stage 5) and very high risk for contrast-induced nephropathy [6].

Marenzi *et al.* used a different approach and initiated haemofiltration (fluid replacement rate, 1000 mL/h) and saline hydration in patients with chronic renal failure 4–8 h before the coronary intervention and continued haemofiltration for 18–24 h after the procedure was completed. In that trial baseline creatinine clearance was 26 mL/min. They showed that periprocedural haemofiltration prevented contrast-induced nephropathy and was associated with improved in-hospital and long-term outcomes. They reported very impressive data, i.e. the cumulative 1-year mortality was significantly lower in the haemofiltration group (10% mortality) compared to the control group (30% mortality) [9]. Because of the complexity, cost and risk associated with this procedure, haemofiltration may not be directly applicable to all high-risk patients who are exposed to radiocontrast agents for simpler procedures.

Practical recommendations including prophylactic haemodialysis

Based on clinical and experimental data, recommendations for prophylaxis and treatment of contrast-induced nephropathy have been published [10–13]. If confirmed by future studies, the novel results on the effects of haemodialysis and haemofiltration on patient outcome should be added to clinical practice considerations to prevent contrast-induced nephropathy in patients with advanced renal failure, i.e. patients with chronic kidney disease stage 5 but not yet on maintenance dialysis. These extended recommendations are listed in Table 1.

Conflict of interest statement. None declared.

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Success of the peritoneal dialysis programme in Hong Kong

Philip Kam-Tao Li and Cheuk-Chun Szeto

Departments of Medicine and Therapeutics, Prince of Wales Hospital, The Chinese University of Hong Kong, Shatin, Hong Kong, China

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Is CAPD successful in Hong Kong?

The success of a dialysis programme can be exemplified by a high utilization rate, excellent patient and technique survival, reduced complication rates and good quality of life.

Utilization rate

The incidence of dialysis-dependent end-stage renal disease (ESRD) in Hong Kong in 2005 was 173 per million population in Hong Kong while the prevalence of ESRD was 965 per million population. This figure is comparable to most western countries, with the exception of Taiwan and the USA [1]. As of 31 March 2007, there were 3410 patients treated with peritoneal dialysis (PD) in Hong Kong, with a median age of 62.3 years. Nearly 40% of all new dialysis patients had diabetic nephropathy as the underlying disease while around 21% had glomerulonephritis. Only ∼5% of our chronic PD patients used automated PD. The discussion will therefore focus on continuous ambulatory peritoneal dialysis (CAPD).

Correspondence and offprint requests to: Philip K. T. Li, Departments of Medicine and Therapeutics, Prince of Wales Hospital, Chinese University of Hong Kong, Shatin, N.T., Hong Kong, China. Tel: +852-2632-3616; Fax: +852-2637-5396; Email: philipli@cuhk.edu.hk

Patient and technique survival

In general, Chinese CAPD patients enjoyed an excellent survival. Our previous cohort study showed that the 2-year actuarial survival was 83.0% [2], which compared favourably to that of the Canadian (79.7%) and USA subgroup (63.2%) of the CANUSA study [3]. Our recent cohort of 328 incident CAPD patients recruited in the Prince of Wales Hospital between 1 January 2000 and 31 December 2004 also showed a very acceptable patient and technique survival. There were 170 male patients and 158 female patients with a mean age of 57.6 ± 13.9 years (mean ± SD). 38% (127/328) had the renal failure caused by diabetes mellitus (DM). Another 25 patients (8%) had DM as a comorbid condition and not the cause of the renal failure. The 2-year patient survival was 91% and technique survival 82% (Figure 1). Even for elderly patients (>65 years old), our recent analysis showed excellent 2- and 5-year technique survival of 84.0% and 45.7%, respectively [4].

Peritonitis rate

With the extensive use of disconnect and double-bag systems, our patients enjoyed very low peritonitis rates. In the mid-1990s, our peritonitis rate was around one episode every 17 patient-months of treatment with a simple disconnect system [5]. It gradually improved to one episode every 29 to 34 patient-months in the late 1990s [6] and then to every 36 to 45 patient-months with the application of double-bag systems [7]. Our recent analysis also showed that the probability of a 12-month peritonitis-free period for our CAPD patients was 76% [4]. With the improvement in connectology, however, the proportion of peritonitis episodes