RESEARCH / ARAŞTIRMA
DOI: 10.26650/IUITFD.1422363
İst Tıp Fak Derg 2024 / J Ist Faculty Med 2024

PERITONEAL DIALYSIS IN NEWBORNS AND INFANTS IN THE LAST 20 YEARS: SINGLE CENTER EXPERIENCE

SON 20 YILDA YENİDOĞAN VE SÜT ÇOCUĞUNDA PERİTON DİYALİZİ: TEK MERKEZ DENEYİMİ

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Cite this article as: Aksu B, Yürük Yıldırım Z, Bor M, Yaşa B, Bilgin L, Uygur N, et al. Peritoneal dialysis in newborns and infants in the last 20 years: Single center experience. J Ist Faculty Med 2024;87(2):127-133. doi: 10.26650/IUITFD.1422363

ABSTRACT

Objective: To evaluate patients who underwent acute and chronic peritoneal dialysis (PD) under the age of one one in terms of etiology, complications, and prognosis over 20 years and to compare the results between the first and last 10 years of acute and chronic peritoneal dialysis.

Material and Method: Seventy-four peritoneal dialysis patients under the age of one in the Division of Pediatric Nephrology and Neonatal Intensive Care Unit of our hospital between January 2002 and December 2023 were evaluated retrospectively. The patients were divided into two groups: patients admitted in the 2002-2013 period (Group I) and patients admitted in the 2013-2023 period (Group II). Patients in Group I and Group II were compared in terms of acute and chronic peritoneal dialysis etiology, complications, and prognosis.

Result: Forty-four of the patients (60%) were newborns, and the remaining 30 were infants (40%). There were 39 patients in Group I and 35 patients in Group II. There was no difference between Group I and Group II for acute dialysis in terms of neonatal and infant diagnoses, infectious and non-infectious complications, and prognosis (p>0.05). There was no difference between Group I and Group II in terms of neonatal and infant diagnoses, infectious and non-infectious complications, and infant prognosis (p>0.05). There was no death in the newborns in Group II and patient survival was higher than in the newborns in Group I (p=0.019).

ÖZET

Amaç: Bir yaş altında akut ve kronik periton diyalizi (PD) uygulanan hastaları 20 yıllık süreçte etiyoloji, komplikasyon ve prognoz açısından değerlendirmek ve akut ve kronik periton diyalizinin ilk ve son on yıllık dönemleri arasındaki sonuçları karşılaştırmak.

Gereç ve Yöntem: Hastanemiz Çocuk Nefroloji ve Yenidoğan Yoğun Bakım Ünitesi'nde Ocak 2002 ile Aralık 2023 tarihleri arasında yatan bir yaş altı 74 periton diyalizi hastası retrospektif olarak değerlendirildi. Hastalar 2002-2013 döneminde başvuran hastalar (Grup I) ve 2013-2023 döneminde başvuran hastalar (Grup II) olmak üzere iki gruba ayrıldı. Grup I ve Grup II'deki hastalar akut ve kronik periton diyalizi hastalığının etiyolojisi, komplikasyonları ve prognozu açısından karşılaştırıldı.

Bulgular: Hastaların 44'ü (%60) yenidoğan, geri kalan 30'u sütçocuğu (%40) idi. Grup I'de 39 hasta, Grup II'de ise 35 hasta vardı. Akut diyaliz için Grup I ve Grup II arasında yenidoğan ve sütçocuğu tanıları, enfeksiyöz ve enfeksiyöz olmayan komplikasyonlar ve prognoz açısından fark yoktu (p>0,05). Kronik diyaliz için Grup I ve Grup II arasında yenidoğan ve sütçocuğu tanıları, enfeksiyöz ve enfeksiyöz olmayan komplikasyonlar ve sütçocuğu prognozu açısından fark yoktu (p>0,05). Grup II'deki yenidoğanlarda ölüm yoktu ve hasta sağ kalımı Grup I'deki yenidoğanlara göre daha yüksekti (p=0,019).

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Submitted/Başvuru: 19.01.2024 • **Revision Requested/Revizyon Talebi:** 29.01.2024 •
Last Revision Received/Son Revizyon: 20.02.2024 • **Accepted/Kabul:** 23.02.2024 • **Published Online/Online Yayın:** 18.03.2024

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Conclusion: Peritoneal dialysis is the most commonly used method for renal replacement therapy in children facing both acute and chronic renal failure. In the last decade, despite high-quality care in the neonatal care unit, positive technological developments and effective management of PD, the most common infectious complication was still peritonitis, and the non-infectious complication was dialysate leakage, as in the previous 10 years.

Keywords: Newborn, infant, peritoneal dialysis

Sonuç: Periton diyalizi, hem akut hem de kronik böbrek yetmezliği ile karşı karşıya olan çocuklarda renal replasman tedavisi için en sık kullanılan yöntemdir. Son on yılda, yenidoğan bakım ünitesindeki yüksek kaliteli bakıma, olumlu teknolojik gelişmelere ve PD'deki etkin yönetime rağmen, önceki 10 yılda olduğu gibi en sık görülen enfeksiyöz komplikasyon hala peritonit, enfeksiyöz olmayan komplikasyon ise diyalizat kaçağıydı.

Anahtar Kelimeler: Yenidoğan, sütçocuğu, periton diyalizi

INTRODUCTION

Peritoneal dialysis (PD) is a renal replacement treatment method that can be applied at all ages, including the neonatal age group. PD is based on water and solute transport via diffusion, ultrafiltration, and absorption through the peritoneal membrane, which separates the blood in the peritoneal capillaries and the dialysis solution in the peritoneal cavity. Peritoneal dialysis can be used in both acute and chronic treatment of renal failure (1, 2). It is the preferred treatment option, especially in hemodynamically unstable and newborn babies and infants (3-5). In addition to acute kidney injury (AKI) in the neonatal period, PD is an effective method for disorders that are unresponsive to medical treatment, such as electrolyte disorders, resistant acidosis, and hyperammonemia secondary to congenital metabolic diseases. PD applications are performed through single or double-felt, straight or curved PD catheters placed in the peritoneal cavity by percutaneous or open surgical methods (6). The primary objective of this study was to assess children who underwent acute and chronic peritoneal dialysis under the age of 1 within 20 years, with a focus on etiology, complications, and prognosis. The secondary objective aimed to compare the outcomes of acute and chronic peritoneal dialysis between the initial and later ten-year periods.

MATERIAL and METHODS

Seventy-four peritoneal dialysis patients under the age of one in the Division of Pediatric Nephrology and Neonatal Intensive Care Unit of our hospital between January 2002 and December 2023 were evaluated retrospectively. The dialysis indications of the cases were decided by the neonatology and nephrology teams, and the process was managed by these two teams. PD catheters were inserted percutaneously or via open surgery. Catheter exit site care and dressing were performed by peritoneal dialysis nurses at one-day intervals. Patients were evaluated daily in terms of PD complications.

Cell counts were performed daily in the peritoneal fluid to evaluate peritonitis. Peritonitis was defined as ≥100 leukocytes/mm^3 and >50% neutrophils in the peritoneal fluid or culture positivity (7, 8). Exit-site infection was defined as erythema around the site where the catheter exits from the skin or purulent drainage from the exit site or both. A tunnel infection was defined as erythema or tenderness or edema over the subcutaneous pathway of the catheter (9). Dialysate leakage, catheter dysfunction, hydrocele/hernia, bleeding at the catheter exit site, catheter displacement, and protrusion of the catheter cuff were considered non-infectious complications (10).

The patients were divided into two groups: patients admitted in the 2002-2013 period (Group I) and patients admitted in the 2013-2023 period (Group II). The etiology, complications, and prognosis of patients with acute and chronic PD were obtained from the patient files and recorded in the study form. Patients in the newborn and infant (<1 year of age) groups were compared in terms of acute and chronic PD etiology, complications, and prognosis. Additionally, Group I and Group II were compared in terms of acute and chronic dialysis. This study was approved by the Ethical Committee of İstanbul University İstanbul Faculty of Medicine (Date: 15.12.2023, No: 25).

Statistical analysis

Statistical analyses were performed using the Statistical Package for Social Sciences (SPSS) for Windows, version 22.0 (IBM SPSS Corp., Armonk, NY, USA). For the presentation of quantitative data, mean, standard deviation, minimum, and maximum were given. Frequency and percentage values were used to present categorical variables (qualitative variables). Chi-Square and Fisher's exact tests were used to compare the rates between groups. During statistical analysis, the confidence interval $p<0.05$ was considered significant.

RESULTS

Out of the total 74 patients, forty-four (60%) were newborns, and the remaining 30 were infants (40%). Acute peritoneal dialysis was applied to 45 patients, while chronic peritoneal dialysis was administered to 29 patients. The boy/girl ratio was 1.4. Group I consisted of 39 patients from the 2002-2013 period, and Group II included 35 patients from the 2013-2023 period.

Acute peritoneal dialysis

Acute PD was administered to 45 patients (29 newborns, and 16 infants). The most common diagnoses for new-

borns were prematurity (45%) and sepsis (14%), while infants presented with metabolic diseases (25%) and after surgery (25%). The etiologies of patients who underwent acute PD are shown in Table 1. There were 24 girls and 21 boys. Group I included 27 patients, and Group II had 18 patients. Azotemia, oligoanuria, and hypervolemia were indications for acute PD in 40 patients (89%), hyperkalemia (≥6.5 mmol/L) in 21 patients (47%), and resistant acidosis in 26 patients (58%). The mean age of onset of acute PD was 8.0±9.4 days (1.0-39.0 days) in newborns and 128.1±118.8 days (31.0-388 days) in infants. The total duration of acute PD was 14.3±16.8 days (1.0-67.0) for newborns and 15.8±17.9 days (1.0-56.0 days) for infants. The most common complication was non-infectious complications in both groups. Dialysate leakage was present in 28 out of 45 patients. Nine patients (20%) had peritonitis, and 1 patient (2%) had a catheter exit site infection. Complications of acute PD are detailed in Table 2. The catheter was replaced in 28% of newborns and 19% of infants due to non-infectious complications. Mortality rates were 72.4% for newborns and 56.3% for infants.

Chronic peritoneal dialysis

Chronic PD was applied to 29 patients (15 newborns, and 14 infants). The most common diagnosis for newborns was congenital kidney and urinary tract anomalies (CAKUT) (87%), while infants had CAKUT (50%) and congenital nephrotic syndrome (21%). The etiologies of patients who underwent chronic PD are outlined in Table 1. There were 7 girls and 22 boys. Group I included 12 patients, and Group II had 17 patients. The mean age of onset of chronic PD was 15.3±17.6 days (2.0-62.0 days) for newborns and 34.2±49.0 months (2.0-148 months) for infants. The total duration of chronic PD was 27.1±24.8 months (3.3-71.5) for newborns and 32.3±23.4 days (5.0-72.0 months) for infants. The most common complication for newborns was non-infectious complications. Dialysate leakage (53%) and catheter dysfunction (27%) were the most common complications in newborns. Infectious complications were more common in infants. Thirteen patients (93%) had peritonitis, and six patients (43%) had a catheter exit site infection. Complications of chronic PD are listed in Table 3. Mortality rates were 27% in newborns and 43% in infants.

Comparison of patients in groups I and II according to dialysis modality

Acute peritoneal dialysis

The gender distribution of the patients was not different in the two groups (p>0.05). There was no difference between group I and group II in terms of neonatal and infant diagnoses, neonatal and infant infectious and non-infectious complications, and neonatal and infant prognosis (p>0.05) (Table 2).

Chronic peritoneal dialysis

The gender distribution of the patients was not different in the two groups (p>0.05). There was no difference between group I and group II in terms of neonatal and infant diagnoses, neonatal and infant infectious and non-infectious complications, and infant prognosis (p>0.05) (Table 3). A significant difference was found between group I and group II in terms of neonatal prognosis (p=0.019). There was no death and patient survival was higher in group II patients. Patients in group I and group II, who started chronic PD in the neonatal period, were similar in terms of gender, history of prematurity, and other parameters (p>0.05) (Table 3).

Table 1: Etiology in acute and chronic peritoneal dialysis patients

	Acute PD		Chronic PD	
	Newborns (n=29)	Infants (n=16)	Newborns (n=15)	Infants (n=14)
	n (%)	n (%)	n (%)	n (%)
CAKUT	4 (14)	3 (19)	13 (87)	7 (50)
ARPKD	2 (7)	-	1 (7)	2 (14)
Metabolic disease	2 (7)	4 (25)	-	-
Drug-induced acute kidney injury	1 (3)	-	-	-
Prematurity	13 (45)	-	-	-
Sepsis	4 (14)	3 (19)	-	-
Congenital heart disease	-	1 (6)	-	-
After surgery	-	4 (25)	-	-
Unknown	1 (3)	1 (6)	-	-
Hydrops fetalis	2 (7)	-	-	-
Congenital nephrotic syndrome	-	-	-	3 (21)
Bilateral renal vein thrombosis	-	-	1 (7)	-
Primary hyperoxaluria	-	-	-	1 (7)
Bilateral diffuse mesangial sclerosis	-	-	-	1 (7)

ARPKD: Autosomal recessive polycystic kidney disease, CAKUT: Congenital kidney and urinary tract anomalies in children, PD: Peritoneal dialysis

Table 2: Comparison of Group I and Group II in terms of acute dialysis

	Newborns			Infants		
	Group I (n=15)	Group II (n=14)	p	Group I (n=12)	Group II (n=4)	p
	n (%)	n (%)		n (%)	n (%)	
Gender			0.782			1.000
Boy	10 (67)	10 (71)		3 (25)	1 (25)	
Girl	5 (33)	4 (29)		9 (75)	3 (75)	
Diagnoses			0.208			0.114
CAKUT	2 (13)	2 (14)		1 (8)	2 (50)	
ARPKD	2 (13)	-		-	-	
Metabolic disease	2 (13)	-		4 (33)	-	
Drug-induced acute kidney injury	1 (7)	-		-	-	
Prematurity	5 (33)	8 (57)		-	-	
Sepsis	3 (20)	1 (7)		1 (8)	2 (50)	
Congenital heart disease	-	-		1 (8)	-	
After surgery	-	-		4 (33)	-	
Hydrops fetalis	-	2 (14)		-	-	
Unknown	-	1 (7)		1 (8)	-	
Non-infectious complications						
Dialysate leakage	11 (73)	12 (86)	0.411	3 (25)	2 (50)	0.547
Bleeding at the catheter exit site	3 (20)	-	-	3 (25)	-	-
Catheter dysfunction	4 (27)	1 (7)	0.164	1 (8)	2 (50)	0.136
Catheter displacement	3 (20)	-	-	-	-	-
Hydrocele/hernia	2 (13)	1 (7)	1.000	1 (8)	-	-
Infectious complications						
Peritonitis	3 (20)	2 (14)	0.684	3 (25)	2 (50)	0.547
Catheter exit site infection	-	-	-	-	1 (25)	-
Prognosis			0.682			0.521
Renal improvement	5 (33)	3 (21)		3 (25)	2 (50)	
Death	10 (67)	11 (79)		7 (58)	2 (50)	
Switching to HD	-	-		2 (17)	-	

ARPKD: Autosomal recessive polycystic kidney disease, CAKUT: congenital kidney and urinary tract anomalies in children, HD: Hemodialysis, PD: Peritoneal dialysis

Although the total PD duration was longer in group I than in group II (24.5 months vs 12.8 months), it was not statistically significant (p=0.694). The median age of onset PD was younger in group I than in group II (5.5 days vs 24.0 days; p=0.009). All four patients who died in group I were male and 75% of them were premature. The mean age of onset PD was 4.8±2.2 days (2.0-7.0 days). The mean total PD duration was 8.8±4.2 months (3.3-12.5 months).

DISCUSSION

Peritoneal dialysis is the most commonly used method for renal replacement therapy in children facing both acute and chronic renal failure (11). Its effectiveness is particularly noteworthy in newborns and infants, primarily due to the high ratio of peritoneal surface area to body surface area (12). This method is characterized by its technical simplicity and reliability in gradually removing both liquid and solute loads. Coagulation control and the absence of the need for vascular intervention are the reasons for its preference. In newborns and infants, it is mostly caused by many factors such as hypovolemia, hypotension, hypoxia, asphyxia, and septicemia. Acute PD is applied to remove metabolites in acute kidney injury and metabolic diseases (13, 14). In the literature, PD in the first two months of life has been most frequently applied to AKI (68.8%) followed by metabolic disorders (23.4%), and these rates are similar to our cases (15-17). It has been reported that the most common diagnosis of primary end-stage renal disease (ESRD) and therefore chronic PD in patients under 1 year of age is CAKUT (18). Similarly, in our study, the most common cause of ESRD in our patients under the age of 1 who underwent chronic PD was CAKUT (87% in newborns, 50% in infants). Additionally, when our patients in Group I and Group II were compared in terms of the reasons for starting acute and chronic dialysis, no difference was found between the 2 groups.

PD is recognized as an invasive procedure. The International Society of Peritoneal Dialysis (ISPD) recommends

Table 3: Comparison of Group I and Group II in terms of chronic dialysis

	Newborns			Infants		
	Group I (n=8)	Group II (n=7)	p	Group I (n=4)	Group II (n=10)	p
	n (%)	n (%)		n (%)	n (%)	
Gender			0.200			1.000
Boy	8 (100)	5 (71)		3 (75)	6 (60)	
Girl	-	2 (29)		1 (25)	4 (40)	
Prematurity			0.119			1.000
Yes	3 (38)	6 (86)		1 (25)	4 (40)	
No	5 (62)	1 (14)		3 (75)	6 (60)	
Diagnoses			0.364			0.163
CAKUT	6 (75)	7 (100)		1 (25)	6 (60)	
ARPKH	1 (13)	-		-	2 (20)	
Bilateral renal vein thrombosis	1 (13)	-		-	-	
Congenital nephrotic syndrome	-	-		2 (50)	1 (10)	
Primary hyperoxaluria	-	-		1 (25)	-	
Other	-	-		-	1 (10)	
Non-infectious complications						
Dialysate leakage	5 (63)	3 (43)	0.447	2 (50)	2 (20)	0.520
Bleeding at the catheter exit site	2 (25)	-	-	1 (25)	-	-
Catheter dysfunction	3 (38)	1 (14)	0.569	2 (50)	1 (10)	0.176
Catheter displacement	2 (25)	-	-	1 (25)	-	-
Hydrocele/hernia	3 (38)	1 (14)	0.569	1 (25)	1 (10)	0.505
Protrusion of catheter cuff	2 (25)	1 (14)	0.176	-	-	-
Infectious complications						
Peritonitis	6 (75)	6 (86)	1.000	4 (100)	9 (90)	1.000
Catheter exit site infection	3 (38)	2 (29)	0.714	2 (50)	4 (40)	1.000
Prognosis			**0.019**			0.286
Renal improvement	-	2 (29)		-	2 (20)	
Death	4 (50)	-		2 (50)	4 (40)	
Transplantation	4 (50)	1 (14)		1 (25)	-	
PD	-	3 (43)		-	3 (30)	
Switching to HD	-	1 (14)		1 (25)	1 (10)	

ARPKD: Autosomal recessive polycystic kidney disease, CAKUT: Congenital kidney and urinary tract anomalies in children, HD: Hemodialysis, PD: Peritoneal dialysis

starting peritoneal dialysis 10-15 days after catheter insertion to prevent dialysate leakage (5). Unfortunately, the performance of acute PD is associated with a higher incidence of catheter-related complications. This is attributed to the emergency placement of catheters and their immediate utilization upon insertion. Additionally, in newborns and infants, insufficient abdominal wall elasticity, dialysis peritoneal dialysis fluids around the catheter increase the possibility of leakage, and omentum adhesions may cause difficulties in fluid drainage (12). Dialysate leakage is particularly prevalent in low-birth-weight children, with reports indicating a threefold increase in occurrence among those weighing less than 12.4 kilograms (19). Studies have suggested that the risk of leakage is heightened in individuals with a short interval between the insertion of the PD catheter and its commencement of use (3, 4). Gozmen et al. conducted a study identifying the most common acute PD complications, including catheter-related leakage, catheter dysfunction, and, less frequently, hyperglycemia and peritonitis (17). Hakan et al., in their research, reported hyperglycemia (52.2%) as the most prevalent PD complication, with dialysate leakage occurring less frequently (19.4%) (15). In our cases, dialysate leakage around the catheter was detected as the most common complication of acute PD, especially in newborns (79%) and also in infants (31%).

Non-infectious complications, such as dialysate leakage, bleeding at the catheter exit site, catheter dysfunction, catheter displacement, hydrocele/hernia, and protrusion of the catheter cuff, are widely recognized as the primary causes of catheter revision. The PD catheter revision rate in children ranges from 13% to 34%. Revision is usually required within four weeks following the initial insertion of the catheter (5). In a study by Duzalka et al., mechanical

dysfunction (60%) emerged as the most common reason for PD catheter revision followed by peritonitis (16%), tunnel infection (12%), fluid retention, and leakage (6%) (5). Radtke et al. reported that children weighing less than 10 kilograms exhibit a higher frequency of revision (3). The one-year survival rate of the catheters in children under 6 months of age is 50%, while for children aged 6-24 months, it is noted as 83.7% (4,18). In our present study, catheter replacement due to non-infectious complications was required in 28% of newborns and 19% of infants. Notably, peritonitis is identified as the most prevalent cause of catheter revision beyond the initial year (5). It is stated that peritonitis is more common in the 0-2 age group compared to older children (4, 18).

The most common complications observed in pediatric patients undergoing chronic PD were non-infectious complications in newborns and infectious complications in infants within the content of our study. Our patients in Group I and Group II exhibited comparable occurrences of acute and chronic dialysis complications. However, despite technological advancements in PD application, peritonitis and catheter-associated within the scope of our study complications persist as the primary factors influencing patient morbidity (5).

Limited data are available regarding the mortality rates of newborns and infants undergoing PD. Mortality mostly depends on the underlying cause or developing complications (12, 13). No fatalities were attributed to peritonitis or other PD-related complications in our study. The causes of mortality in our study cohort were identified as sepsis in all newborns and cardiovascular complications in infants. In the literature, the mortality rate for children across various age groups undergoing acute PD was reported as 62% (35-95%) (15-17, 20).

For newborns undergoing chronic PD, the mortality rate within the first year of life was reported as 48% (21). Our study identified mortality rates of 72.4% for newborns 56.3% for infants in acute PD, and 27% for newborns and 43% for infants in chronic PD. Notably, despite no difference in acute dialysis outcomes, a more favorable prognosis was observed between 2013-2023, indicating a decline in mortality rates among children undergoing chronic dialysis when compared to the period from 2002 to 2013. Between 2002-2013, four children who started chronic PD in the first week of life during the neonatal period died at the end of a follow-up period of approximately nine months. There was no death between 2013-2023. It is not possible to interpret the reason for this difference with the data we obtained.

CONCLUSION

Peritoneal dialysis is the most commonly used method for renal replacement therapy in children facing both acute and chronic renal failure. Between the years 2002-2013 and 2013-2023, when acute and chronic peritoneal dialysis diagnoses were compared in terms of diagnoses, infectious and non-infectious complications, and prognosis, there was no difference in almost all factors between the two periods. In the last decade, positive developments were observed only in chronic PD deaths that started in the neonatal period. Despite high-quality care in the neonatal care unit, positive technological developments, and effective management in PD, the most common infectious complication was still peritonitis, and the non-infectious complication was dialysate leakage, as in the previous 10 years.

Ethics Committee Approval: The study has ethical approval from the İstanbul University İstanbul Faculty of Medicine (Date: 15.12.2023, No: 25).

Informed Consent: Due to the retrospective design of the study, informed consent was not taken.

Peer Review: Externally peer-reviewed.

Author Contributions: Conception/Design of Study- B.A., Z.Y.Y., M.B., B.Y., L.B., N.U., A.Y.; Data Acquisition- B.A., Z.Y.Y., M.B., B.Y., L.B., N.U., A.Y.; Data Analysis/Interpretation- B.A., Z.Y.Y., M.B., B.Y., L.B., N.U., A.Y.; Drafting Manuscript- B.A., Z.Y.Y., M.B., B.Y., L.B., N.U., A.Y.; Critical Revision of Manuscript- B.A., Z.Y.Y., M.B., B.Y., L.B., A.Y.; Final Approval and Accountability- B.A., Z.Y.Y., M.B., B.Y., L.B., N.U., A.Y.

Conflict of Interest: The authors have no conflict of interest to declare.

Financial Disclosure: The authors declared that this study received no financial support.

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