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BRIEF REPORT

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Intraperitoneal pressure and hernias in children on peritoneal dialysis

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Abstract Abdominal wall hernias have been increasingly recognized in patients on continuous ambulatory peritoneal dialysis (CAPD). They are also more frequent in children than in adults. The aim of this study was to determine the influence of intraperitoneal pressure (IPP) on the development of hernias in children on CAPD, and if there was a difference between IPP in children and adults. We studied 14 children aged 11.2±3.2 years, body weight 31.1±9.4 kg, who had undergone CAPD for 16.2±14.4 months. Also, 10 adults were studied, aged 48±18 years, body weight 62.4±13.9 kg, on the CAPD program for 35±27 months. The IPP was measured via a column of dialysate in the peritoneal dialysis line, immediately before the drainage of the peritoneal cavity. The pressure was measured with the patients in the supine position, at the level of the umbilical cicatrix with the zero point located on the mean axillary line. IPP was measured at inspiration and at expiration, and the mean of these two measurements was calculated. The children were divided in two groups : group 1 (n=7) without hernias and group 2 (n=7) with hernias (5 umbilical and 2 inguinal). The IPP of all children was 9.5±2.9 cm H_2O. The IPP was 8.1±2.6 and 10.9±2.6 cm H_2O in groups 1 and 2, respectively (P=0.003). The instilled volume for test was similar in both groups. The IPP of the adults was 13.8±2.8 cm H_2O, which was significantly greater than that of the children (P=0.001). In conclusion, hernia is a common complication in children on CAPD and its prevalence is affected by IPP. Other associated factors may be the presence of anatomically weak sites in the abdominal wall of the children, since IPP is lower in children than in adults.

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Introduction

Although hydrostatic intraperitoneal pressure (IPP) has been measured for many years in patients on peritoneal dialysis (PD) [1], its measurement has increased since Durand et al. [2] described a practical and easy technique for IPP measurement in 1992. IPP can determine how much intraperitoneal volume is tolerated by patients on continuous ambulatory peritoneal dialysis (CAPD) and prevent mechanical complications (hernias, dialysis fluid leakage, gastroesophageal reflux, hydrothorax, dorsolumbar problems, hemorrhoids, etc.) [3–5], and pulmonary and cardiac dysfunction [6, 7]. It also facilitates optimization of intraperitoneal volume and hence dialysis dose [8, 9], as the IPP influences fluid and solute transport during CAPD [10–12]. Some factors can modify IPP, such as volume of dialysate, obesity, sex, age, and abdominal girth [1, 3, 13]. The IPP can also be influenced by constipation, coughing, straining, and the patient's position (supine, sitting, upright) [1, 3, 14]. When the peritoneal cavity is empty, IPP is approximately 0.5–2.2 cm H_2O, and it increases linearly in proportion to the volume of dialysate instilled [6, 15]. The mean supine IPP in adult patients ranged from 12 to 13.4 cm H_2O [1, 2, 12] and the maximal acceptable IPP is less than 18 cm H_2O [7]. Fischbach et al. [16] reported an IPP of 10±2 cm H_2O in children, when the instilled volume was 1,000 ml/m^2 and an IPP of 11.0±2.0 cm H_2O when the instilled volume was 1,200 ml/m^2 [15]. Aranda et al. [17] reported an IPP of 9.4±2.6 cm H_2O with an instilled volume of 1,200 ml/m^2 in children on a CAPD program. A higher IPP has also been described in pediatric patients in the upright position (18.4±4.8 cm H_2O with 1,000 ml/m^2) [14].

Abdominal wall hernias are not uncommon in patients on CAPD, and some risk factors have been identified.

These include female gender, increasing age, longer time on peritoneal dialysis, increasing number of laparotomies, and multiparity [1, 3, 13]. These risk factors are associated with anatomical weakness sites, metabolic factors, and increased abdominal pressure (with or without increased activity) [13, 18]. Male sex and age younger than 6 years were risk factors also reported by Tsai et al. [19]. Hernias are more frequent in children than adults on PD. The incidence ranged from 2.0% to 31.4% in adults [20–22] and from 11.8% to 40% in pediatric patients [23, 24, 25], and was lower with intermittent PD (only supine position) than with CAPD (supine plus upright positions) [13]. Patients with hernias may develop pain, peritonitis due to incarcerated bowel, intestinal obstruction, and strangulation [3, 22]. Rocco and Stone [20] reported a morbidity of 13% in these patients on a CAPD program, and in another study abdominal hernias represented 4% of the causes of hospitalization [26]. Although hernias seldom result in death [27], they may lead to discontinuation of CAPD [19]. PD is an important renal replacement therapy for pediatric patients and studies of complications influencing its morbidity are important [28, 29]. The aim of this study was to determine the influence of IPP on the development of hernias in children on CAPD and if there was a difference in IPP between children and adults.

Patients and methods

Patients

Fourteen children (8 females, 6 males) aged 11.2±3.2 years (range 6–15 years), with a body weight of 31.1±9.4 kg (range 15.3–47.5 kg), on a CAPD program for 16.2±14.4 months (range 2–48 months) were studied. The etiology of the renal failure was glomerular nephropathy in 8 patients, cystinosis in 2 patients, cortical necrosis in 1 patient, hemolytic uremic syndrome in 1 patient, vesicourethral reflux and urinary tract infection in 1 patient and posterior urethral valve in 1 patient. Ten adult patients (6 females, 4 males) aged 48±18 years (range 23–70 years), with a body weight of 62.4±13.9 kg (range 39.9–84.5 kg), on a CAPD program for 35±27 months (range 4–72 months) were studied. The etiology of the renal failure was glomerular nephropathy in 7 patients, vascular nephropathy in 2 patients and diabetic nephropathy in 1 patient.

Methods

After a 4-h exchange, the IPP was obtained by measuring a column of dialysate in the peritoneal dialysis line, immediately before drainage of the peritoneal cavity. The patients were in the supine position, and the pressure was measured at the level of the umbilical cicatrix with the zero point located on the mean axillary line. IPP was measured at inspiration and at expiration, the average of these two measurements was calculated. Patients were quiet and comfortable during the measurements. The instilled volume for the test was 1,233±157 ml/m^2 of body surface for children and 1,217±161 ml/m^2 of body surface for adults (P>0.05). The instilled volume for the test was the routine volume of dialysate used by the patients. The patients did not have any change in their usual instilled volume per exchange in the 2 months preceding the measurement of IPP.

Statistics

Statistical analyses were carried out using Student's unpaired t test and chi-squared test. Variance is expressed as mean±SD. Significance was considered as $P \leq 0.05$.

Results

The IPP of the adults and of all children, using the same instilled volume per square meter of body surface, was 13.8±2.8 cm H_2O and 9.5±2.9 cm H_2O (P=0.001), respectively. Of the 14 children studied, 7 had hernias at the time of the evaluation of the IPP. Two male patients had inguinal hernias, 1 unilateral, 1 bilateral, and both constant in all positions. One patient with inguinal hernia had also a hernia in the implantation cicatrix of the Tenckhoff catheter. Five patients had umbilical hernias that changed in intensity with the patients' position (upright and supine). We divided the patients into two groups: group 1, without hernias (n=7, 5 females and 2 males), and group 2, with hernias (n=7, 3 females and 4 males). Although there were more males in the group with hernias, this difference was not significant (P=0.5). Results for groups 1 and 2 children respectively were: mean age 10.4±3.6 years and 11.2±2.7 years (P=0.63); mean time on CAPD program, 15.5±15.6 months and 17.0±14.6 months (P=0.86); instilled volume in the test, 1,177±161 ml/m^2 and 1,244±156 ml/m^2 (P=0.44). But the IPP was 8.1±2.6 and 10.9±2.6 cm H_2O in groups 1 and 2 (P=0.03), respectively.

Discussion

Fischbach et al. [16] reported a higher IPP in children during the first 2–3 days post surgical peritoneal catheter implantation (15±4 cm H_2O), despite low dialysate volume per exchange (10 ml/kg). After 2 weeks, the IPP decreased (10±2 cm H_2O), despite an increase in dialysate volume from 10 to 50 ml/kg (1,000 ml/m^2). When adult patients on PD had their instilled volume changed acutely, the IPP increased 2.18 cm H_2O for each liter of dialysate volume instilled [7]. The time on CAPD induces a tolerance, with a progressive decline in IPP [7, 15]. Hence it is only possible to compare the IPP of adults and children when they have been on a CAPD program for a long time and have similar instilled volumes. The mean instilled volume for the test of our patients (children and adults) was almost 1,200 ml/m^2 and they did not have any change in their usual instilled volume per exchange in 2 months preceding the measurement of IPP, but it was significantly greater in adults than in children (P=0.001). However; hernias are more frequent in children than adults on CAPD [20–25]. The development of hernia is not only related to the IPP, but also depends on other risk factors, such as metabolic changes and anatomical weak sites in the abdominal wall [13, 27]. Subclinical or occult hernias were demonstrated by scintigraphy, and can develop during CAPD by increasing the IPP [30, 31].

More studies are necessary to determine if there is a difference between the incidence of subclinical hernias in adults and children. The instilled volume for the test was similar in the children with and without hernias and although there were more males in the group with hernias, this difference was not significant; however, there was a significant difference in IPP. The maximal acceptable IPP for adults in the supine position is less than 18 cm H_2O; higher IPPs may induce pulmonary and cardiac dysfunction [7]. But what is the ideal IPP to prevent mechanical complications such as hernias? This study showed that children on CAPD with hernias had a higher supine IPP. Fischbach et al. [14] found a higher IPP in children in the upright than the supine position (130%±35%). Perhaps IPP in the upright position may have a higher correlation with hernias, but more studies are necessary to determine the value of IPP measurement in preventing such complications in children on CAPD. In conclusion, IPP is greater in adults than in children on CAPD and is a risk factor for the development of hernias in children.

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