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REVIEW

Barts flank-free modified supine position vs prone position in percutaneous nephrolithotomy: Systematic review and meta analysis

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Summary *Introduction: Percutaneous Nephrolithotomy (PCNL) has been performed in various positions, including prone position and several modifications of supine position. The Barts flank-free modified supine (FFMS) position is a newly enhanced version of the supine positions. This study aims to compare the outcomes of Barts FFMS and prone position in PCNL.*

Methods: This study followed PRISMA 2020 guideline and was registered to PROSPERO CRD42024530426. Comprehensive search in PubMed, Sciencedirect, and Scopus was conducted until May 2024. Stone-free rates, complications, surgery duration, fluoroscopy duration, use of nephrostomy, and length of stay were collected. Data were analyzed using RevMan 5.4.

Results: A total of 4 studies were included in this review. There was no significant difference in stone-free rates between Barts FFMS and prone positions (OR = 1.12, 95% CI 0.64-1.95, p = 0.70). There were no significant difference in incidence of fever (OR = 0.91, 95% CI 0.38-2.18, p = 0.84), need for blood transfusion (OR = 0.46, 95% CI 0.11-1.88, p = 0.28), and urine leakage (OR = 0.41, 95% CI 0.16-1.05, p = 0.06). The surgery duration was significantly shorter in Barts FFMS position than in prone position (MD = -15.48, 95% CI [(-26.42)-(-4.55)], p = 0.006). There was no significant difference in patients requiring nephrostomy (OR = 0.19, 95% CI 0.01-3.75, p = 0.28). There were no significant difference in fluoroscopy duration (MD = 0.27, 95% CI [(-6.85)-7.40], p = 0.94) and the length of hospital stay (MD = -0.20, 95% CI [(-0.74)-0.33], p = 0.46).

Conclusions: The surgery duration was significantly shorter in Barts FFMS position than in prone position. There were no significant differences regarding stone-free rates, complications, fluoroscopy duration, use of nephrostomy, and length of hospital stay. This indicates that neither Barts FFMS nor prone position is superior, and the choice should be based on the surgeon's preference and the patient's clinical status.

KEY WORDS: *Barts; Flank-free; Supine; Prone; PCNL.*

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INTRODUCTION

Nephrolithiasis is among the most prevalent urological conditions, impacting around 12% of the global population (1). Its prevalence varies worldwide, starting from 1-5% in Asia, 5-9% in Europe, and 7-13% in North America (2). The global morbidity and *disability-adjusted life years* (DALYs) of nephrolithiasis increased substantially between 1990 and 2019 (3). The majority of kidney stones are composed of calcium, primarily in the form of calcium oxalate or calcium phosphate stones (2). Nephrolithiasis is often symptomatic (4).

Percutaneous nephrolithotomy (PCNL) is the primary treatment in patients with symptomatic nephrolithiasis larger than 2 cm (5). Over time, PCNL has been through many alterations in patient positioning. The first ever PCNL was done by *Fernström et al.* in prone position, back in 1976. The prone position was believed to be safely avoiding vital organs, such as the colon (6). Later, the first report of supine PCNL was introduced by *Valdivia et al.* in 1990 (7) and further elaborated in 1998 (8). Since then, the supine position has undergone variable modifications. This includes the flank roll position, Galdakao-modified Valdivia position, crossed-leg supine position, complete supine position, and the most recent Barts FFMS position (9). All of them have been reported to decrease the duration of PCNL procedures by eliminating the need for patient repositioning and allowing quick airway access (10).

Barts *flank-free modified supine* (FFMS) position is a newly enhanced version of the traditional supine position, with better access to the kidney (10). It offers several advantages compared to the prone position, including easier fluoroscopy access, more comfortable patient positioning, simpler tract dilation, reduced kidney pressure, improved fragment clearance, and easier transition to RIRS (11). Given these potential benefits, it is crucial to determine whether Barts FFMS is superior to the prone position in terms of clinical outcomes.

This study aims to compare the Barts FFMS and prone positions in PCNL, focusing on key clinical outcomes such as stone-free rates, complications, and surgery duration. By identifying the optimal patient positioning for PCNL, this study seeks to contribute to the improvement of patient care and surgical efficiency in the treatment of nephrolithiasis.

Methods

Study design

This systematic review and meta-analysis followed PRISMA 2020 guidelines and was registered to PROSPERO CRD42024530426.

Search strategy

Comprehensive search by the authors in scientific databases such as *PubMed*, *Sciencedirect*, and *Scopus* was conducted until May 2024. The keywords used were "PCNL" AND ("*flank-free*" OR "*Barts*"). The authors engaged in discussions to settle any disagreements.

Eligibility criteria

Inclusion criteria cover studies in English, RCT or cohort studies, and adult patients who had undergone standard PCNL in Barts FFMS compared to prone position. The definition of Barts FFMS position included in this study is a supine position with a 15° tilt of the ipsilateral flank, achieved by placing a 3-liter saline bag under the rib cage and a gel pad under the pelvis, thus creating the 'flank-free' position (8).

Stone-free rates, postoperative complications, and duration of surgery were the expected primary outcomes, while fluoroscopy duration, need for nephrostomy, and length of stay were chosen as secondary outcomes. Exclusion criteria cover non-English articles, study designs other than RCTs or prospective studies, non-standard PCNL procedures, and PCNL positions other than Barts FFMS and prone position.

Data extraction

Information was systematically collected using a structured format as first author, publication year, study design, sample size, age, *body mass index* (BMI), stone size, stone-free rates, complications, duration of surgery, duration of fluoroscopy, number of patients needing nephrostomy, and length of hospital stay.

Data analysis

The analysis for this study was conducted using Review Manager version 5.4 (*The Cochrane Collaboration, The Nordic Cochrane Centre, Copenhagen, Denmark*). For continuous data, the *Mean Difference* (MD) was utilized, while dichotomous data were analyzed using the *Odds Ratio* (OR). Meta-analysis was performed when two or more studies provided the same type of data. To assess the heterogeneity among the included studies, Cochran's Q and I^2 statistics were employed. A fixed-effects model was used when there was statistical homogeneity (defined as p-value > 0.1 and $I^2 < 50\%$). In cases where heterogeneity was present (p-value ≤ 0.1 or $I^2 \geq 50\%$), a random-effects model was applied. Statistical significance was determined with a threshold of $p < 0.05$.

Quality appraisal

To assess the selected studies, we utilized two different tools. We utilized two different tools: the Jadad score for *randomized controlled trials* (RCTs) and the *Newcastle-Ottawa Scale* (NOS) for cohort studies. If any discrepancies arose in bias assessments or justifications, they will be resolved through discussions among the authors until a consensus was reached.

Results

Study selection

The search yielded 263 results, with 231 records removed due to duplicates and irrelevance. After this removal, 32 potentially relevant articles remained. A thorough examination of the full texts resulted in 4 studies meeting the inclusion criteria for this review. The process is illustrated in the PRISMA flow chart (Figure 1).

Figure 1.
PRISMA flowchart.

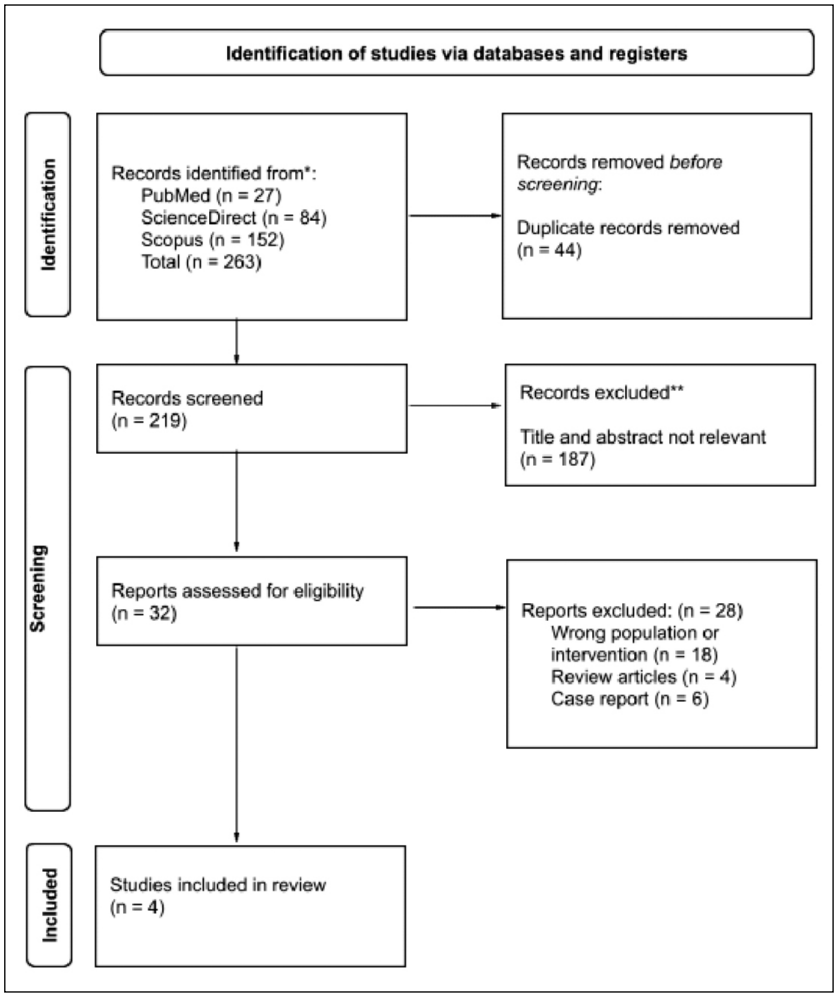


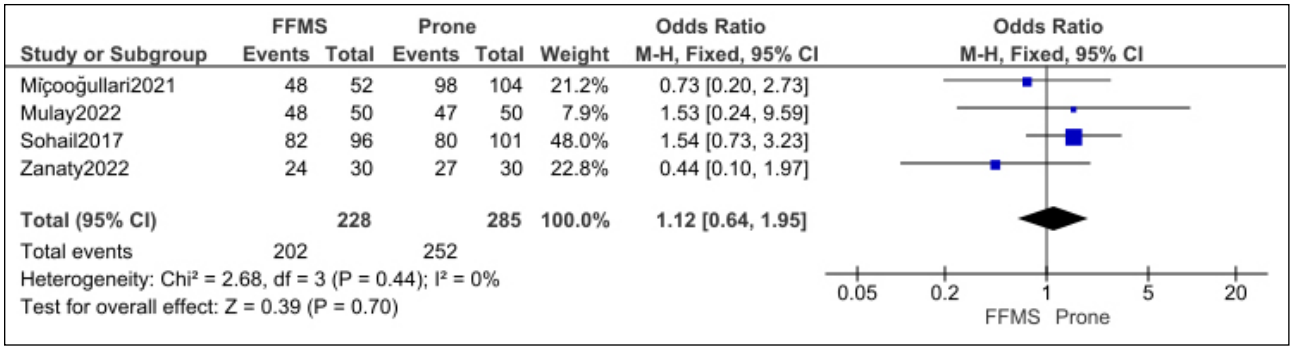
Table 1.
Assessment of the studies included.

Author	Study design	Assessment	
		Jadad score	Newcastle-Ottawa scale
Mulay et al., 2022 (12)	RCT	1	-
Miçooğullari et al., 2021 (13)	Cohort	-	7
Sohail et al., 2017 (14)	Cohort	-	7
Zanaty et al., 2022 (15)	RCT	2	-

Table 2.
Baseline characteristics of the studies included.

Study	PCNL position	Sample size (n)	Mean age (years)	BMI (kg/m^2)	Stone size (cm)	Stone-free rate (%)	Definition of stone-free status	Follow-up time
Mulay et al. (2022)	Barts FFMS	50	40.16	N/A	2.43 ± 1.23	96	Residual stones < 4 mm	1 month
	Prone	50	42.80		2.6 ± 1.23	94		
Zanaty et al. (2022)	Barts FFMS	30	47.40 ± 7.89	32.55 ± 8.98	4.56 ± 1.51	80	N/A	N/A
	Prone	30	47.67 ± 8.82	31.21 ± 5.48	4.05 ± 1.21	90		
Sohail et al. (2017)	Barts FFMS	96	38.9 ± 10.1	27.9 ± 7.2	2.99 ± 1.26	85	-No residual stones,	1-3 months
	Prone	101	45.2 ± 9.5	28.7 ± 6.5	2.97 ± 1.51	79	or -Residual stones < 5 mm	
Miçooğullari et al. (2021)	Barts FFMS	52	43.9 ± 16.2	24.4 ± 2.9	3.21 ± 0.73	92	Residual stones < 3 mm	1 month
	Prone	104	40.8 ± 14.6	24.8 ± 2.9	3.27 ± 0.82	94		

Figure 2.
Stone-free rates.



Study assessment
Two RCTs were included, assessed using the Jadad score and classified as poor quality. Two cohort studies were assessed using the Newcastle-Ottawa Scale, all rated as good quality. The assessment details are presented in Table 1.

Study characteristics
There were 4 studies with a total of 228 PCNL patients operated in the Barts FFMS position and 285 patients in the prone position.
The data in Table 2 provides a summary of the subject's baseline characteristics.
From the 4 studies, only 3 of them showed proper data to account for the mean age of the patients. One study by *Zanaty et al.* lacked the *standard deviation* (SD) in mean age data. The baseline characteristics such as the sample size, mean age, BMI, stone size, stone-free rate, the definition of stone-free status, and follow up time were available in Table 2.

Stone-free rates
Based on the forest plot presented in Figure 2, which included all 4 studies, there was no significant difference in the stone-free rate between Barts FFMS and the prone position (OR = 1.12, 95% CI 0.64-1.95, p = 0.70).

Complications (Clavien-Dindo)
Fever (Clavien-Dindo Grade 1)
All studies reported fever as a postoperative complication. Figure 3 indicates that the incidence of fever did not differ significantly between Barts FFMS and the prone position (OR = 0.91, 95% CI 0.38-2.18, p = 0.84).

Blood loss requiring transfusion (Clavien-Dindo Grade 2)
Only 3 studies reported blood transfusion.
Forest plot in Figure 4 demonstrates that there was no significant difference in the incidence of blood loss requiring transfusion between patients in the Barts FFMS and prone positions (OR = 0.46, 95% CI 0.11-1.88, p = 0.28).

Urine leakage (Clavien-Dindo Grade 3)
Figure 5 illustrates that the incidence of urine leakage was not significantly different between the Barts FFMS and prone position groups, as shown in the Forest plot of 3 studies (OR = 0.41, 95% CI 0.16-1.05, p = 0.06).

Surgery duration
The duration of surgery was significantly shorter in Barts

Figure 3.
Fever.

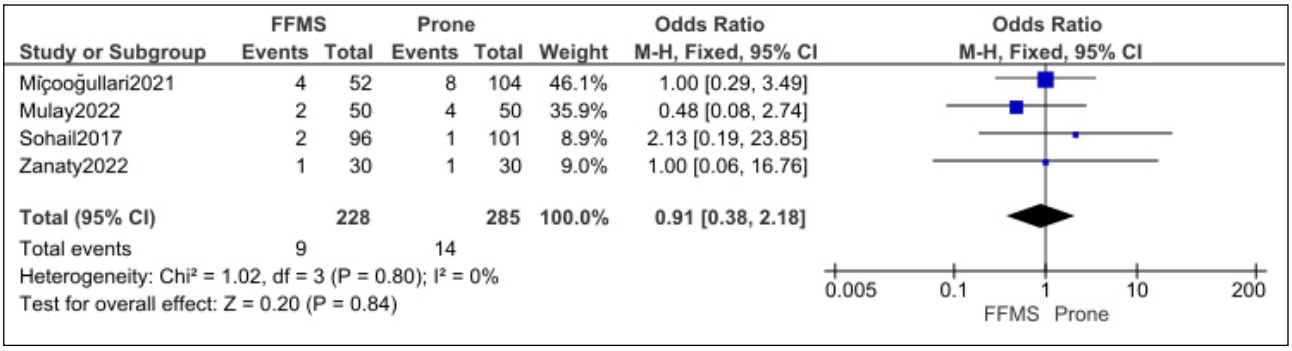


Figure 4.
Blood loss requiring transfusion.

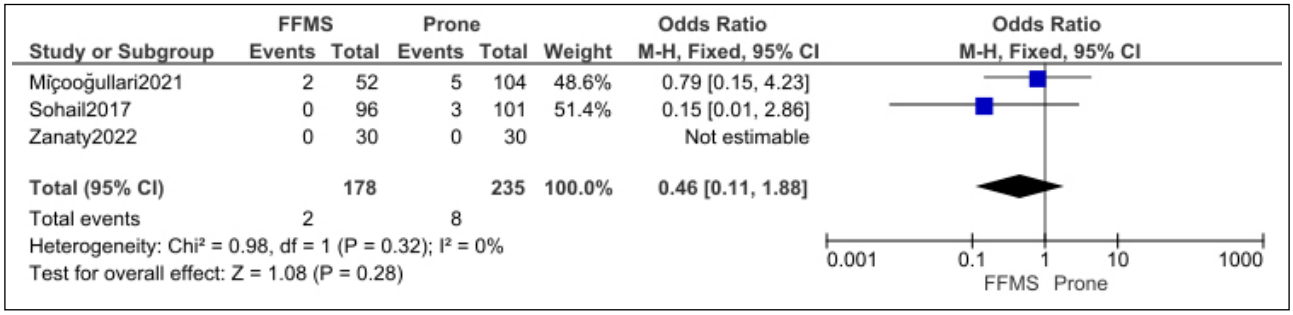


Figure 5.
Urine leakage.

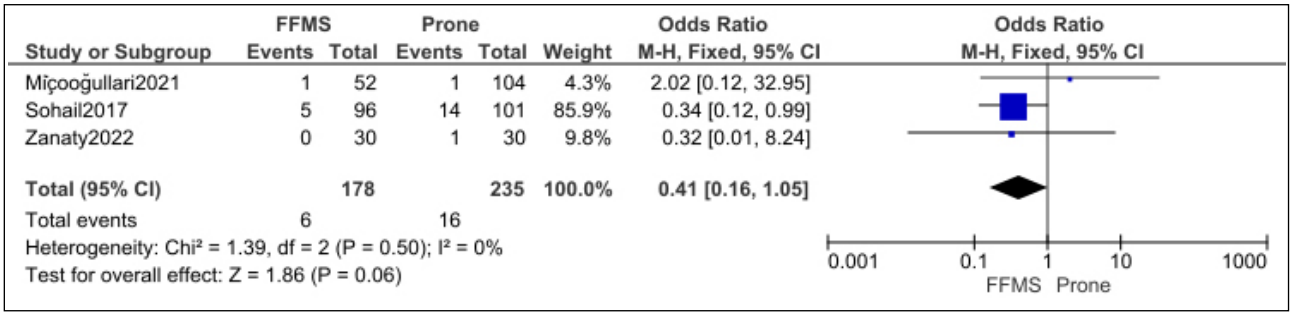
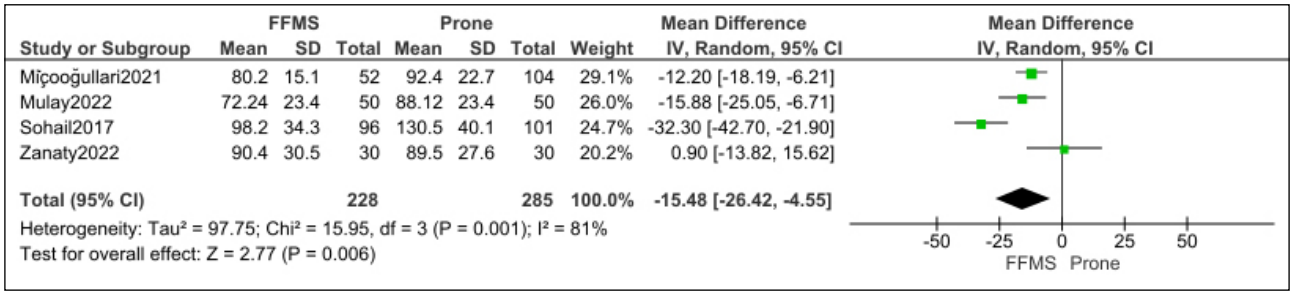


Figure 6.
Duration of surgery.



FFMS position than in prone position, as indicated in Figure 6 (MD = -15.48, 95% CI [(-26.42)-(-4.55)], p = 0.006). It also showed the studies were heterogeneous.

Use of nephrostomy

In Figure 7, the forest plot of 3 studies displayed that the use of nephrostomy after PCNL did not differ significant-

Figure 7.
Nephrostomy.

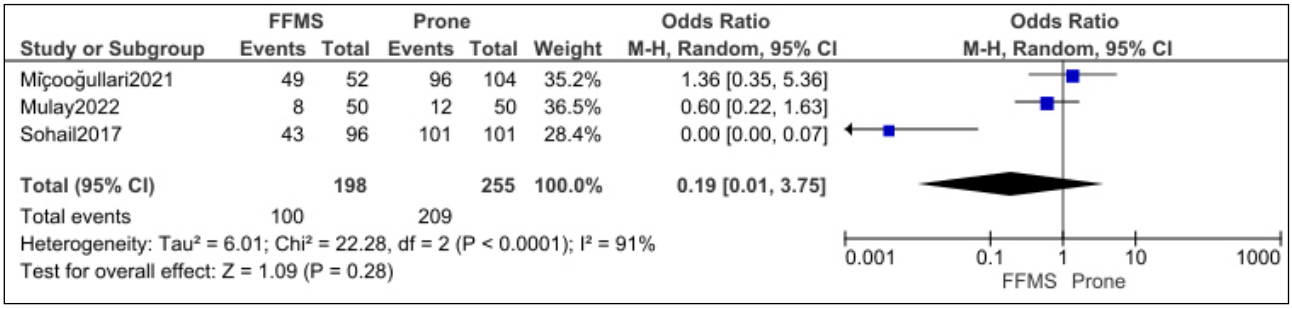


Figure 8.
Duration of fluoroscopy.

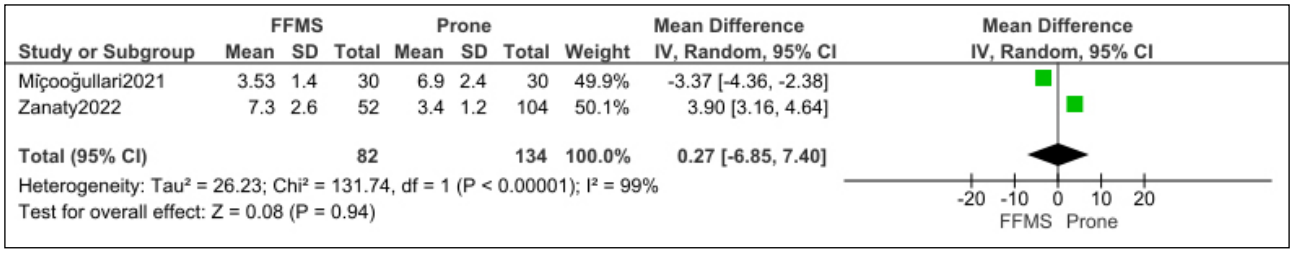
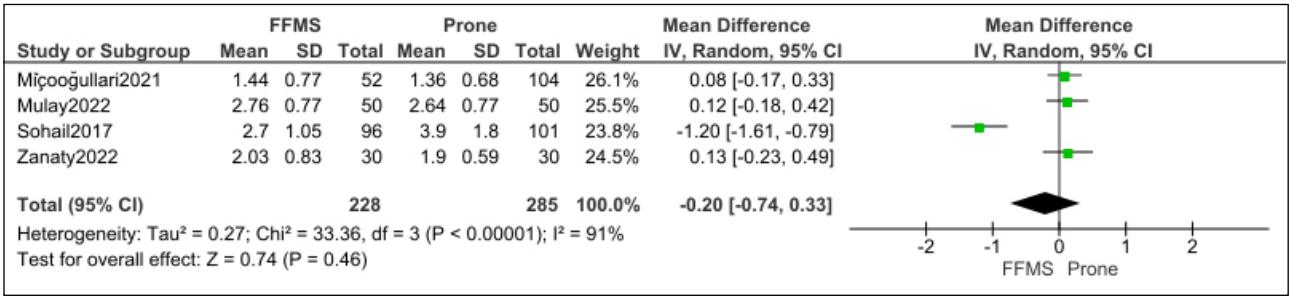


Figure 9.
Length of hospital stay.



ly in Barts FFMS and prone position (OR = 0.19, 95% CI 0.01-3.75, p = 0.28).
The studies were heterogeneous.

Fluoroscopy duration

Only 2 studies reported the duration of fluoroscopy used in PCNL, and they were heterogeneous. As shown in Figure 8, the duration of fluoroscopy did not significantly differ between the Barts FFMS and prone position groups (MD = 0.27, 95% CI [(-6.85)-7.40], p = 0.94).

Length of hospital stay

The included studies in this outcome were heterogeneous. There was no significant difference between patients in the Barts FFMS and prone positions, as shown in Figure 9 (MD = -0.20, 95% CI [(-0.74)-0.33], p = 0.46).

Discussion

When choosing between the Barts FFMS and prone positions, it is important to note that all supine positions, regardless of the modification, offer several advantages over the prone position. These include easier positioning for anesthesia, reduced risk of nervous system injury, and suitability for patients with comorbidities such as cardiovascular disease, risk of infection, and obesity (16). Additionally, the total cost of supine PCNL is lower than that of prone PCNL, due to savings on surgical equipment and anesthesia expenses (17).
To determine whether the Barts FFMS or prone position is superior, this review focused on stone-free rates, complications, and surgery duration as primary outcomes.
The stone-free rates were not significantly different between the Barts FFMS and prone positions. While a meta-analysis by *Birowo et al.* (18) found higher stone-free rates for supine positions in general, *Li et al.* (19) reported no significant difference between supine and prone positions.
Complications were classified using the Clavien-Dindo system: fever as grade 1, blood loss requiring transfusion as grade 2, and urine leakage as grade 3. The incidences of fever, transfusion due to blood loss, and urine leakage

were not significantly different between the Barts FFMS and prone positions. However, *Li et al.* (19) found no significant difference in complication rates between supine and prone positions, while *Birowo et al.* (18) reported significantly lower major complications in supine positions. These discrepancies may be due to inconsistencies in outcome reporting, as not all studies used the Clavien-Dindo classification.

In this review, the duration of PCNL was significantly shorter in the Barts FFMS position compared to the prone position. This aligns with *Li et al.* (19), who also found shorter durations in supine positions, but contrasts with *Birowo et al.* (18) who reported no significant difference. Literature suggests that supine positions should reduce operation time by eliminating the need for patient repositioning and allowing quick airway access (10).

Additionally, supine positions facilitate easier anesthesia, further shortening the duration of surgery (16).

The insertion of a nephrostomy tube after PCNL remains as a standard procedure. It served as drainage, a means to tamponade bleeding after surgery, and an access for a second exploration if necessary (20).

In this review, the use of nephrostomy was reported in three articles and showed no significant difference between the Barts FFMS and prone positions.

The use of fluoroscopy is a crucial step in PCNL, allowing urologists to guide the needle to a safe location. The imaging helps them to navigate into Brodel's line of bloodless incision, minimizing the probability of bleeding (21). Fluoroscopy duration was reported in only two studies in this review, showing no significant difference between Barts FFMS and prone patients.

In this study, the length of hospital stay did not significantly differ between the Barts FFMS and prone positions. This is consistent with meta-analyses by *Birowo et al.* (18) and *Li et al.* (19).

This review article provides valuable information to assist surgeons in choosing between the two positions. However, this study has limitations, including a small number of included studies, inconsistencies in outcome reporting, and high heterogeneity in some outcomes. Future research should explore the cost-benefit analysis and potential advantages of the Barts FFMS position to optimize PCNL procedures.

Conclusions

The surgery duration was significantly shorter in Barts FFMS position than in prone position. There were no significant differences regarding stone-free rates, complications, fluoroscopy duration, use of nephrostomy, and length of hospital stay.

Overall, the Barts FFMS position was not superior to the prone position. It offers a viable alternative to the prone position in PCNL, with no significant differences in clinical outcomes. Therefore, the choice of patient position should be based on the surgeon's preference and the patient's clinical condition.

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