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BRIEF REPORT

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Can the DOQI guidelines be met by peritoneal dialysis alone in pediatric patients?

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Abstract DOQI guidelines recommend minimal standards for automated peritoneal dialysis (APD), with a weekly Kt/V of 2.1 and creatinine clearance (C_{Cr}) of 63 l/1.73 m^2. The purpose of this study was to assess if the DOQI guidelines could be met by dialysis alone in children on PD. Dialysis clearance studies were retrospectively analyzed in 20 pediatric patients on APD, all with a dwell volume of at least 1,000 ml/m^2. Mean dialytic Kt/V was 2.0; only 45% had a Kt/V above the recommended 2.1. Mean dialytic C_{Cr} was 43.5 l/week per 1.73 m^2; only 10% achieved a C_{Cr} above the recommended 63 l/week per 1.73 m^2. Despite the significant correlation between total therapy volume (TTV) and both Kt/V and C_{Cr}, only 2 of 10 patients with a TTV over 10 l/m^2 per day reached the target C_{Cr}. All patients had currently recommended dwell volumes, therapy times, and nocturnal cycles, but DOQI guidelines were difficult to achieve with dialysis alone. Strict adherence to DOQI guidelines in anephric pediatric PD patients may result in changing dialysis modality. However, without evidence of a correlation between delivered dose of dialysis and improved outcome, adequate dialysis should not be assessed by only measuring Kt/V and C_{Cr}.

Key words Peritoneal dialysis · Dialysis clearance adequacy · DOQI guidelines · Pediatric patients

Introduction

The Canada-USA (CANUSA) study, a prospective cohort study showed that higher urea and creatinine clearances (C_{Cr}) in patients on peritoneal dialysis (PD) were associated with better patient survival, better technique survival, and fewer days in hospital [1]. In response to the CANUSA and other studies, the Dialysis Outcomes Quality Initiative (DOQI) Guidelines were published, recommending minimum targets for combined clearances of residual renal function (RRF) and PD in adults [2]: a weekly Kt/V of 2.1 for continuous cycling PD (CCPD), 2.2 for nocturnal intermittent PD (NIPD); a weekly C_{Cr} of 63 l/1.73 m^2 for CCPD and 66 l/1.73 m^2 for NIPD. Clinical judgment suggested that the target dose of PD for children should meet or exceed the adult standards, although there are no definite outcome data in pediatric patients to suggest that any measure of dialysis adequacy is predictive of long-term well-being, morbidity, or mortality [3–5]. To assess the feasibility of these recommendations in anephric patients, we investigated whether DOQI targets could be achieved by dialysis alone in children on automated PD (APD).

Patients and methods

Dialysis clearance studies from patients on APD between May 1994 and August 1998 were retrospectively analyzed. Only patients with a minimum dwell volume of 1,000 ml/m^2 body surface area (BSA) and who received at least 10 h of nightly dialysis were included. If suitable patients had more than one adequacy test performed, the best study result for Kt/V and/or C_{Cr} was accepted.

Adequacy tests were performed according to a standardized protocol by one investigator (B.B.). Dialysate collections (24-h) were obtained by the patients and were brought to clinic. Dialysate volumes were accurately measured and a 10-ml aliquot was sampled. Cr and urea in dialysate and blood were determined for calculation of weekly C_{Cr} and Kt/V (equations 1 and 2). Dialysate Cr was measured on an Ektachem 700 by an enzymatic method, which does not require correction for dialysate glucose. Peritoneal equilibration tests were performed on our patients; however the test results were only used to alter dwell times in the latter period of this study.

$$\text{Weekly Kt / V} = \frac{(\text{D urea})(\text{D volume})7}{\text{P urea} \times \text{V}} \quad (1)$$

$$\text{Weekly Ccr} = \frac{(\text{D creat})(\text{D volume})7}{\text{P creat}} \text{ in liters} \quad (2)$$

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D = Dialysate, P = Plasma ,V = Volume of distribution of urea urea in mmol/l, Cr in μmol/l

C_{Cr} results were divided by BSA and then normalized to 1.73 m^2. If patients had RRF, only clearances from PD were analyzed. The volume of distribution was calculated according to the Mellits-Cheek method for children [6]. The data were analyzed using SPSS software. Results are reported as mean (± standard deviation). Analysis was performed using Pearson correlation test, with $P<0.05$ regarded as statistically significant.

Results

Twenty patients had undergone 38 adequacy tests. Only one test with the best Kt/V and/or C_{Cr} result was included for analysis. Seven patients were functionally or surgically anephric. The mean age was 11.42 years (SD 5.28 years). Three patients were on NIPD, 2 on tidal PD, and the remainder on CCPD. The mean dwell volume was 1,085 ml/m^2 (SD 79) and the mean total therapy volume (TTV) 9,344 ml/m^2 per day (SD 463). The mean number of nocturnal cycles was 7.8 (range 6–12), excluding patients on tidal dialysis. Dialysis duration was 10 h for all patients. Seventeen patients had a day dwell, 3 did not.

The mean Kt/V urea was 2.0 (SD 0.53, range 1.04–3.26). Only 45% achieved a Kt/V above the recommended 2.1 for patients on CCPD. The mean C_{Cr} was 43.5 l/week per 1.73 m^2 (SD 14.2, range 21.7–79.1). Only 10% of patients were above the recommended 63 l/week per 1.73 m^2. As expected, there was a significant correlation between TTV per square meter per day and weekly peritoneal Kt/V (r=0.642, P=0.01) as well as C_{Cr} (r=0.496, P=0.05). Patients receiving less than 8 l of TTV/m^2 per day never achieved recommended DOQI guidelines for Kt/V or C_{Cr}. Over half the patients receiving between 8 and 10 l/m^2 per day had an adequate Kt/V, but none reached the target C_{Cr} of 63 l/week per 1.73 m^2. Patients dialyzed with over 10 l/m^2 per day all had a Kt/V very close to or above DOQI recommendations, but still only a minority (2 of 10) of these patients reached the recommended C_{Cr} (Fig. 1).

We explored the possibility of larger and older children being relatively underdialyzed when dwell volumes are adjusted according to BSA. Kt/V and C_{Cr} did not change with increasing height, age, BSA, or weight. There was no difference in dialytic Kt/V and C_{Cr} between surgically and functionally anephric patients.

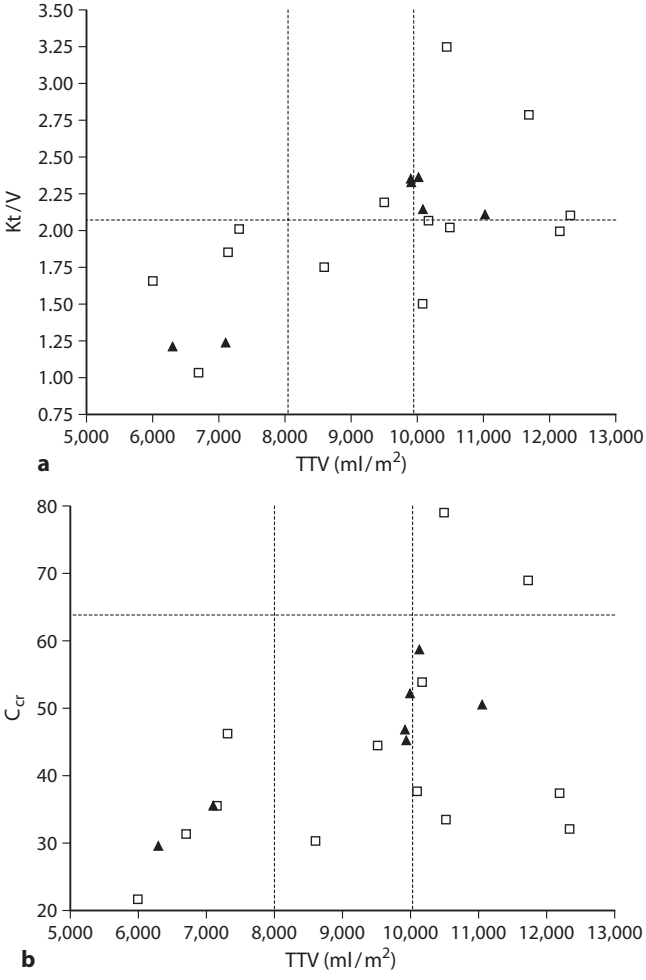

Fig. 1a, b Correlation between total therapy volume per square meter (*TTV/m*^{2}) and Kt/V and creatinine clearance (C_{Cr}). The *horizontal lines* represent the target weekly Kt/V of 2.1 and C_{Cr} of 63 l/1.73 m^2. The *vertical lines* represent TTVs of 8,000 ml/m^2 and 1,0000 ml/m^2. *Solid triangles* (▲) represent anephric patients

Discussion

The 20 patients included in this study all had dwell volumes of at least 1,000 ml/m^2; their mean dwell volume was 1,085 ml/m^2. This compares favorably with the DOQI guidelines, where a dwell volume of 1,100 ml/m^2 is regarded as adequate. The therapy time was 10 h, number of nocturnal cycles between 6 and 12, and 85% of patients had a day dwell volume. The minimal DOQI targets for APD were however not met by dialysis alone in the majority of our patients. In our study, 35% (7 of 20) of children were functionally or surgically anephric. Neither Kt/V nor C_{Cr} was different between anephric and presumed anephric patients. Previous studies have shown similar percentages of anephric children on PD [3, 7], and this number will increase over time with the natural decline in RRF [8].

In some of the earlier pediatric studies of PD adequacy, smaller dwell volumes were used and lower Kt/V and C_{Cr} were obtained [3]. In the studies where adequate dwell volumes were used, clearance results similar to our study were found [4, 7]. Peritoneal clearances in adults are also similar to our results (in the CANUSA study the peritoneal Kt/V was 1.68 and the peritoneal C_{Cr} was 45.6 l/week per 1.73 m^2) [1]. It seems that in general it is difficult to achieve DOQI recommendations with PD alone, using clinically acceptable dwell volumes.

We showed a significant correlation between TTV per square meter and both Kt/V and C_{Cr}. Those patients with a TTV less than 8,000 ml/m^2 never achieved the recommended Kt/V or C_{Cr}. Guidelines should therefore not only

suggest adequate dwell volumes, but also minimum TTV. We should aim to maximize TTV by increasing dwell volumes, using day dwells and day exchanges if feasible. The number of nocturnal cycles should not be increased without increasing total therapy time, because of the reduction in equilibration time. Kt/V will always be higher than C_{Cr} in patients on APD, but which is the better marker for adequacy is unknown. The DOQI guidelines are the only guidance available and are therefore welcomed for setting standards in pediatric PD. At present it is uncertain if pediatric patients without kidney function can achieve the DOQI guidelines. However, without long-term outcome data confirming the efficacy of these guidelines, it is uncertain if maintenance of such standards is necessary in children. Strict adherence to DOQI guidelines may result in patients changing dialysis modality because of failure to achieve the recommended clearances of urea or Cr. This may have a profound psychological, social, and economic effect on the patient and their family and should only be considered after detailed evaluation of the patient's overall clinical well-being. It seems prudent to measure PD clearances to individualize and optimize PD prescriptions, but clinical studies are required to elucidate whether urea kinetics and C_{Cr} are sufficient tools for the evaluation of adequacy of dialysis treatment in children.

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LITERATURE ABSTRACT

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Percutaneous renal biopsy in the 1990s: safety, value, and implications for early hospital discharge

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To determine the parameters associated with significant bleeding and to examine the value of performing a renal biopsy, we studied 83 consecutive patients, including 24 renal allograft recipients, who had undergone percutaneous renal biopsy. The patients were stratified into four groups according to the percentage of decline in their hematocrit (Hct) at 24 hours postbiopsy, as follows: 10% or greater (n = 21; 25%) and less than 10% decline (n = 62; 75%). The latter group was further subgrouped into 5% to 10% (n = 22) and less than 5% decline (n = 40). There was a significant decline in Hct postbiopsy, with a linear correlation between the decrease in Hct at 6 and 24 hours (R^2 = 0.47; P < 0.0001), suggesting that the former was a predictor of the latter. There was a linear correlation between the number of passes and number of cores obtained for the first four passes, but an inverse correlation when five passes or greater were required. Interestingly, there was no correlation between bleeding (>10% decline in Hct) and the number of passes or cores obtained. Gross hematuria and blood transfusion requirement were each encountered in three patients (3.6%). Importantly, the prebiopsy clinical diagnosis was altered in 18 of 59 native kidney biopsies (33%) and 10 of 24 transplant biopsies (41%). We conclude that percutaneous renal biopsy using an automated spring-loaded gun device coupled with ultrasound guidance is a safe technique and provides essential clinical information. Importantly, patients with a stable Hct at 6 hours were at low risk for bleeding at 24 hours while hospitalized. It remains to be determined if these findings could be extrapolated to early discharge from hospital.