Relationship between intraperitoneal hydrostatic pressure and dialysate volume in children on PD.

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Source

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Abstract

As a result of the theoretical risk of an excessive increase in intraperitoneal pressure (IPP) in association with peritoneal dialysis, reduction of instilled intraperitoneal dialysate volume (IPV) is often proposed in infants compared to adults; a further reduction is often noted in neonates compared to children. To better evaluate the significance of this risk, we have tested the relationship between the IPP (cm of water) and the IPV (mL/m2) in our population of children on peritoneal dialysis (n = 17) during the last three years. IPP was measured after a nocturnal dialysis session, during a morning study day, after sequential exchanges of ten minutes' dwell time each, with progressively increased instilled dialysate volumes from 600 to 1400 mL/m2. Mean IPP values were 8.2 +/- 3.8 cm for a mean IPV of 990 +/- 160 mL/m2 body surface area. These values are lower than the IPP values established for adults (13.4 +/- 3.1 cm), which were given for higher IPV values of 1585 +/- 235 mL/m2. The relationship between IPP and IPV was age-dependent. In neonates, stable IPP values (3.5 +/- 1.6 cm) were noted for IPV from 600 to 800 mL/m2; thereafter, increasing IPV led to an increase in IPP. In the range of 600 to 1200 mL/m2 IPV, no significant increment of mean IPP was noted in infants (4.8 +/- 2.6 cm) and in children (9.6 +/- 2.1 cm). However, increasing the dialysate volume over 1000 mL/m2 induced an overincrement of the individual IPP value in most cases, and the rise of IPP was substantial when IPV rose from 1200 to 1400 mL/m2.

Relationship between Intraperitoneal Hydrostatic Pressure and Dialysate Volume in Children on PD

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IP P was measured after a nocturnal dialysis session, during a morning study day, after sequential exchanges often minutes' dwell time each, with progressively increased instilled dialysate volumesfrom 600 to 1400 mL/m2. Mean IPP values were 8.2 :t 3.8 cm for a mean IPV of 990 :t 160 mUm2 body surface area. These values are

lower than the IPP values establishedfor adults (13.4 :t 3.1 cm), which were givenfor higher IPV values of 1585 :t 235 mU m2. The relationship between IPP and IPV was age dependent. In neonates, stable IP P values (3.5 :t 1.6 cm) were noted for IPV from 600 to 800 mUm2; thereafter, increasing IPV led to an increase in IPP. In the range of 600 to 1200 mUm2 IP V; no significant increment of mean IPP was noted in infants (4.8 :t 2.6 cm) and in children (9.6:t 2.1 cm). However, increasing the dialysate volume over 1000 mU m2 induced an overincrement of the individual IP P value in most cases, and the rise of IPP was substantial when IP V rose from 1200 to 1400 mUm2.

Key words

Intraperitoneal pressure, intraperitoneal volume, children, infants, neonates

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Introduction

Dialysate dwell volume prescription is still controversial in children on peritoneal dialysis (PO). Reduction of instilled dialysate volume is often proposed in infants when compared to adults, and even more in neonates compared to children. Since the description by Ourandetal. in 1992 (I) ofa very simple method of hydrostatic intraperitoneal pressure (IPP) measurement in adults, we have evaluated IPP in children (2) on PD. We have analyzed the relationship between IPP (cm of water) and dialysate dwell volume standardized by body surface area (mL/m2), and consider IPP as an objective tool to determine individual dwell volume tolerance.

Material and methods

IPP was measured with patients in a supine position using the method described in adults (I), adapted for children (2). IPP was expressed in centimeters of water by measuring the height of the column of dialysate in the drainage tube of a y twin bag (Baxter Healthcare, Oeerfield, IL), pressure being correlated to the drained dialysate volume (see Appendix).

IPP was measured in our PD population (n = 17 patients) during the last three years. Our population consisted of 3 neonates (aged 3 to 6 weeks), 8 infants (aged 3 to 24 months), and 6 children (aged 28 months to 16 years) who were in stable condition and in each case more than two weeks had elapsed after peritoneal catheter implantation. The measurements were taken either during hospitalization or a routine outpatient visit.

IPP was measured after a nocturnal dialysis ses.: sion. During the morning study day, the patient was placed at rest in a supine position. Several IPP measurements were taken after sequential exchanges of ten minutes' dwell time each. The changes were performed with progressively increased instilled intraperitoneal dialysate volumes (IPV), from 600 to 1400 mL/m2, using isotonic dialysate (1.36% dextrose).

Each patient (n = 17) was tested on three different days during the follow-up period (N = 255 detenninations for the entire population). IPP was correlated to IPV and age group. A time-induced tolerance factor to a dialysate dwell volume increase was tested by measuring IPP before changing the IPV prescription, immediately after the change in prescription and one month later, at the next routine outpatient visit. Thus, in 14 patients, IPV was increased for a period of one month from 1000 to 1200 mL/m2. Results are expressed as mean :t SD. Differences between the patient groups were analyzed for significance by Student's t-test. Parents and children were infonned and gave spoken consent.

Results

The mean IPP value of our entire PD population (n = 17 patients, N = 255 detenninations) was 8.2 :t 3.8 cm of water in association with a mean IPV of 990 :t 160 mL/m2 body surface area. In contrast, the mean IPP values were lower (5.2 :t 2.6 cm) for smaller IPV (600 :t 50 mL/m2) and higher (14.1 :t 3.6 cm) for larger IPV (1400 :t 50 mL/m2) (Table I, Figure I).

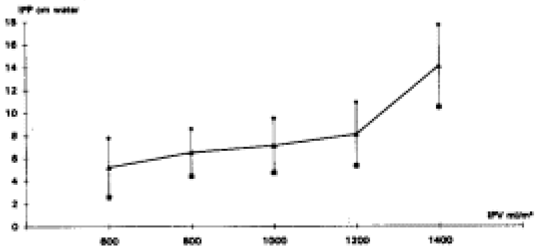

FIGURE 1 Intraperitoneal pressure (IPP) related to intraperitoneal dialysate volume (IPV) for a pediatric population (n = 17 patients, N = 255 determinations).

TABLE I Relationship between intraperitoneal dialysate volume (IPV; mL/m²) and intraperitoneal pressure (IPP; cm of water) measured in different age groups

	IPP (cm of water) per IPV (mL/m²)				
Patients	600±50 (mL/m²)	800±50 (mL/m²)	1000±50 (mL/m²)	1200±50 (mL/m²)	1400±50 (mL/m²)
Neonates (n=3;N=45) (cm)	3.0±2.0	4.0±2.0	7.0±1.5	8.0±2.0	11.0±4.0
Infants (n=8;N=120)(cm)	4.0±2.0	4.8±1.5	5.0±3.0	6.0±3.0	14.0±4.0
Children (n=6; N=90) (cm)	8.0±2.0	9.5±3.0	10.0±2.0	11.0±3.0	16.0±3.0
All patients (n=17; N=255) (cm)	5.2±2.6	6.5±2.1	7.1±2.4	8.1±2.8	14.1±3.6

n = number of patients; N = number of measurements.

The mean IPP values appeared to vary with the age groups: neonates, infants, and children (Table I, Figure 2). In the range of 600 to 1200 mL/m2 dialysate volume, no significant increment of IPP was noted in children and infants. Thereafter, mean IPP increased significantly with an increment of more than 50% at 1400 mL/m2. On the other hand, in neonates, an increase of the IPP was noted earlier, at 1000 mL/m2 dwell volume.

TABLE II Evolution of IPP expressed as percentage (%) after increment of IPV from 1000 mL/m² to 1200 mL/m², measured either immediately after increment of IPV (30 minutes), or delayed, one month later, at the next routine outpatient visit

	IPP %		
	Initially	*Immediately*	*Delayed*
Infants (n=7)	100	128±13*	98±11*
Children (n=6)	100	115±9*	105±12*
All patients (n=14)	100	121±10*	103±9*

* $p < 0.001$ (statistically significant).

The basal IPP level was defined and detennined for each age group from the relatively IPV -independent IPP curve profiles (Figure 2). The basal IPP appeared lower in neonates (3.5 :t 1.6 cm for a mean IPV of720 :t 80 mL/m2) compared to infants (4.9 :t 2.6 cm for a mean IPV of 890 :t 120 mL/m2) and children (9.6 :t 2.1 cm for a mean IPV of910 :t 140 mL/m2).
Measurement of IPP values immediately after increment of dwell volume revealed an elevation from 100% (basal value) to 121 :t 10% (Table II, Figure 3). However, measurement ofIPP one month later, at the next routine outpatient visit, revealed a value of 103 :t 9%, nearly the same as the initial basal IPP value.

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Discussion

Patient tolerance for intraperitoneal instilled dialysate volume has to be considered when prescribing the peritoneal dialysis dwell volume. The usefulness of a very simple method of IPP measurement (1,2) encouraged us to use IPP as an objective tool to determine individual dwell volume tolerance (3).
In adults the normal mean IPP values (13.4 :t 3.1 cm ofwater) were given for a mean IPV of2820 :t 419 mL or 1585 :t 235 mL/m2 body surface area (1). From the relatively IPV-independent IPP values (Figure I), we defmed the pediatric normal mean IPP values as 8.2 :t 3.8 cm of water for a mean IPV of 990 :t 160 mL/m2. In our pediatric population, increasing the IPV to 1400 mL/m2 induced a substantial rise ofIPP (Figure 1) to 14.1 :t 3.6 cm. Thus the IPP level does not appear to be in a lower range in a pediatric population compared to an adult population, if IPV is similarly prescribed in the same range, normalized for body surface area.

The pediatric IPP values do seem to be influenced by IPV changes. The rise of IPP was substantial, from 1200 to 1400 mL/m2, regardless of the age group (Figure 1). Therefore, such a dwell volume increase should be used with caution for a pediatric population in terms of the risks related to high intraperitoneal pressure (pain, dyspnea, leakage, etc.).
The relationship between IPP and dialysate volume appeared to be age-dependent. On the one hand, mean IPP values appeared to be in a lower range in neonates than in infants or children (Table I). On the other hand, a stable IPP level was related to a lower IPV in neonates than in infants and children (Figure 2). In neonates an increase in IPPwas noted at 1000 mL/m2 IPV (Figure 2). In infants and in children the increase in IPP was noted at 1200 mL/m2 IPV (Figure 2). Despite the low mean IPP values in neonates, the IPP profile increment suggests that an IPV prescription over 800 mL/m2 in neonates should be used with caution.
Acute and delayed measurements of IPP in our dialyzed population (Table II, Figure 3) showed an initial increment ofIPP secondary to an intraperitoneal volume increment, then followed after one month in a decrease in IPP, reaching nearly the initially measured IPP value. This time-related IPP profile suggests a time-induced tolerance factor.
IPP measurements revealed important interindividual variations. In our clinical experience IPP value was an individual patient feature.

Conclusion

Our three-year clinical practice of IFF measurement confIrms the usefulness of the IFF value as an objective tool to analyze individual IFV tolerance in its relationship to age and time, age-related and timerelated. However, we have also learned that the limits of the so-called normal values of IFF measurements reveal important interindividual variations. Therefore, we believe that the IFF variations for a given patient are more informative than the comparison of an IFF value with presumed normal values. The initially published results (2) had shown lower IFF values in children than in adults. But, with a larger studied population of children, IFF values appeared to be in the same range for children and adults, if the same IFV normalized for body surface area was prescribed. We also must emphasize that the IFF measurements were performed in children in a supine position. Accordingly, these IFF values can be taken as an objective tool for IFV tolerance in children during a cycler peritoneal dialysis session, but not for those children on continuous ambulatory peritoneal dialysis (CAFD).

Acknowledgment

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Appendix

Measurement of hydrostatic intraperitonea/ pressure in chi/dren on peritonea/ dia/ysis

SUPPLIES

- Metric measurement of the height of the dialysis fluid column in the FD tube, directly connected to the peritoneal cavity (like a central venous pressure),

- A rule (scale graduated in centimeters) on a bracket,
- CAFD connecting system, either a disconnect (e.g., y -system) or nondisconnect system.

PROCEDURE

- The patient is at rest, lying in a supine position.
- Connection with the peritoneal system is made (as usual), and the patient's peritoneal cavity is filled.
- The FD line is fIXed vertically on the bracket, and there is no counterpressure in the distal part of the measurement tubing.
- The level of the column of dialysis fluid in the FD line is read with a scale graduated in centimeters after the height of the column stabilizes, first after deep inspiration (IPF insp) and secondly after deep expiration (IFF exp); determination of mean IFF:

$$\frac{\text{IPP insp} + \text{IPP exp.}}{2}$$

- The zero level of the column is set at the center of the abdominal cavity, on the midaxillary line.
- The peritoneal cavity is emptied after taking the IFF reading, and the volume of the dialysis fluid is measured (relation oflFF dialysate volume).
- IFF is measured at atmospheric pressure without any counterpressure in the distal part of the measurement tubing. The technique used depends upon the geometry of the FD system. In disconnect systems there is no counterpressure in the line or in the empty drainage bag after the line has been connected. In nondisconnect systems there is almost always a moderate counterpressure, so an air inlet is needed, accomplished before the readings are made by introducing a trocar at the injection site of the bag.

RISKS

- There is a potential risk of peritonitis during IFF measurement because of the new connection. Therefore this procedure should be performed only by nurses trained for peritoneal dialysis management. Moreover, the measurement should be taken most often during the usual connection for dialysis.

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