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SYSTEMATIC REVIEW

The prophylactic omentectomy procedure in reducing the complication rate of continuous ambulatory peritoneal dialysis in pediatric: A systematic review and meta-analysis

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Summary

***Introduction:** The role of the omentectomy procedure on Continuous Ambulatory Peritoneal Dialysis (CAPD) catheter placement in pediatric patients has been differently evaluated in the literature, with some studies showing improvement while others showing no difference. Our study aims to define the advantages of omentectomy compared to a procedure without omentectomy.*
***Methods:** The literature searching in online databases (PubMed/MEDLINE, Cochrane Library, EMBASE, Scopus, and ClinicalTrial.gov) following the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines, has been registered on PROSPERO (CRD42023412846). The protocol was performed through April 2023 and focused on pediatric patients treated with an omentectomy procedure and related complications. The risk of bias in each study was assessed using the risk of bias for the non-randomized control trials (ROBINS-I). The effect estimates were extracted as risk ratios with 95% confidence intervals (CI). The heterogeneity of the studies was considered as high heterogeneity if I2 values above 50% or p < 0.05.*
***Results:** In the total of 676 articles identified in the database searching for screening, nine studies with 775 patients met the criteria for inclusion. The omentectomy procedure significantly showed a lower incidence of catheter obstruction compared to the control group, (OR 0.24 [95% CI, 0.12-0.49], p < 0.0001, I^2 = 0%). Moreover, omentectomy demonstrated a similar trend in the rate of removal or reinsertion of the catheter with high heterogeneity, OR 0.25 [95% CI, 0.12-0.51), p = 0.0002, I^2 = 70%).*
***Conclusions:** The omentectomy procedure showed a lower incidence of catheter obstruction and complications leading to removal or reinsertion of the catheter.*

KEY WORDS: *Continuous ambulatory peritoneal dialysis; Omentectomy; Omental procedure; Pediatric; Renal failure; Complication.*

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INTRODUCTION

Renal replacement therapy for pediatric patients with *end-stage renal disease* (ESRD) can be through both *peritoneal dialysis* (PD) and hemodialysis modalities (1). Compared to hemodialysis, PD has the advantage to be performed in a continuous ambulatory setting, called *Continuous Ambulatory Peritoneal Dialysis* (CAPD). Other advantages are less risk to induce hemodynamic instability due to less pro-inflammatory effect involved with the procedure, providing nutritional support via dextrose in the dialysate, lower cost in long-term treatment due to minimal hospital visits or home-care hemodialysis, especially in a remote or rural setting where long-term dialysis is hardly obtained (2-4). The mortality risk for patients treated with PD is better than with hemodialysis in the short-term and long-term survival is better (1). Even though CAPD treatment was less common than hemodialysis, CAPD has recently become the preferred mode of treatment for pediatric patients with ESRD (1, 5).

Despite these facts, CAPD is related to several mechanical complications related to catheter placement, including catheter obstruction by omentum, clot, or fibrin, and catheter migration out of the pelvis. Other complications are hypoalbuminemia, hyperglycemia, and infection, which can lead to peritonitis. All complications can lead to catheter failure, needing catheter removal or reinsertion (2, 6). According to ISPD Guidelines, the insertion of catheters in pediatric patients had an 18% of complication rate, including peritonitis, block of catheter, and catheter leakage (7). The omentectomy procedure, partial or total, was hypothesized for lowering the complication incidence. However, the role of the omentectomy procedure on CAPD catheter placement in pediatric patients has been differently evaluated in the literature, with some studies showing improvement while others showing no difference (6, 8-11). Our study aims to define the advantages of omentectomy as a prophylactic procedure in pediatric patients.

METHODS

The systematic review was conducted following the *Preferred Reporting Items for Systematic Reviews and Meta-Analysis* (PRISMA) (12). Our protocol was registered in the PROSPERO database (CRD42023412846).

Search strategy

According to the PRISMA statement, the systematic search was conducted in electronic databases, including *PubMed/MEDLINE*, *Cochrane Library*, *EMBASE*, *Scopus*, and *ClinicalTrial.gov* for studies published until April 2023. The literature search included the following terms: (peritoneal dialysis[MeSH Terms]) OR continuous ambulatory peritoneal dialysis[MeSH Terms] OR (peritoneal dialysis[Title/Abstract] OR continuous ambulatory peritoneal dialysis[Title/Abstract] OR catheter dialysis [Title/Abstract] OR CAPD[Title/Abstract]) AND (omentum[MeSH Terms] OR bursa, omental[MeSH Terms] OR omentectomy[Title/Abstract] OR omental procedure [Title/Abstract] OR omentum procedure[Title/Abstract]).

Eligibility criteria

For the systematic review, we included studies reporting about pediatric patients, below 18 years old, diagnosed with the end-stage renal disease treated by CAPD. The exclusion criteria were studies that did not compare the outcome or report a comparative outcome without any data on omentectomy. Review articles, case reports, case series, animal studies, and editorial articles were not eligible for this study. The literature screening was done for the article in English only.

Study selection

Two author reviewers, at least one specialized in pediatric urology, independently evaluated the citations and abstracts. Each reviewer identified article titles relevant to the topic. The selection processes of the study initiate with assessing the clarity of the eligibility criteria and the consistency of each author's decisions. The literature was screened by two reviewers independently (G.W.K.D. and R.S.) for the study's eligibility. First, the studies were screened by the title and the abstract, then they proceeded to full-text screening. In case of disagreement with the study selection, a third author (P.M.W.T) helped to solve controversies.

Data extraction

One reviewer conducted data extraction, while another double-checked it to tabulate the necessary data for each study. Data were extracted by two reviewers (G.W.K.D. and R.S.) from all the included studies, including the first author's name, publication date, place were studies were performed, sample mean age, sex, surgical procedure, complication rate (including catheter malposition, migrating catheter, catheter failure, catheter leakage, bleeding, and peritonitis). Catheter failure was defined as the complication of CAPD that needed the removal or re-insertion of the catheter, while catheter obstruction was defined as the occlusion of the catheter due to omental wrapping or fibrin deposition.

Risk of bias assessment

The risk of bias assessment of included studies was evaluated with the risk of bias in non-randomized studies of interventions (ROBINS-I) tool by two reviewers (13). Based on the eligibility of the information, the study was classified as low, moderate, serious, or critical for each domain. In case of discrepancies in the scores, the reviewers discussed to define a mutually accepted score.

Statistical analysis

All dichotomous outcomes of retrospective studies were estimated as *odd ratios* (OR) with 95% *confidence intervals* (CI). When the heterogeneity of the studies showed a p value < 0.05, the random-effects model will be used for the calculation. The meta-analysis data were presented as a Forest plot using the RevMan version 5.4 application.

RESULTS

A total of 676 articles were identified in the database searching for screening. After duplicate removal and 573 studies were screened by title and abstract. Out of them 27 studies were identified as potentially eligible studies and assessed by full-text for eligibility. Nine studies (14-22) including 775 patients met the criteria for inclusion, as shown in Figure 1.

Figure 1.
Literature Search and Selection Flow Chart.

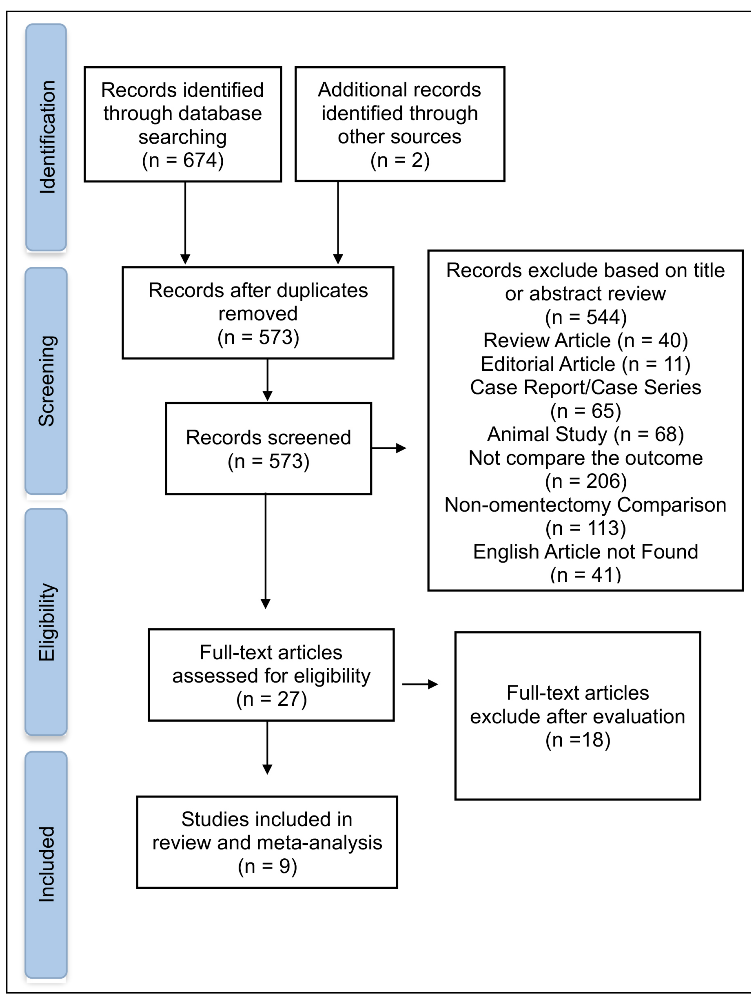


Table 1.
Characteristics study and profile patient of the included studies.

Author	Location	Study surgery	Total patients	Age (year)	Sex (Gender, %)	Operation technique	Complication	Catheter survival time
Ahmed, 2012 (14)	Saudi Arabia	Retrospective Review	31	3.8 ± 6.5	Male, 55 Female, 45	Open Laparotomy	Peritonitis Catheter Occlusion by omentum Catheter Malposition Catheter leakage	N/A
Cribs, 2012 (15)	USA	Retrospective Review	81	12	Male, 56 Female, 44	Laparoscopy and Open Approach	Catheter Occlusion omentum and fibrin plug Dialysate Leakage Perforation	177 ± 204 days
Ladd, 2011 (16)	USA	Retrospective Review	163	6.3 ± 5.6	Male, 49.1 Female, 50.9	Laparoscopy and Open Surgery	Catheter Occlusion by omental wrapping, fibrin plug Peritonitis Catheter Malposition Dialysate Leakage Intestinal Perforation Catheter Disruption	759 days for omentectomy 198 days for non-omentectomy
LaPlant, 2018 (17)	USA	Retrospective Review	153	4 ± 5.3	N/A	Open and Laparoscopy Surgery	Catheter Leakage Infection Adhesion Catheter Migration Ventral Hernia	585 days, range 36-2872 days
Macchini, 2006 (18)	Italy	Retrospective Review	78	6.3 ± 6.1	Male, 61.5 Female, 38.5	Open Technique	Infection Inguinal Hernia Catheter Dislocation Catheter Obstruction by intestinal organs Catheter Leakage	80% > 12 months 62% > 24 months 58% > 48 months
Numanoglu, 2008 (19)	South Africa	Prospective Cohort	26	8.6	Male, 53.8 Female, 46.2	Laparoscopy Technique	Catheter Obstruction by fibrinous adhesion, fimbria, sigmoid colod, omentum Catheter Leakage Bleeding Displacement Infection	6.4 ± 6.3 months
Schuh, 2021 (20)	USA	Retrospective Review	184	7.4 (0.27-14.7)	Male, 62.5 Female, 37.5	Open and Laparoscopy technique	Mechanical Failure Infection Catheter Migration Catheter Leakage	39 days (17-112)
Pumford, 1994 (21)	United Kingdom	Retrospective Review	21	1-10 (range)	Male, 47.6 Female, 52.4	Mini-Laparotomy	Catheter obstruction	N/A
Lewis, 1995 (22)	United Kingdom	Retrospective Review	38	7.8	N/A	Mini Laparotomy	Catheter obstruction by omentum Peritonitis Appendicitis	N/A

N/A: not available. Data are expressed as mean ± standard deviation or median (min-max interquartile range) or count %, as appropriate.

Table 2.
Risk of Bias Assessment.

Study	Design	Bias due to confounding	Bias in selection of participants into the study	Bias in measurement of interventions	Bias due to departures from intended interventions	Bias due to missing data	Bias in measurement of outcomes	Bias in selection of the reported result	Overall bias
Ahmed 2012	Retrospective Review	Serious	No Information	Serious	Moderated	Low	Moderated	Moderated	Serious
LaPlant 2018	Retrospective Review	Serious	Serious	Serious	No Information	Low	Moderate	Moderate	Serious
Ladd 2011	Retrospective Review	Serious	Serious	Serious	Moderated	Moderated	Serious	Serious	Serious
LaPlant 2018	Retrospective Review	Serious	Serious	Serious	No Information	Low	Moderate	Moderate	Serious
Manchini 2006	Retrospective Review	Serious	No Information	Moderate	Low	Low	Moderate	Moderate	Serious
Numanoglu 2008	Prospective Cohort	Serious	No Information	Serious	Moderate	Low	Moderate	Serious	Serious
Schuh 2021	Retrospective Review	Serious	Moderate	Moderate	Moderated	Moderate	Moderated	Moderated	Serious
Pumford 1994	Retrospective Review	Serious	Serious	Serious	No Information	No Information	Serious	Moderate	Serious
Lewis 1995	Retrospective Review	Serious	Serious	Serious	No Information	No Information	Serious	Serious	Serious

Four studies were conducted in America, three in Europe, one in Africa, and another in Asia. The characteristics of included studies are summarized in Table 1.

The risk of bias assessment showed that all included studies have a serious bias, as shown in Table 2. The funnel plot used to assess the publication bias and heterogeneity

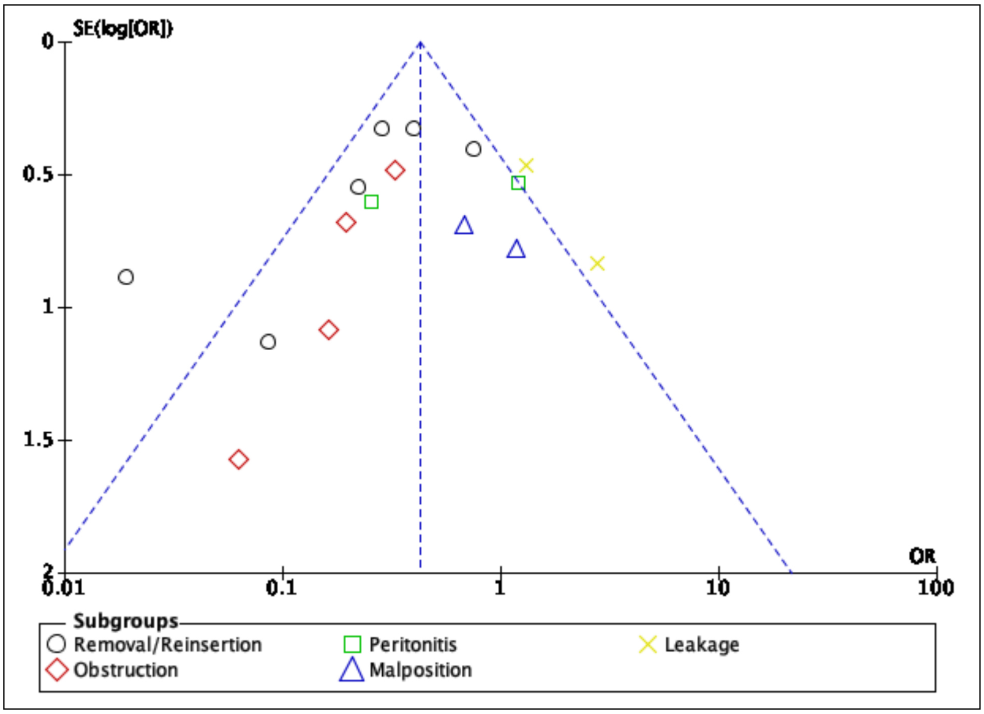


Figure 2.
Funnel Plot showing that the analysis of removal or reinsertion and leakage of the catheter has high heterogeneity.

is presented in Figure 2. The meta-analysis was assessed for four comparative outcomes: complications leading to removal or reinsertion, catheter obstruction, infections, and catheter leakage.

Among 339 patients in four studies, the omentectomy procedure significantly showed a lower incidence of catheter obstruction compared to the control group (OR 0.24 [95% CI, 0.12-0.49], $p < 0.0001$, $I^2 = 0\%$) as in the Forest plot shown in Figure 3A (16, 18, 21, 22). Moreover, omentectomy demonstrated a similar trend for removal or reinsertion of the catheter in five studies, including 685 patients, with high heterogeneity (OR 0.25 [95% CI, 0.12-0.51), $p = 0.0002$, $I^2 = 70\%$). Forest plot is shown in Figure 3B (14-17, 19, 20).

The complication of peritonitis and catheter leakage were reported only in two studies for each complication (16, 17, 22). In contrast, the analysis of both complications demonstrated insignificant results with no heterogeneity

Figure 3.
Forest plot pooled effect estimated showed statistical significance. A) Omentectomy showed a lower incidence of complications lead to catheter removal in pediatric patients; B) Omentectomy showed a lower incidence of complication specific to catheter obstruction compare than without performing omentectomy.

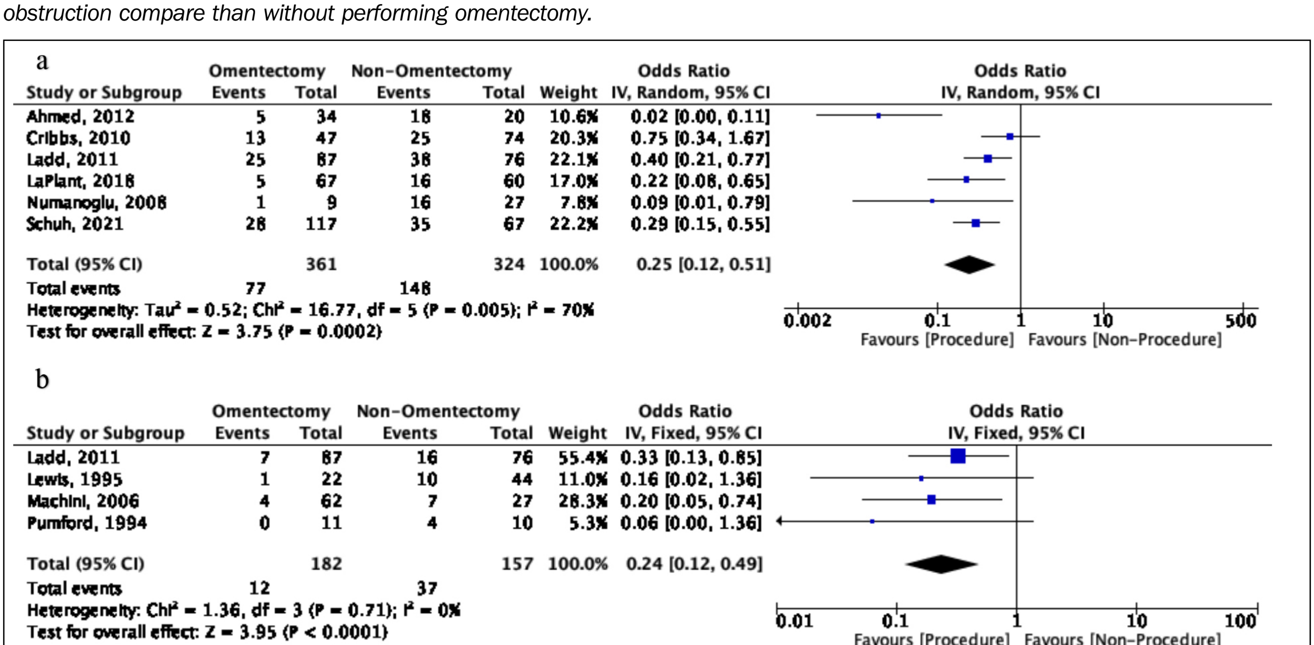
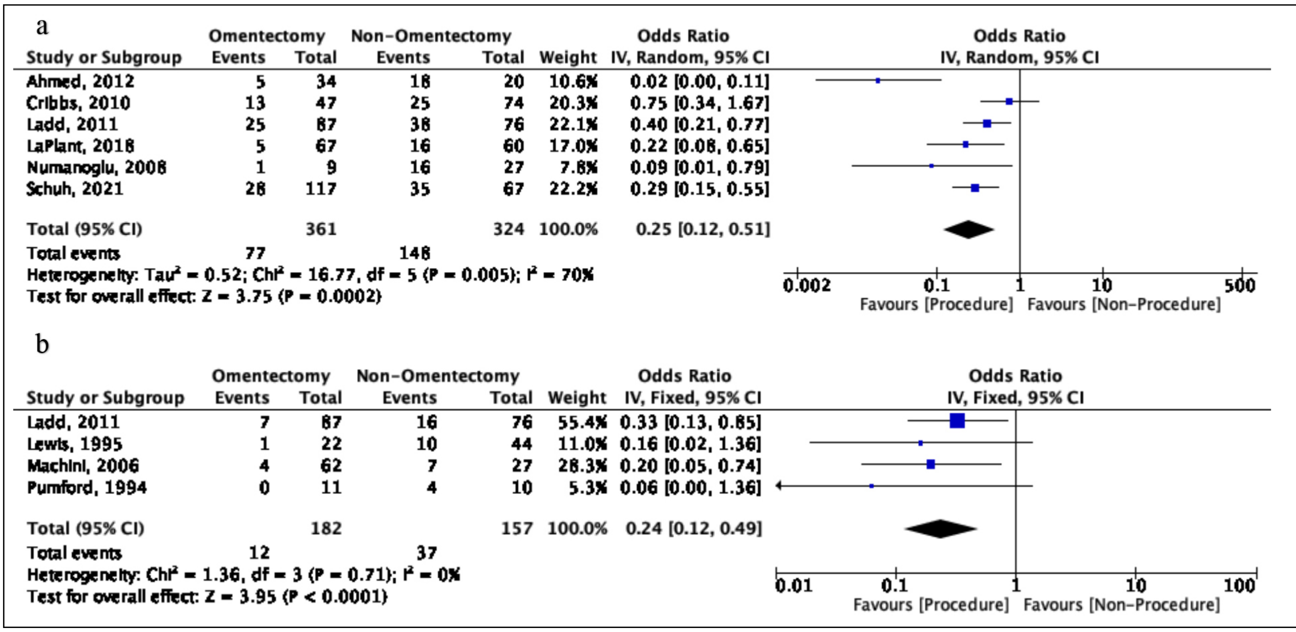


Figure 4.
Forest plot pooled effect estimated showed an insignificant result. A) Omentectomy procedure was compared to non-omentectomy for peritonitis, showing an insignificant different result; B) Odds of catheter leakage was insignificantly higher in patients with omentectomy.



found (p-value heterogeneity > 0.05). The omentectomy procedure has a insignificantly lower incidence of infections leading to peritonitis (OR 0.61 [95% CI, 0.28-1.34], p = 0.22, I^2 = 73%), as shown in Forest plot in Figure 4A. The omentectomy procedure showed a insignificantly higher incidence of catheter leakage compared to CAPD without omentectomy (OR 1.55 [0.70-3.45], p = 0.28, I^2 = 0%), as shown in Forest plot in Figure 4B.

Discussion

In pediatric renal replacement therapy, CAPD is the preferred treatment option which can be performed at home by low-trained caregivers without routinely visiting the hospital. To reduce the complication of CAPD, catheter insertion and the improvement in out-hospital care are essential (23). The catheters used for PD are varied, including rigid catheters, Tenckhoff catheters, which consist of straight, swan neck, or coiled, and adapted catheters, either from nasogastric tube, surgical drain, or dialysis catheter. However, the most preferred catheter in CAPD is a flexible cuffed, single or double cuffed, catheter, which can be placed through laparoscopic surgery, open surgery, or the Seldinger technique (a guidewire technique under local anesthesia). The omentectomy procedure can be performed only in surgical insertion, either laparoscopic or open technique (2, 23). Despite the catheter variability and differences in insertion methods, the comparison of different types and different techniques did not affect the complication rate of CAPD (24, 25).
The complication of CAPD catheter may lead to PD failure, which prompts catheter removal/reinsertion or return to hemodialysis. The most common causes of CAPD failure are catheter-related infection and malfunction (26). However, most infectious complications, catheter-related or peritonitis, resolve with conservative treatment, while the catheter obstruction, due to omental blockage, fibrin blockage, clot blockage, or catheter migration with obstruction, may necessitate removal or replacement (10). Even if catheter-related infections and peritonitis can be resolved by medication, peritonitis is the more common cause of catheter revision in the first year of treatment (27). The study by *Phan et al.* demonstrated that non-omentectomy catheter insertion was associated with a high re-operative rate for infection and malfunction (25). Therefore, the malfunction of the catheter, related to obstruction and catheter migration, often leads to catheter failure (7).
Moreover, pediatric patients have thinner abdominal muscle layers compared to adults making it difficult to affix the catheter in place, but it helps prevent catheter tip movement and catheter liquid leakage to the skin. These differences might contribute to the different complication rates in pediatrics (15).The comparative studies demonstrated that omentectomy is a statistically significant protective factor in ages below one year old to lower the incidence of early obstruction. The catheter placement with an omentectomy procedure was postulated as a preventive measure against catheter failure due to fluid entrapment or obstruction (24, 27). In this study, the analysis of odds of catheter failure and catheter obstruction in pediatrics significantly assessed the advantage of omentectomy procedures, which means that omentectomy reduces the risk of catheter failure and catheter obstruction due to omental wrap. The same result was shown in a meta-analysis study by *Kim et al.* in the general population (28).
The current guidelines for PD in pediatrics did not discuss in deepl regarding the effect of omentectomy procedures (7, 29, 30). On the contrary, there were several recommendations for successful peritoneal dialysis in infants

and children. The most common complication is peritonitis, minimalized by prophylactic antibiotics and a downward or lateral exit site placement, appropriate distance from the ostomy site and double-cuffed peritoneal dialysis catheter. For catheter leakage, prevention depend by subcutaneous tissue. Therefore, in infants weighing below 3 kg it is recommended to use a single cuff due to the lack of substantial subcutaneous tissue. The other recommendations are delaying initiation of peritoneal dialysis post-catheter insertion for more than 48 hours, using low fill volumes when initiation is started, and using a Tenckhoff catheter (7, 30, 31).

Our study meta-analysis is an update on omentectomy outcome, with more specific analysis in pediatric patients. The previous study by *Kim et al.* has a similar design, but it analyses omental procedures in the general population (27). The limitation of our study is that all included studies were retrospective studies, which are at high risk of bias. Therefore, this study cannot differentiate confounding factors that may affect the outcome, including children's age, weight, type of catheter, surgical techniques (laparoscopic or open surgical), and out-hospital care. However, the current literature demonstrated that those confounding factors, except the patient's age, did not statistically affect the results. Our meta-analysis study brings conclusive finding for controversial advantages of the prophylactic omentectomy procedure. Besides, inclusion studies demonstrated a low heterogeneity, which ascertains the findings of the analysis. The rating of the evidence base of this study according to the GRADE criteria, classified it as moderate (32). Finally, we encourage all academicians to perform further research on the omentectomy procedure, as a mono-factor, to decrease the incidence of CAPD complications.

Conclusions

Our meta-analyses demonstrated that the CAPD with omentectomy as prophylactic procedure in pediatrics is advantageous. In fact, although the omentectomy procedures might increase the risk of catheter exit leakage ($p = 0.28$), it significantly showed a lower incidence of catheter obstruction ($p < 0.0001$, OR 0.24) and complications leading to removal or reinsertion of the catheter ($p < 0.0001$, OR 0.25).

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Conflict of interest: The authors declare no potential conflict of interest.