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*Original Article*

# Preoperative Use of Alpha-1 Receptor Blockers in Male Patients Undergoing Extracorporeal Shock Wave Lithotripsy for a Ureteral Calculus

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**In this retrospective single-center cohort study, we investigated the impact of preoperative use of an alpha-1 adrenergic receptor (AR) blocker on the outcome of single-session extracorporeal shock wave lithotripsy (SWL) in 193 male patients who underwent SWL for a single ureteral calculus between 2006 and 2016. We reviewed their medical records to obtain the data on the preoperative use of alpha-1 AR blockers. The primary outcome was treatment success after single-session SWL. We performed a multivariable logistic regression analysis adjusting for clinically important confounders to examine the association between preoperative use of alpha-1 AR blockers and the treatment success of SWL. Among the 193 patients, 15 (7.8%) were taking an alpha-1 AR blocker preoperatively. A multivariable analysis showed that preoperative use of an alpha-1 AR blocker was a significant negative predictor for treatment success of SWL (adjusted odds ratio 0.17; 95% confidence intervals, 0.04-0.74). Our findings suggest that the preoperative use of an alpha-1 AR blocker was a negative predictor of treatment success of SWL in male patients with a single ureteral calculus. Clinicians should pay more attention to the preoperative drug use in determining an appropriate stone therapy modality.**

**Key words:** urolithiasis, extracorporeal shockwave therapy, adrenergic alpha-1 receptor antagonists

Upper urinary tract calculi is a common disorder with a prevalence of 5.2% in the United States (between 1988 and 1994) and showing an increasing trend all over the world [1]. The patients present with varied symptoms, and the condition may sometimes prove fatal [2,3]. Once patients are diagnosed with upper urinary tract calculi, urologists determine the most suitable type of surgical treatment from among various modalities, such as extracorporeal shock wave lithotripsy (SWL), ureteroscopic lithotripsy (URSL), and percutaneous nephrolithotomy (PCNL), based on the size and localization of the calculus in the urinary system [4]. In Japan, about 60% of the patients with upper urinary tract calculi were treated surgically in 2015, and 60% and 39% of these patients underwent

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SWL and URSL or PCNL, respectively [5]. Of the aforementioned treatments, SWL is a good alternative modality that may have a clinical advantage over URSL in patients with solitary upper urinary tract calculi ≤20 mm [4]. The guidelines issued by the European Association of Urology (EAU) [4] and American Urological Association (AUA)/Endourological Society (https://www.auanet.org/guidelines/kidney-stones-surgical-management-guideline) have provided a grade B recommendation for both SWL and endourology (URSL) in the management of solitary non-lower pole calculi ≤20 mm in size.

Some meta-analyses have reported the beneficial effects of alpha-1 adrenergic receptor (AR) blockers, which could cause an earlier expulsion of the stone and decrease the requirement for analgesics following SWL for ureteral calculi [6,7]. The current EAU guidelines also recommend postoperative medical expulsive therapy (MET) with alpha-1 AR blockers after SWL in cases of residual fragments [4]. On the other hand, alpha-1 AR blockers are prescribed for benign prostatic hyperplasia (BPH) as well as for MET in men in clinical practice. Only one study has revealed beneficial SWL outcomes with preoperative administration of alpha-1 AR blockers for BPH [8]. However, the effects of preoperative alpha-1 AR blockers in patients who failed MET and underwent subsequent SWL is still unknown. Therefore, in this study, we aimed to characterize the preoperative use of alpha-1 AR blockers based on the purpose of prescription in male patients who underwent SWL for ureteral calculi and to evaluate the impact of the preoperative administration of alpha-1 AR blockers on the outcomes of a subsequent SWL procedure.

## Materials and Methods

***Study design.*** We performed a retrospective single-center cohort study.

***Research setting.*** The study was conducted at the Onomichi Municipal Hospital in Japan. We included patients diagnosed with ureteral calculi from 1 January, 2006 to 31 December, 2016.

***Inclusion and exclusion criteria.*** We included patients who had been diagnosed with solitary upper urinary tract calculi on non-contrast computed tomography (NCCT) within the study period. To evaluate the association of alpha-1 AR blockers with SWL outcomes, only male patients with a solitary ureteral calculus were included. We excluded the patients with multiple calculi, for whom other surgical modalities such as URSL or PCNL were more suitable rather than SWL. We also excluded patients with indwelling ureteral stents, those for whom we did not have follow-up data, and those with missing outcome-data.

***Measurement of exposure.*** For this study, we reviewed the registration forms filled out by the patients at the first visit. The registration forms, which were available in the medical records of patients, had been recorded by well-trained nurses and contained the details of every prescription drug the patients were taking. We utilized this data to determine whether the patient was taking any alpha-1 AR blocker (*e.g.*, tamsulosin, naftopidil, silodosin, or urapidil) preoperatively. It is important to note that none of the patients who underwent SWL at Onomichi Municipal Hospital also underwent postoperative MET (post-MET) for residual fragments. The patients who were on preoperative alpha-1 AR blockers (both for BPH and for preoperative MET (pre-MET)) continued to receive them until the completion of SWL. Pre-MET was performed on the same day as the diagnosis of calculus.

***Main outcome measures.*** Our primary outcome measure was the proportion of cases in which treatment was successfully completed in a single session. We defined a successful treatment as one where the patient needed no additional treatment for the ureteral stone after completion of a single session of SWL. We evaluated the outcome of the procedure based on the abdominal X-ray KUB (kidney, ureter, and bladder) film taken at the patient's next visit to the outpatient clinic. If the size of the targeted calculus had been <4 mm, the SWL was deemed successful only when the calculus had passed completely and was undetectable on the KUB film. If the size of the targeted calculus had been ≥4 mm, the procedure was labelled successful either if the calculus had completely passed and was undetectable on KUB, or if the residual renal fragments after the SWL were determined to be clinically insignificant residual fragments (CIRF), which were defined as fragments <4 mm [9]. Also, we defined patients who required further treatment with modalities such as URSL or PCNL (instead of a second session of SWL) as treatment failures (NOT successful treatment).

***SWL method.*** When the calculus did not pass spontaneously in four weeks, regardless of preoperative administration of an alpha-1 AR blocker, the SWL was

performed with the Dornier Lithotripter D (Dornier MedTech, Wessling, Germany) at the hospital. All patients were administered transrectal diclofenac as an analgesic prior to the procedure. For targeting upper ureteric calculi, patients were placed in the supine position. For targeting mid-to-lower ureteric calculi, patients were placed in the prone position. The shock waves were applied at a rate of 60 per minute. The shock wave energy was gradually increased according to patient tolerance. The maximum allowable number of 3000 shocks was administered to almost all the patients. The first postoperative follow-up was conducted within 1 month. Statistical significance was set at $p < 0.05$.

***Data collection.*** We collated the relevant data from the patients' medical records. A standardized protocol was formulated to collect the data on exposure and outcome. The protocol provided instruction on how to measure exposure and outcome in each patient.

***Statistical analysis.*** We analyzed the group-wise patient demographics of those who were receiving alpha-1 AR blockers and those who were not, using the Wilcoxon rank sum test for the continuous variables and the Fisher's exact test for the categorical variables. To evaluate the effectiveness of alpha-1 AR blockers, we mainly applied a multivariable logistic regression analysis. We selected 5 variables (age, location of the calculus, stone length, mean stone density (MSD), and skin-to-stone distance (SSD)) as the most important confounders, based on published guidelines [4]. The selected confounders were converted to dichotomous variables, with reference to social factors, anatomical factors, and previous studies: age (cut-off value: 65 years), localization of the calculus (upper or mid-to-lower ureter), stone length (cut-off value: 5 mm) [10], MSD (cut-off value: 600 Hounsfield units (HU)) [11], and skin-to-stone distance (cut-off value: 120 mm) [11]. We also included information on whether the administered alpha-1 AR blocker had effectively served the purpose for which it had been prescribed. We performed an additional analysis of the reasons for which the alpha-1 AR blockers were prescribed and also carried out a multivariable logistic regression analysis of the dichotomously classified confounders to estimate their influence on the outcome of the SWL. Thus, we performed a complete-case analysis. The data were analyzed using STATA ver. 15.1 (Stata Corp., College Station, TX, USA).

***Ethical considerations.*** The study was approved by the Institutional Review Board of the hospital. The approval number was 17-23. The data were scrubbed of all identifying markers and anonymized before the statistical analysis. This is a retrospective observational study, and therefore written informed consent was not required.

## Results

A flowchart with study participant information is presented in Fig. 1. We reviewed the medical records of all the patients who underwent SWL at the hospital between January 2006 and December 2016 and found that 193 patients were eligible to participate. Of these, 15 patients (7.8%) had been on some alpha-1 AR blocker before the procedure. Table 1 shows the char-

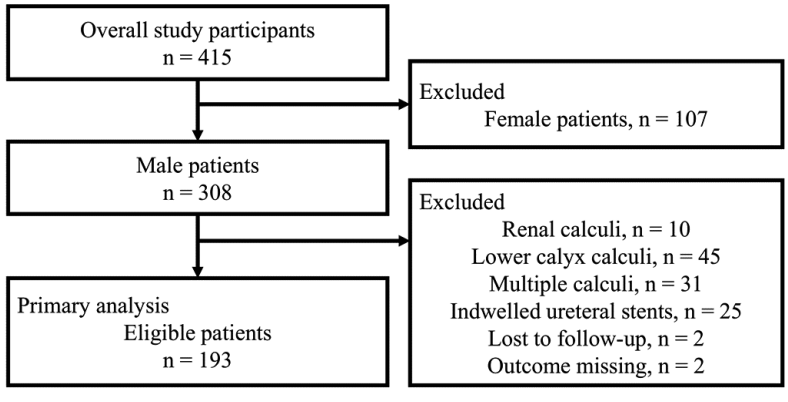


Fig. 1 Flow-diagram of this study. A total of 415 patients underwent SWL in the hospital. Of these, female patients, patients with renal, lower calyceal or multiple calculi, patients with indwelling ureteral stents, and patients lost-to-follow-up were excluded. Consequently, a total of 193 patients were eligible.

acteristics of the included patients. The median age was 57 years and the median BMI was 23.8 kg/m$^2$. The median stone length was 5.6 mm, and the median MSD was 882 HU. An upper ureteral calculus was diagnosed in 135 (69.9%) of the 193 patients. The patients taking alpha-1 AR blockers were found to be older than those who were not (62 years vs. 56 years). In addition, the calculi in the treated group were smaller in diameter (4.9 vs. 5.6 mm), had lower MSD (870 vs. 893.5 HU), and had a lower proportion of occurrence in the upper ureter (60.0% vs. 67.0%), respectively. However, these differences were not found to be statistically significant. A successful treatment outcome was seen in 136 (70.5%) of the 193 patients. The patients taking the alpha-1 AR blockers achieved a significantly lower treatment success rate compared to those who were not on the medications (46.7% (7 of the 15 patients) vs. 72.5% (129 of the 178 patients), $p=0.043$).

Table 2 shows the results of the multivariable logistic regression analysis estimating the treatment success of a single session of SWL. After making the necessary adjustments, the administration of alpha-1 AR blocker was found to be negatively associated with a successful treatment outcome (adjusted odds ratio (aOR) 0.17;

**Table 1** Patients characteristics of the study

| Characteristic | Total, n=193 | | Patients without alpha-1 AR blocker, n=178 | | Patients with alpha-1 AR blocker, n=15 | | *p*-value |
|---|---|---|---|---|---|---|---|
| | Median [IQR] | | Median [IQR] | | Median [IQR] | | |
| Age (years) | 57 [43–65] | | 56 [42–65] | | 62 [51–68] | | 0.076 |
| BMI (kg/m$^2$) | 23.8 [22.2–26.2] | | 23.9 [22.1–26.2] | | 23.5 [23.3–25.4] | | 0.982 |
| History of urolithiasis (present; n, %) | 75 | 39.7 | 70* | 40.2 | 5 | 33.3 | 0.785 |
| Stone length (mm) | 5.6 [4.7–7.3] | | 5.6 [4.7–7.3] | | 4.9 [4.6–9] | | 0.613 |
| Mean stone density (HU) | 882 [661–1,117] | | 893.5 [662–1,125.5] | | 870 [509–1,154] | | 0.946 |
| SSD (mm) | 115.7 [104.7–124] | | 115.7 [103.7–123.7] | | 119 [108.7–125] | | 0.313 |
| Localization of calculus (n, %) | | | | | | | 0.581 |
| Upper ureter | 135 | 69.9 | 126 | 70.8 | 9 | 60.0 | |
| Middle ureter | 23 | 11.9 | 21 | 11.8 | 2 | 13.3 | |
| Lower ureter | 35 | 18.1 | 31 | 17.4 | 4 | 26.7 | |

AR, adrenergic receptor; IQR, interquartile range; BMI, body mass index; AR, adrenergic receptor; HU, Hounsfield units; SSD, skin-to-stone distance.
*Data were missing for 4 of the 178 patients.

**Table 2** Multivariable logistic regression analysis estimating treatment success of SWL

| | aOR | 95% CI | *p*-value |
|---|---|---|---|
| Medication of alpha-1 AR blocker (ref. absent) | | | |
| present | 0.17 | (0.04–0.74) | 0.018 |
| Age (ref. 65 years or more) | | | |
| less than 65 years | 2.16 | (1.02–4.60) | 0.045 |
| Localization of calculus (ref. mid-to-lower ureter) | | | |
| upper ureter | 1.96 | (0.91–4.23) | 0.087 |
| Stone length (ref. 5 mm or more) | | | |
| less than 5 mm | 4.51 | (1.64–12.42) | 0.004 |
| Mean stone density (ref. 600 HU or more) | | | |
| less than 600 HU | 6.82 | (1.44–32.20) | 0.015 |
| SSD (ref. 120 mm or more) | | | |
| less than 120 mm | 1.11 | (0.54–2.28) | 0.776 |

SWL, shock wave lithotripsy; aOR, adjusted odds ratio; CI, confidence interval; AR, adrenergic receptor; HU, Hounsfield units; SSD, skin-to-stone distance.

95% confidence intervals (CI) 0.04 to 0.74; $p=0.018$). A significant association of treatment success was also seen with physical and anatomical characteristics such as age <65 years (aOR 2.16; 95% CI: 1.02 to 4.60; $p=0.045$), stone length <5 mm (aOR 4.51; 95% CI 1.64 to 12.42; $p=0.004$), and MSD <600 HU (OR 6.82; 95% CI 1.44 to 32.20; $p=0.015$).

Table 3 shows the details of the preoperative administration of alpha-1 AR blockers. Among the included patients, an alpha-1 AR blocker was preoperatively administered for BPH and pre-MET to 7 and 8 patients, respectively. The median durations of administration for BPH and pre-MET were 90 days (range: 10 to 1460) and 22 days (range: 7 to 90 days), respectively. We performed an additional analysis using a multivariable logistic regression model, as shown in Table 4, and the results indicated that SWL for pre-MET, but not SWL for BPH, was a negative predictor for SWL success (aOR 0.14, 95% CI 0.02-0.90, $p=0.038$; and aOR 0.23, 95% CI 0.03-1.97, $p=0.180$, respectively).

## Discussion

In this study, we described the preoperative use of alpha-1 AR blockers and evaluated its association with the outcome of a subsequently performed SWL for ureteral calculi. Among the patients, about 8% were taking an alpha-1 AR blocker preoperatively, with about 4% taking an alpha-1 AR blocker for pre-MET. We achieved an overall treatment success rate of 70.1% in our study, which was comparable or superior to those attained in previous studies (49.6% to 69.9%) [11-13]. In addition, we evaluated the association based on the purpose of prescription. We found that the preoperative administration of an alpha-1 AR blocker was a statistically significant negative predictor for the success of SWL.

Medical expulsive therapy (MET) with alpha-1 AR blockers is widely utilized for ureteral stones, since the drugs are localized in the ureter and the blockade of alpha-1 AR can relax the ureteric smooth muscle [14]. The EAU guidelines recommended alpha-1 AR blockers

**Table 3** Details of alpha-1 AR blocker use

| Purpose of prescription | Drugs | Dosage | n | Median administration period (days [range]) |
|---|---|---|---|---|
| For BPH | Tamsulosin | 0.2 mg | 4 | 90 [10 to 1,460]* |
| | Silodosin | 8 mg | 2 | |
| | Naftopidil | 25 mg | 1 | |
| For pre-MET | Tamsulosin | 0.2 mg | 8 | 22 [7 to 90] |

AR, adrenergic receptor; BPH, benign prostatic hypertrophy; pre-MET, preoperative medical expulsive therapy.
*Data were missing for 2 of the 7 patients.

**Table 4** Multivariable logistic regression estimating the treatment success of SWL according to the purpose of alpha-1 AR blocker prescription

| | aOR | 95% CI | *p*-value |
|---|---|---|---|
| Medication of alpha-1 AR blocker (ref. absent) | | | |
| present for BPH | 0.23 | (0.03–1.97) | 0.180 |
| present for pre-MET | 0.14 | (0.02–0.90) | 0.038 |
| Age (ref. 65 years or more) | | | |
| less than 65 years | 2.19 | (1.03–4.67) | 0.042 |
| Localization of calculus (ref. mid-to-lower ureter) | | | |
| upper ureter | 2.00 | (0.92–4.35) | 0.082 |
| Stone length (ref. 5 mm or more) | | | |
| less than 5 mm | 4.60 | (1.65–12.79) | 0.003 |
| Mean stone density (ref. 600 HU or more) | | | |
| less than 600 HU | 6.83 | (1.44–32.30) | 0.015 |
| SSD (ref. 120 mm or more) | | | |
| less than 120 mm | 1.13 | (0.55–2.32) | 0.748 |

SWL, shock wave lithotripsy; AR, adrenergic receptor; aOR, adjusted odds ratio; CI, confidence interval; BPH, benign prostatic hypertrophy; pre-MET, preoperative medical expulsive therapy; HU, Hounsfield units; SSD, skin-to-stone distance.

for spontaneous passage of both ureteral stones and fragments created after SWL [4]. However, few studies have evaluated the effectiveness of preoperative alpha-1 AR blockers. Indeed, to our knowledge there has been only one such study which found that preoperative alpha-1 AR blockers administered for BPH patients improved the stone-free rate after SWL [8]. Moreover, the results of this study were not adjusted sufficiently for confounding factors (*e.g.*, patient age, stone size, stone location, number of SWL sessions and shockwaves administered per session). In contrast, in the present analysis we adjusted for sufficient confounding factors including NCCT factors, and we found that the use of preoperative alpha-1 AR blockers for BPH had no association with SWL success. We do not think our findings were contrary to those of the aforementioned study, since our small sample size may have prevented our detecting an association between alpha-1 AR blocker use for BPH and SWL success. On the other hand, we did find a negative association between alpha-1 AR blocker use for pre-MET patients and SWL success despite our small sample size. We speculate that patients who underwent SWL after pre-MET represented those who were resistant to SWL, especially to stone passage. One possible mechanistic explanation is that such patients might have decreased ureteral peristalsis due to low expression of alpha-1 AR in their ureters [15], *i.e.*, a MET-resistant condition, and/or might have impacted stones, for which the effect of SWL is limited [16].

Our study has two important strengths. First, we adjusted for all the known and important confounding factors, including the ones detected on NCCT (patient age, stone length, localization of the calculus, MSD, and SSD). In addition, we had no missing data with respect to the confounders due to the rigorous data collection. Secondly, we investigated the purpose of the prescribed alpha-1 AR blockers in an additional analysis. To our knowledge, this is the first study to show that alpha-1 AR blockers administered to pre-MET patients had a negative impact on the success of a subsequent SWL. Despite these strengths, our study also has some limitations. First, our study is a single-center study. All the patients included were of Asian ethnicity, and were from a rural city (Onomichi). Therefore, further studies will be needed before our findings can be generalized to patients of different races or social backgrounds. Secondly, our study cannot help us identify the mechanism by which preoperative alpha-1 AR blockers decrease the treatment success rate of SWL. We need further studies to clarify the mechanism underlying our findings. Thirdly, although the most common waiting period of SWL was four weeks, we did not obtain either the actual waiting period of SWL or that of preoperative alpha-1 AR blocker medication. Therefore, we could not clarify the relationship among the duration of the waiting period, pre-MET, and SWL success. Finally, the prescribed dose of tamsulosin was lower than the standard (0.4 mg/day), because only 0.2 mg/day for benign prostatic hyperplasia is provided by the Japanese health insurance system.

Our study has a significant clinical implication. The negative influence of the alpha-1 AR blockers is so prominent (aOR 0.17 for SWL success) that, based on our findings, we recommend urologists pay more attention to the use of preoperative alpha-1 AR blockers when selecting treatment modalities. Subsequently, doing a URSL might be preferable to SWL. As mentioned above, future studies should focus on verifying our findings and discerning the mechanism behind them.

In conclusion, our findings suggest that the preoperative use of an alpha-1 AR blocker, especially for MET, was a negative predictor for treatment success of SWL in male patients with a single ureteral calculus. Therefore, urologists should pay more attention to the use of alpha-1 AR blockers when selecting a treatment modality in patients with a single ureteral calculus. Further studies are needed to validate and generalize our findings as well as to elucidate the mechanism of action of the alpha-1 AR blockers in this scenario.

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