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Supine versus prone percutaneous nephrolithotomy: A comparison of efficacy and safety in obese patients

Supin ve pron perkütan nefrolitotomi: obez hastalarda etkinlik ve güvenlik karşılaştırması

Taner Kargı[1], Mithat Ekşi[1], Ubeyd Sungur[1], Osman Özdemir[1], Serdar Karadağ[1], İsmail Evren[1], Ahmet Hacıislamoğlu[1], Hakan Polat[1], Feyzi Arda Atar[2], Alper Bitkin[1], Ali İhsan Taşçı[1]

1 Bakirkoy Dr. Sadi Konuk Training and Research Hospital, Department of Urology, Istanbul, Turkey
2 Basaksehir Cam and Sakura City Hospital, Department of Urology, Istanbul, Turkey

ÖZET

Amaç: Obez hastalarda supin ve pron perkütan nefrolitotomiyi (PNL) etkinlik ve güvenlik açısından karşılaştırmak.

Gereç ve Yöntemler: Ocak 2011 ile Eylül 2020 tarihleri arasında Dünya Sağlık Örgütü (WHO) vücut kitle indeksi (VKİ) ≥30 kg/m2 sınıflamasına göre 2 cm'den büyük böbrek taşı olan, supin veya pron pozisyonda PNL uygulanan hastalar retrospektif olarak çalışmaya dahil edildi. Demografik özellikler, intraoperatif, postoperatif veriler ile birlikte Modifiye Clavien Derecelendirme Sistemine göre komplikasyonlar listelendi. Hastalar taşsızlık durumu belgelenerek 3 ay boyunca takip edildi.

Bulgular: Toplam 156 obez hastanın 74'üne (%47,4) supin PNL (grup 1) ve 82'sine (%52,6) pron PNL (grup 2) uygulandı. Hemoglobin düşüşü pelvikalisiyel akses sayısı, kan transfüzyonu, hastanede kalış süresi, komplikasyon oranları, taşsızlık durumu açısından gruplar arasında istatistiksel olarak anlamlı fark yoktu (p>0.05). Pelvikalisiyel akses yeri (üst, orta, alt kaliksler) iki grup arasında anlamlı olarak farklıydı (grup 1'de sırasıyla %18,9, %32,4, %42,6, grup 2'de %3,2, %19,3, %77,5) (p<0,001). Ortalama ameliyat süreleri gruplar arasında istatistiksel olarak farklı saptandı (sırasıyla grup 1'de 97,2 ± 18,1 dakika, grup 2'de 119,5 ± 18,9 dakika) (p<0,001).

Sonuç: PNL, hem supin hem de pron pozisyonda uygulanabilen obez hastalarda böbrek taşlarının tedavisinde güvenli ve etkili bir yöntemdir. Hasta karakteristiği göz önünde bulundurularak, supin pozisyonda üst kaliksten erişim de tercih edilebilir. Ek olarak, supin pozisyonun pron pozisyona göre en büyük avantajı daha kısa ameliyat süresine sahip olmasıdır.

Anahtar Kelimeler: *perkütan nefrolitotomi, obez, supin, pron*

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This study was approved by the Ethics Committee of University of Health Sciences, Dr.Sadi Konuk Training and Research Hospital Ethical Committee(Approval Number: 2021/282). All research was performed in accordance with relevant guidelines/regulations, and informed consent was obtained from all participants.

Corresponding Author : Ubeyd Sungur, Zuhuratbaba Mah, Dr. Tevfik Sağlam Cd No:11, 34147 Bakırköy, İstanbul / Turkey
Tel: +90 553 495 79 80 ***e-mail:*** ubeydsungur@gmail.com
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ABSTRACT

Objective: To compare prone and supine percutaneous nephrolithotomy (PNL) in obese patients with respect to efficacy and safety.

Material and Methods: Individuals with kidney stones larger than 2 cm undergoing either prone or supine position PNL were included in the study based on the World Health Organization (WHO) classification of body mass index (BMI) ≥30 kg/m2 between January 2011 and September 2020 retrospectively. Demographic characteristics, intraoperative, postoperative data, and complications according to Modified Clavien Grading System were listed. Patients were followed for 3 months, documenting their stone-free status.

Results: Out of the total 156 obese patients, 74(47.4%) underwent supine PNL (group 1), and 82 (52.6%) were prone to PNL (group 2). There was no statistically significant difference between the groups concerning hemoglobin drop, the number of pelvicalyceal access, blood transfusion, length of hospital stay, complications rates, and stone-free status ($p>0.05$). The location of pelvicalyceal access (upper, middle, lower calyces) was significantly different (18.9%, 32.4%, 42.6% in group 1, 3.2%, 19.3%, 77.5% in group 2, respectively) ($p<0.001$). Mean operative times were statistically different between the groups (97.2 ± 18.1 minutes in group 1, 119.5 ± 18.9 minutes in group 2, respectively) ($p<0.001$).

Conclusion: In the prone or supine position, PNL is a safe and effective method for managing kidney stones in obese patients. Access through the upper calyx may be favored in the supine position considering to patient's characteristics. Additionally, the supine position has the greatest advantage over the prone position due to shorter operative times.

Keywords: *percutaneous nephrolithotomy, obese, supine, prone*

INTRODUCTION

The worldwide prevalence of obesity has been rising rapidly. The Global Burden of Disease Study revealed that 603.7 million adults worldwide were affected by obesity in 2015 (1). Obesity is commonly associated with conditions increasing comorbidity, especially cardiovascular disease and Type-2 diabetes mellitus (2). Numerous studies have reported that the risk of kidney stone formation is higher in obese individuals (3-5). Both the accompanying health conditions and the various technical issues due to greater skin-to-stone distance (such as difficult visualization of the stone and the need for longer surgical instruments) lead to challenges in the management of kidney stones for patients with obesity.

The standard first-line treatment of renal calculi larger than 2 cm is percutaneous nephrolithotomy (PNL) (6). Also, many studies have emphasized that PNL effectively manages obese patients with kidney stones (7,8). As a result of the associated comorbidities in obese individuals, it is suggested that PNL, apart from the standard prone position, may be performed more reliably in the supine position due to the cardiopulmonary advantages it provides (9). Examining the current literature regarding PNL for obese patients, most studies have been designed to contrast the results of obese and non-obese patients in the same position (supine or prone) (10-13). In this study, for only adults with obesity, we compare prone and supine PNL, which are frequently applied at our clinic, in terms of efficacy and safety. Thus, we aim to present a new perspective on the current literature.

MATERIAL AND METHODS

Following the local ethics committee approval (2021-282/17.05.2021) and receiving written consent from the patients, a retrospective review was conducted. Those who presented with stones larger than 20 mm and/or did not have any success with other treatment methods undergoing PNL in their management were involved in this study. The records of 156 individuals in total with a body mass index (BMI) of 30–39,9 kg/m2 (obese) and BMI ≥40 kg/m2 (morbidly obese) are according to the World Health Organization classification between January 2011-September 2020. Patients with a BMI <30 kg/m2, under 18, urinary system anomaly, severe bleeding diathesis, uncontrolled diabetes, and hypertension were excluded from the study. These individuals were operated on in the supine (74 patients) and prone position (82 patients) by surgeons experienced in both surgical techniques at our clinic upon explaining the procedures to the pa-

tient in detail, along with forming a collaborative decision. Diagnosis of patients was made by ultrasonography and a contrast-enhanced imaging modality (CT urography/IVP). The supine PNL group was classified as Group 1, and the prone PNL group as Group 2. Demographic characteristics of the subjects (age, gender, BMI, hydronephrosis grade), preoperative, perioperative, and postoperative data, and complications were compared between groups. The longest axis of the stone was defined as the stone's size. In the case of more than one stone, the sum of all stone diameters was accepted as the stone size. Those with stones in the pelvis and one calyx were described as semi-staghorn, and those with stones in the pelvis and more than one calyx were considered staghorn calculus. Complete blood count (CBC), biochemical tests, coagulation tests, urinalysis, and urine culture, were performed on all patients preoperatively. All individuals were given prophylactic antibiotics. Appropriate antibiotic therapy was administered to patients with positive urine cultures. The surgeries were carried out when the preoperative urine cultures were sterile. For each participant conducting a CBC test after surgery, postoperative hemoglobin (Hb) values were measured and subtracted from preoperative values, and a drop in Hb levels was obtained. The Modified Clavien Grading System was used to analyze complications. Clavien grade I and II complications were regarded as minor, and Clavien grade III, IV, and V ones as major complications.

In Supine PNL, patients were placed in the Galdakao-modified Valdivia position (14). Also, to facilitate the puncture, the abdominal adipose tissue was often pulled to the contralateral side with an adhesive tape, and retrograde insertion of a 5 French (F) ureteral catheter was performed at this position. For prone PNL, a 5F ureteral catheter was placed in a retrograde fashion in the lithotomy position. Afterward, repositioning the patient, the prone position was achieved. In both techniques, access to the pelvicalyceal system was accomplished with fluoroscopy and/or ultrasonography following retrograde pyelography with a ureteral catheter and calyx dilatation. After forming a tract with the sequential plastic dilator, 30F Amplatz was inserted, and access was established via a 28F rigid nephroscope (Karl Storz). A pneumatic lithotripter fragmented the stone (ELMED, vibrolith), and the fragments were extracted with stone forceps and irrigation. Additional calyceal access was created as required. Following the procedure, a 14F nephrostomy catheter was placed in the renal pelvis. Double J (DJ) stent was inserted depending on the surgeon's preference. In all of the patients included in this study, the nephrostomy catheter was removed on the 3rd postoperatively, and the DJ catheter was taken out in the third week.

Kidney, ureter, and bladder (KUB) X-ray graphy or non-contrast CT were applied to the patients postoperatively on the first and third days to assess stone-free status. The success criterion was complete stone clearance or clinically insignificant residual fragments (<4 mm). This study was carried out following the principles of the Declaration of Helsinki.

Statistical Analysis

Categorical data were given in terms of numbers and percentages. Mean and standard deviation values were calculated for numerical data. Kolmogorov-Smirnov test was used to analyze the normal distribution of numerical data. The student's t-test was utilized to compare normally distributed numerical data. In order to contrast the mean of non-normal distributions, the Mann-Whitney U test was used. The frequencies of categorical variables were compared with Pearson Chi Square and Fisher's exact test. P-value below 0.05 was considered statistically significant. Statistical analysis was performed using Statistical Package of Social Sciences version 21 (IBM SPSS Statistics; IBM Corp., Armonk, NY).

RESULTS

The mean age of the patients were 50.5 ± 10.9 years for group 1 and 48.5 ± 11 years for group 2. The mean BMI was 36.4 ± 4.2 kg/m2 for group 1 and 37.1 ± 3.1 kg/m2 for group 2.

There was no significant difference between the two groups regarding mean age, gender, BMI, laterality, and the American Society of Anesthesiologists (ASA) score. There was no meaningful difference between the groups' preoperative hemoglobin, creatinine, and GFR levels. Also, neither group observed no significant variance concerning hydronephrosis grades (Table 1).

Table 1. Demographic characteristics, preoperative, intraoperative and postoperative data

Parameters (mean ± SD ; %)	Total (n=156)	Group 1 "Supine" n= 74 (47.4)	Group 2 "Prone" n= 82 (52.6)	p-Value
Age (years)	49.4 ± 11	50.5 ± 10.9	48.5 ± 11	0.255
Gender (n ; %)				0.212
Male	95 (60.9)	48 (64.9)	47 (57.3)	
Female	61 (39.1)	26 35.1)	35 (42.7)	
BMI (kg/m²)	36.8 ± 3.6	36.4 ± 4.2	37.1 ± 3.1	0.248
Laterality (n ; %)				0.332
Right	70 (44.9)	34 (45.9)	36 (43.9)	
Left	86 (55.1)	40 (54.1)	46 (56.1)	
Previous ESWL History (n ; %)	15 (9.6)	6 (8.1)	9 (11)	0.597
Kidney Stone Surgery History (n ; %)				0.590
PNL	12 (7.7)	5 (6.8)	7 (8.5)	
Open Pyelolithotomy	6 (3.8)	4 (5.4)	2 (2.4)	
Pre-op Hb	13.7 ± 1.9	13.9 ± 1.6	13.5 ± 2.2	0.122
Post-op Hb	12.6 ± 1.8	12.9 ± 1.5	12.3 ± 2	0.062
Hb Drop	1.1 ± 0.7	1 ± 0.7	1.1 ± 0.7	0.595
Hydronephrosis (n ; %)				0.626
0	9 (5.8)	4 (5.4)	5 (6.1)	
1	29 (18.6)	12 (16.2)	17 (20.7)	
2	63 (40.4)	32 (43.2)	31 (37.8)	
3	53 (34)	26 (35.1)	27 (32.9)	
4	2 (1.3)	0 (0)	2 (2.4)	
Number of Access Tracts	1.1 ± 0.3	1.1 ± 0.3	1.1 ± 0.3	0.968
Access Location (n ; %)				**<0.001**
Upper Calyx	19 (10.6)	16 (18.9)	3 (3.2)	
Middle Calyx	46 (25.7)	28 (32.4)	18 (19.3)	
Lower Calyx	114 (63.7)	42 (48.6)	72 (77.5)	
Operation Time (min)	108.9 ± 21.6	97.2 ± 18.1	119.5 ± 18.9	**<0.001**
Convalescence (day)	7.3 ± 1.2	7.3 ± 1.3	7.3 ± 1.1	0.813
LOS (day)	2.5 ± 1.1	2.5 ± 1.1	2.5 ± 1	0.703
Complications (n ; %)				0.900[!]
Absent	131 (84)	63 (85.1)	68 (82.9)	
Minor (Clavien Grade 1-2)	21 (13.5)	9 (12.2)	12 (14.7)	
Major (Clavien Grade 3-4-5)	4 (2.6)	2 (2.7)	2 (2.4)	
Blood Transfusion (n ; %)	5 (3.2)	2 (2.7)	3 (3.7)	0.549
SFS On Post-op Day 1 (n ; %)				0.536
Present	89 (57.1)	42 (56.8)	47 (57.3)	
Absent	67 (42.9)	32 (43.2)	35 (42.7)	
Requirement of Additional Treatment (n ; %)	40 (25.6)	23 (31.1)	17 (20.7)	0.147
Type of Additional Treatment (n ; %)				0.283
Absent	116 (74.4)	51 (68.9)	65 (79.3)	
ESWL	27 (17.3)	17 (23)	10 (12.2)	
F-URS	8 (5.1)	3 (4.1)	5 (6.1)	
Second-Look PNL	5 (3.2)	3 (4.1)	2 (2.4)	0.669
SFS On Post-op Month 3 (n ; %)	135 (86.5)	65 (87.8)	70 (85.4)	0.815

SD, Standard Deviation; ESWL, Extracorporeal Shock Wave Lithotripsy; PNL, Percutaneous Nephrolithotomy; Hb, Hemoglobin; F-URS, Flexible Ureteroscopy; LOS, Length of Hospital Stay; SFS, Stone free status; Pre-op, Preoperative; Post-op, Postoperative ! Fisher Exact Test

Table 2. Stone Characteristics

Parameters (mean ± SD ; %)	*Total (n=156)*	*Group 1 "Supine" n= 74 (47.4)*	*Group 2 "Prone" n= 82 (52.6)*	*p-Value*
Stone Size (mm)	31.3 ± 10.2	31.8 ± 9.9	30.8 ± 10.5	0.544*
HU value of stones	844.5 ± 314.6	854.1 ± 282.8	835.8 ± 342.3	0.718*
Number and Characteristics Of Stones (n ; %)				0.981!
Single	66 (42.3)	32 (43.2)	34 (41.5)	
Semi-staghorn	24 (15.4)	11 (14.9)	13 (15.9)	
Staghorn	27 (17.3)	12 (16.2)	15 (18.3)	
Multiple	39 (25)	19 (25.7)	20 (24.4)	

*HU, Hounsfield Unit. *Independent t Test ! Chi Square Test*

Table 3: Complications according to the Modified Clavien Grading System

(n ; %)	Supine Position (Group 1)	Prone Position (Group 2)
Grade I		
Renal colic	5(6.8)	3(3.7)
Fever	2(2.7	6(7.3)
Grade II		
Blood Transfusion	2(2.7)	3(3.7)
Grade IIIa		
Urinary Leakage	2(2.7)	1(1.2)
Grade IV		
Cardiac System (MI)	-	1(1.2)
Grade V	-	-
Minor complications	9(12.2)	12(14.7)
Major complications	2(2.7)	2(2.4)
Total complications	11(14.9)	14(17.1)

MI, Myocardial infarction

There was no considerable difference between the groups regarding mean stone size, number, and characteristics of stones and Hounsfield unit (HU). Whilst the mean stone size was 31.8 ± 9.9 mm in the supine group; it was 30.8 ± 10.5 mm in the prone group (Table 2). There was no significant difference in the mean number of access tracts in both groups (Table 1). Access through upper calyx in supine PNL was demonstrated to be considered significant, whilst lower calyx was favored in prone PNL ($p<0.001$) (Table 1). Mean operative times were significantly different between the groups; it was shown to be 97.2 ± 18.1 min in group 1 and 119.5 ± 18.9 min in group 2 ($p<0.001$). Complications were observed in 11 (14.9%) patients of group 1 and 14 (17.1%) patients of group 2. Most of the complications in both groups were minor. 2 (2.7%) individuals were identified in group 1 with hemorrhage requiring blood transfusion and 3 (3.7%) in group 2. No significant variance was noted regarding the mean postoperative Hb drop between the two groups (Table 1). The rates of major complications were 2.7% for group 1 and 2.4% for group 2, respectively. DJ stent was inserted due to urinary leakage from the tract after removal of the nephrostomy catheter for 2 patients in group 1 and 1 in group 2 (Clavien Stage IIIa). In the prone position, 1 patient was admitted into the intensive care unit (ICU) for observations due to the development of myocardial infarction (MI) during the operation. Following ICU monitoring, the patient was discharged upon stabilization of the clinical condition (Clavien Stage IV). No mortality was detected in either group (Table 3). The length of hospital stay (LOS) and convalescence for both groups were identical. The success rates evaluating the stone-free status

on postoperative day 1 were 56.8% for the supine group and 57.3% for the prone group. The rates of requiring additional treatments were similar between the two groups. Whilst second-look PNL was performed for 3 (4.1%) patients in group 1, it was done for 2 (2.4%) individuals in group 2. Also, there was no considerable difference between the groups in relation to the second-look PNL application rates. Concerning the evaluation of stone-free status on postoperative month 3, success was achieved in 65 (87.8%) patients overall for the supine group and 70 (85.4%) patients for the prone group. No significant difference was identified between the groups' first and second stone-free status assessments (Table 1).

DISCUSSION

Treatment options from non-invasive to invasive include extracorporeal shock wave lithotripsy (ESWL), flexible ureteroscopy (F-URS), and PNL. According to stone size and BMI, treatment preferences may vary. Despite being the most non-invasive procedure, ESWL's inadequacy in treating large kidney stones (>2 cm) and the drop in success rates as the skin-to-stone distance increases have caused it to be a less preferable option concerning the treatment of nephrolithiasis in obese patients (15,16). Besides, F-URS is a treatment option applicable to the management of obese patients as it is a retrograde procedure and is not affected by the skin-to-stone distance. However, it is established that the efficacy of F-URS reduces as the stone size increases, and following the procedure, many additional interventions are required (17,18). This situation repeatedly exposes obese patients to the risk of anesthesia, given the accompanying comorbid conditions.

The European Association of Urology 2021 guidelines recommend PNL as the first treatment choice for renal calculi larger than 2 cm (6). Many studies evaluated the relationship between BMI and PNL and emphasized that PNL is an effective and safe procedure for obese individuals with kidney stones (11,19,20). In Alyami et al.'s study, patients who underwent PNL were divided into 4 groups ideal body weight (BMI <25 kg/m2), overweight (BMI 25–29 kg/m2), obese (BMI 30–39 kg/m2) and morbidly obese (BMI ≥40 kg/m2). It was reported that the stone-free rates of all 4 groups were similar, with the rates being 90%, 87%, 90%, and 80%, respectively. As for the study of Shohab et al., individuals treated with PNL were separated into 3 groups normal weight (BMI <24 kg/m2), overweight (BMI 24.1–30 kg/m2), obese (BMI >30 kg/m2) and in another study, only 2 groups were formed as obese and non-obese. In both studies, stone-free rates of participants with obesity were similar to other groups (19,20).

Patients need not be repositioned in supine PNL shortens operative time (9). Considering that changing positions becomes more challenging, particularly for obese patients, supine PNL may have a great advantage in terms of operative time. In a study conducted by Desoky et al. examining the impact of BMI on flank-free modified supine PNL, participants were divided into 4 groups of normal weight (18.5 ≤ BMI <25 kg/m2), overweight (25 ≤ BMI <30 kg/m2), obese (30 ≤ BMI <40 kg/m2) and morbidly obese (BMI ≥40 kg/m2). It was revealed that along with similar stone-free rates, there was no significant difference in the mean operative times (87.2, 87.4, 87.9, and 88.7 minutes, respectively) in each of the 4 groups (12). Moreover, another study evaluated the effect of obesity on supine PNL results by allocating patients into 2 groups of non-obese and obese and similarly stated that there was no remarkable difference in terms of success rates and mean operation times of both groups (13).

Studies demonstrate that concerning treating nephrolithiasis in obese patients, both prone PNL and supine PNL are safe techniques with high effectiveness and emphasize that the complication rates for individuals with obesity are similar to those of the general population (10,13). In a study done by Şimşek et al., patients who underwent PNL in the prone position were divided into 4 groups according to BMI: normal body weight (BMI <25 kg/m2), overweight (BMI 25–29.9 kg/m2), obese (BMI 30–39 kg/m2) and morbidly obese (BMI >40 kg/m2). It was reported that there was no significant difference related to the complication rates between all groups (10). Additionally, in the study conducted by Ferreira et al., it was indicated for obese and non-obese patients who had PNL performed that no considerable difference was identified in terms of overall complication rates (13.8% and 13.6%, respectively, as Clavien grade ≥1) and major complication rates (8.4% and 5%, respectively as Clavien grade ≥3) (13).

On review of the current literature concerning PNL in patients with obesity, most of the studies were designed to compare the results of obese and non-obese participants in the same position (supine or prone) (10-13). For a more objective evaluation of nephrolithiasis in obese patients, some authors highlighted the need to contrast the advantages and disadvantages of these two positions within the same study (8). In our study, for only obese patients, we compared prone PNL and supine PNL, frequently performed at our clinic, in terms of efficacy and safety. It was observed in this study that along with similar additional treatment requirements for both groups, stone-free rates in postoperative month 3 were respectively 87.8% and 85.4% in supine and prone groups. Although the success rate was slightly greater in the supine group, no significant difference was detected. Upper calyx access was significantly higher for the supine group than for the prone group ($p<0.001$). We believe the reasons for favoring the supine position in obese patients include that in the prone position, possibly the higher intra-abdominal pressure compared to the supine position and the resulting push of kidneys more towards the head create challenges for upper calyceal puncture and that especially in the supine position, benefitting from the increased mobility of kidney, there are some advantages associated with both respiratory manipulations of anesthesia and desired manual positioning of the kidney by the surgeon.

Moreover, after the literature, operation times were noted to be significantly shorter for supine PNL. Although both groups' minor and major complication rates were identical, it is remarkable that 1 patient in the prone group developed MI (clavien stage 4) intraoperatively. Also, the hospital stay and convalescence duration were similar in both groups.

The main limitation of our study is its retrospective nature and being a single-center study. Prospective randomized studies should confirm our findings. Another limitation is that surgeries performed by more than one surgeon may affect the results by disrupting the homogeneity. However, the strength of our study is that, not in a single position for patients undergoing PNL according to BMI, it compares prone and supine PNL in terms of efficacy and safety for only obese individuals. As a result, we consider that our study will offer a new perspective to the current literature.

CONCLUSION

PNL is a safe and effective method in treating nephrolithiasis for obese patients, whether performed in the prone or supine position. Upper calyx access may also be favored in a supine position according to the patient's needs. The supine position provides significantly shorter operative times.

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

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Ethical Approval: The study was approved by the Ethics Committee of University of Health Sciences, Dr.Sadi Konuk Training and Research Hospital (Decision No: 2021/282). The study protocol conformed to the ethical guidelines of the Helsinki Declaration.

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