Beni-Suef University Journal of Basic and Applied Sciences

RESEARCH

Open Access

Relief of double-J stent-related symptoms: a comparison between mirabegron, tamsulosin and solifenacin

Akrm A. Elmarakbi[1], Osama M. Elsayed[1], Tamer R. Mohamed[1] and Amr M. Lotfy[1*]

Abstract

Background Inserting ureteral stents is a routine intervention that often results in problems. The cornerstone for treating stent-related symptoms is pharmacological therapy. This study was conducted to evaluate and to compare the effectiveness of mirabegron, tamsulosin, solifenacin and control in reducing double-J stent-related symptoms.

Results Patients were evaluated preoperatively, one week after stent insertion and two weeks after the start of medications by the Ureteral Stent Symptom Questionnaire (USSQ), International Prostate Symptom Score (IPSS), overactive bladder questionnaire (OAB-q) and visual analogue pain scale (VAPS). Solifenacin and mirabegron groups had significantly lower sexual scores after the 1st and 2nd weeks post-operatively (PO) when compared with the control group. Mirabegron group had significantly lower sexual scores after 1st and 2nd weeks PO when compared with patients in tamsulosin and solifenacin groups. Patients in mirabegron group had significantly fewer additional problems after the 1st and 2nd weeks PO when compared with patients in the control and tamsulosin groups.

Conclusions To sum up, mirabegron was found to be superior to solifenacin in lowering urinary symptoms scores, sexual performance scores and work performance scores at both first and second weeks post-operatively. Mirabegron is a good alternative choice for SRSs when tamsulosin or solifenacin is ineffective or not tolerated.

Keywords Mirabegron, Tamsulosin, Solifenacin, Lower urinary tract symptoms, Visual analogue pain scale

1 Background

Double-J stents (DJS) are crucial to avoid or treat ureteral blockage [1, 2]. However, some patients may have stent-related morbidities including urinary tract infections (UTI), lower urinary tract symptoms (LUTS), general or pelvic discomfort and hematuria. In both men and women, such morbidities represent a prevalent problem with significant impacts on life quality, sexual matters, general health situation and regular work performance [3]. Stent length, girth modification and avoiding the distal end crossing the midline are crucial and considerably lessen the discomfort associated with stents [4].

Tamsulosin is a medication that specifically inhibits alpha-1a/1d receptors; it works on the contracting smooth muscles of the distal ureter, bladder trigone and bladder neck [5]. Relaxing these smooth muscles is thought to reduce voiding pressure and bladder outlet resistance, which has a beneficial effect in relieving LUTS related to DJ stents [6].

Solifenacin is a medication that specifically blocks the M1/M3 cholinergic receptors. It is prescribed to treat patients with overactive bladder (OAB) and may be beneficial for relieving stent-related symptoms [7, 8].

Alpha blockers and antimuscarinics may have adverse effects. Alpha blockers may lead to postural hypotension,

*Correspondence:
Amr M. Lotfy
alamrlotfy@gmail.com
[1] Urology department, Faculty of Medicine, Beni-Suef University, Beni-Suef Governorate, Egypt

asthenia, headache and ejaculatory abnormalities [9]. Antimuscarinics might result in dry mouth, constipation, disorientation, headache and an elevated risk of urine retention [10].

Mirabegron is a selective β3-adrenergic receptor agonist agent; it has a favorable safety profile and higher tolerability than antimuscarinics. Headache, hypertension and dry mouth are only experienced by a small number of patients [11]. Recently, mirabegron has demonstrated efficacy in relieving SRSs [3].

This study aimed to evaluate and to compare the effectiveness of mirabegron, tamsulosin, solifenacin in reducing double-J SRSs.

2 Methods

This prospective cohort study (observations on already operated subjects) was performed in June 2020 in Urology Outpatient Clinic our University Hospital. Patients who underwent temporary ureteral stent placement were assessed for eligibility to the study.

2.1 Inclusion criteria

Patients aged > 18-year planning ureteral stenting for > 5 days and experienced double-J SRSs.

2.2 Exclusion criteria

Patients with bilateral stents. History of bladder or prostate surgery. Patients with contraindications for receiving either tamsulosin or mirabegron or solifenacin (i.e. end-stage renal disease, urinary retention, orthostatic hypotension, known QT prolongation, uncontrolled hypertension, severe aortic regurgitation), significant cognitive impairment, presence of neurogenic bladder, OAB syndrome, in addition to active urinary tract infection.

2.3 Methodology

A total of 200 patients with 6F polyurethane D-J stent were included in this study. The surgeon markings on the ureteric catheter that was inserted from the ureteral orifice to the renal pelvis were used to estimate the proper stent length in each patient. Patients were selected as four groups of 50 each; patients in group one served as controls and did not take any medications (control non-exposed arm). Patients in group two received 0.4 mg tamsulosin once daily, while those in group three patients received 5 mg solifenacin once daily, and those in group four received 50 mg mirabegron once daily. The medications were taken one week after stent placement for those who experienced DJ-related symptoms till removal of the stent.

The researchers observed patients preoperatively, one week after stent insertion and two weeks after the start of medications, by filling out the validated USSQ, the IPSS, OAB-q and VAPS questionnaire forms.

2.4 Perioperative assessment

The researchers obtained the history of all patients' demographics including age and sex from patient records. Then they recorded the operative details including indication of ureteric stenting, laterality and length of the stents used. Urine analysis and culture were performed to ensure that patients have sterile urine before the procedure. KUB was done before discharge to confirm the exact position of the stent. Urine analysis was done to exclude any existing infection. The patients were discharged when they were vitally stable and after removal of the urethral catheter.

2.5 Sample size

Using the G*Power 3.1.9.4 program, the sample size was determined to be 212 for the necessary sample and 220 for any data loss. Selected people were then randomly assigned to the study's four groups.

2.6 Statistical data analysis

SPSS for Windows, version 23, was used to tabulate, code and analyze the data that had been obtained. Categorical data were reported as percentages, whereas continuous variables were shown as mean values standard deviation (SD). Chi-square test and Fisher test were used to compare qualitative data. Independent sample t test was used to compare groups in quantitative data. Appropriate statistical tests of significance were utilized for further statistical analysis. Statistics were deemed significant for P values under 0.05.

3 Results

The results of demographic and anthropometric data are recorded in Table 1. The clinical data showed insignificant difference between the four studied groups as shown in Table 2. In the present study, patients in solifenacin and mirabegron groups had significantly lower urinary symptoms scores 1 week post-operative as well as 2 weeks post-operative (Table 3) when compared with patients in control group ($P < 0.001$ for both). Moreover, patients in solifenacin and mirabegron groups had significantly lower urinary symptoms scores 1 week post-operative as well as 2 weeks post-operative when compared with patients in tamsulosin group ($P < 0.001$ for both). Regarding pain score, patients in solifenacin and mirabegron groups had significantly lower body pain 1 week post-operative as well as 2 weeks post-operative when compared with patients in control group ($P < 0.001$ for both) (Table 4). Patients in solifenacin and mirabegron groups in the present study

Table 1 Comparison of demographic, anthropometric data and stent length between the studied. groups

	Control group Mean ± SD	Tamsulosin group Mean ± SD	Solifenacin group Mean ± SD	Mirabegron group Mean ± SD	*P* value
Gender					
Female	14 (28.0%)	17 (34.0%)	10 (20.0%)	19 (38.0%)	
Male	36 (72.0%)	33 (66.0%)	40 (80.0%)	31 (62.0%)	0.223
Age	45.54 ± 16.05	43.72 ± 16.27	51.12 ± 16.52	52.48 ± 15.82	**0.018***
Patient height	166.42 ± 7.20	166.14 ± 6.55	161.84 ± 10.18	166.76 ± 11.16	**0.021***
Stent length	22.28 ± 0.70	22.24 ± 0.66	22.08 ± 0.40	22.00 ± 0.00	**0.023***

Post hoc *P* value

	Control vs Tamsulosin	Control vs Solifenacin	Control vs Mirabegron	Tamsulosin vs Solifenacin	Tamsulosin vs Mirabegron	Solifenacin vs Mirabegron
Age	1.000	0.516	0.198	0.139	**0.044***	1.000
Patient height	1.000	0.070	1.000	0.106	1.000	**0.041***
Stent length	1.000	0.334	**0.046***	0.751	0.131	1.000

P values less than 0.05 were considered as statistically significant, *SD* standard deviation

Table 2 Comparison of clinical data between the 4 studied groups

	Control group Count (%)	Tamsulosin group Count (%)	Solifenacin group Count (%)	Mirabegron group Count (%)	*P* value
Laterality					
Left	20 (40.0)	19 (38.0)	25 (50.0)	22 (44.0)	0.634
Right	30 (60.0)	31 (62.0)	25 (50.0)	28 (56.0)	
Indication of stenting					
1	28 (56.0)	29 (58.0)	34 (68.0)	33 (66.0)	0.682
2	18 (36.0)	14 (28.0)	13 (26.0)	12 (24.0)	
3	4 (8.0)	7 (14.0)	3 (6.0)	5 (10.0)	
Urine analysis & urine culture pre-stenting					
Positive	4 (8.0)	3 (6.0)	4 (8.0)	2 (4.0)	0.921
Negative	46 (92.0)	47 (94.0)	46 (92.0)	48 (96.0)	
Urine analysis & urine culture post-stenting					
Positive	5 (10.0)	3 (6.0)	2 (4.0)	0 (0.0)	0.150
Negative	45 (90.0)	47 (94.0)	48 (96.0)	50 (100.0)	

P values less than 0.05 were considered as statistically significant, SD: standard deviation

had significantly lower body pain 1 week post-operative as well as 2 weeks post-operative when compared with patients in tamsulosin group ($P=0.026$ for both and $P=0.012$ for both, respectively). General health index scores are recorded in Table 5. Patients in solifenacin and mirabegron groups had significantly lower general health index scores 1 week post-operative as well as 2 weeks post-operative when compared with patients in control group ($P=0.003$ for both and $P<0.001$ for both, respectively). In addition, no significant difference was reported between patients in solifenacin and tamsulosin groups regarding general health either 1 week or 2 weeks post-operative. It is worth noting that patients in mirabegron group had significantly lower general health index scores 1 week post-operative as well as 2 weeks post-operative when compared with patients in tamsulosin group ($P=0.012$ for both). Work performance score results are recorded in Table 6. Patients in mirabegron group had significantly lower work performance scores 1 week post-operative as well as 2 weeks post-operative when compared with patients in control and solifenacin groups ($P<0.001$ for both and $P=0.050$ for both, respectively). Regarding sexual scores

Table 3 Comparison of urinary symptoms between the 4 studied groups

	Control group Mean ± SD	Tamsulosin group Mean ± SD	Solifenacin group Mean ± SD	Mirabegron group Mean ± SD	*P* value
Urinary symptoms (preoperative)	28.30 ± 8.59	31.28 ± 4.43	29.96 ± 4.08	29.98 ± 2.94	0.060
Urinary symptoms (1 week PO)	23.76 ± 7.10	21.94 ± 2.89	17.40 ± 3.30	14.26 ± 1.94	**< 0.001***
Urinary symptoms (2 weeks PO)	23.56 ± 6.11	21.64 ± 2.84	17.43 ± 3.35	14.20 ± 1.92	**< 0.001***

Post hoc *P* value

	Control vs Tamsulosin	Control vs Solifenacin	Control vs Mirabegron	Tamsulosin vs Solifenacin	Tamsulosin vs Mirabegron	Solifenacin vs Mirabegron
Urinary symptoms (1 week PO)	0.209	**< 0.001***	**< 0.001***	**< 0.001***	**< 0.001***	**0.002***
Urinary symptoms (2 weeks PO)	0.207	**< 0.001***	**< 0.001***	**< 0.001***	**< 0.001***	**0.002***

Bold and asterisk indicates statistically significant data

P values less than 0.05 were considered as statistically significant, *PO* post-operative, *SD* standard deviation

Table 4 Comparison of body pain between groups

	Control group Mean ± SD	Tamsulosin group Mean ± SD	Solifenacin group Mean ± SD	Mirabegron group Mean ± SD	*P* value
Body pain (pre-operative)	14.14 ± 14.34	16.98 ± 15.39	17.50 ± 14.06	19.54 ± 13.27	0.305
Body pain (1 week PO)	11.60 ± 12.74	8.60 ± 12.28	2.69 ± 8.22	2.19 ± 6.55	**< 0.001***
Body pain (2 weeks PO)	11.71 ± 12.70	8.67 ± 12.28	2.66 ± 8.12	2.17 ± 6.65	**< 0.001***

Post hoc *P* value

	Control vs Tamsulosin	Control vs Solifenacin	Control vs Mirabegron	Tamsulosin vs Solifenacin	Tamsulosin vs Mirabegron	Solifenacin vs Mirabegron
Body pain (1 week PO)	0.820	**< 0.001***	**< 0.001***	**0.026***	**0.012***	1.000
Body pain (2 weeks PO)	0.810	**< 0.001***	**< 0.001***	**0.026***	**0.012***	1.000

Bold and asterisk indicates statistically significant data

P values less than 0.05 were considered as statistically significant, *PO* post-operative, *SD* standard deviation

(Table 7), patients in solifenacin group had significantly lower sexual scores 1 week post-operative as well as 2 weeks post-operative when compared with patients in control group ($P = 0.001$ for both and $P < 0.001$ for both, respectively). Patients in mirabegron group had significantly lower sexual performance 1 week post-operative as well as 2 weeks post-operative when compared with patients in tamsulosin and solifenacin groups ($P < 0.001$ for both and $P = 0.004$ for both, respectively). Patients in mirabegron group in the current study had significantly lower additional problems 1 week post-operative as well as 2 weeks post-operative when compared with patients in tamsulosin group ($P = 0.009$ for both) (Table 8).

4 Discussion

The use of indwelling DJ stents, a frequent urological technique, has seen an increase in justifications in the era of minimally invasive procedures. It is very important to avoid or treat ureteral obstruction in a variety of circumstances. However, during the stenting phase, this intervention is often linked to stent-related symptoms (SRS), which are responsible for patients' pain and have a detrimental impact on quality of life [12].

Table 5 Comparison of general health between groups

	Control group Mean ± SD	Tamsulosin group Mean ± SD	Solifenacin group Mean ± SD	Mirabegron group Mean ± SD	*P* value
General health (preoperative)	12.40 ± 7.26	11.72 ± 6.66	11.74 ± 4.98	11.44 ± 2.76	0.857
General health (1 week PO)	11.24 ± 6.52	10.28 ± 5.17	8.26 ± 2.75	6.54 ± 0.86	**< 0.001***
General health (2 weeks PO)	11.44 ± 6.50	10.18 ± 5.16	8.36 ± 2.73	6.53 ± 0.82	**< 0.001***
Post hoc *P* value					
	Control vs Tamsulosin	**Control vs Solifenacin**	**Control vs Mirabegron**	**Tamsulosin vs Solifenacin**	**Tamsulosin vs Mirabegron**	**Solifenacin vs Mirabegron**
General health (1 week PO)	1.000	**0.003***	**< 0.001***	0.180	**< 0.001***	0.234
General health (2 weeks PO)	1.000	**0.003***	**< 0.001***	0.182	**< 0.001***	0.240

Bold and asterisk indicates statistically significant data

P values less than 0.05 were considered as statistically significant, *PO* post-operative, *SD* standard deviation

Table 6 Comparison of work performance between groups

	Control group Mean ± SD	Tamsulosin group Mean ± SD	Solifenacin group Mean ± SD	Mirabegron group Mean ± SD	*P* value
Work performance (preoperative)	9.50 ± 3.69	9.72 ± 4.15	9.10 ± 3.22	9.70 ± 2.92	0.802
Work performance (1 week PO)	9.18 ± 3.34	9.16 ± 3.93	8.48 ± 2.98	6.68 ± 1.96	**< 0.001***
Work performance (2 weeks PO)	9.28 ± 3.54	9.26 ± 3.73	8.38 ± 2.88	6.88 ± 1.91	**< 0.001***
Post hoc *P* value					
	Control vs Tamsulosin	**Control vs Solifenacin**	**Control vs Mirabegron**	**Tamsulosin vs Solifenacin**	**Tamsulosin vs Mirabegron**	**Solifenacin vs Mirabegron**
Work performance (1 week PO)	1.000	0.859	**< 0.001***	0.543	**< 0.001***	**0.050***
Work performance (2 weeks PO)	1.000	0.960	**< 0.001***	0.550	**< 0.001***	**0.050***

Bold and asterisk indicates statistically significant data

P values less than 0.05 were considered as statistically significant, *PO* post-operative, *SD* standard deviation

Alpha blockers and antimuscarinics are the cornerstones of pharmaceutical therapy of SRSs. It is believed that alpha blockers may reduce voiding pressures and reflux by relaxing the smooth muscles in the ureter, trigonal and prostatic regions [13]. Antimuscarinics work by similar processes to those used to treat overactive bladder (OAB) by decreasing bladder spasms [7]. A beta-3 adrenoceptor agonist called mirabegron is authorized for use in treating OAB patients [14].

The mucosa and muscle layers of the bladder as well as the ureter express beta-3 adrenoceptors. Therefore, it is anticipated that beta-3 agonists would reduce SRSs via comparable processes. Alpha blockers and antimuscarinics, however, have related adverse effects. Alpha blockers may induce postural hypotension, asthenia, headaches and ejaculatory abnormalities, while antimuscarinics may result in dry mouth, constipation, disorientation, headaches and a higher risk of urine retention [15].

In contrast, mirabegron has a superior safety record and tolerance than antimuscarinics; only a small proportion of patients experience headache, hypertension, or dry mouth [14]. Mirabegron has shown efficacy in

Table 7 Comparison of sexual performance between groups

	Control group Mean ± SD	Tamsulosin group Mean ± SD	Solifenacin group Mean ± SD	Mirabegron group Mean ± SD	*P* value
Sexual (pre-operative)	5.44 ± 1.05	5.24 ± 1.02	5.60 ± 1.46	5.58 ± 1.23	0.416
Sexual (1 week PO)	5.36 ± 1.16	5.07 ± 0.73	4.54 ± 1.03	3.68 ± 1.40	**< 0.001***
Sexual (2 weeks PO)	5.26 ± 1.06	5.04 ± 0.83	4.34 ± 1.13	3.78 ± 1.30	**< 0.001***
Post hoc *P* value					
	Control vs Tamsulosin	**Control vs Solifenacin**	**Control vs Mirabegron**	**Tamsulosin vs Solifenacin**	**Tamsulosin vs Mirabegron**	**Solifenacin vs Mirabegron**
Sexual (1 week PO)	0.770	**0.001***	**< 0.001***	0.140	**< 0.001***	**0.004***
Sexual (2 weeks PO)	0.870	**0.001***	**< 0.001***	0.140	**< 0.001***	**0.004***

Bold and asterisk indicates statistically significant data

P values less than 0.05 were considered as statistically significant, *PO* post-operative, *SD* standard deviation

Table 8 Comparison of additional problems between groups

	Control Group Mean ± SD	Tamsulosin Group Mean ± SD	Solifenacin Group Mean ± SD	Mirabegron Group Mean ± SD	*P* value
Additional problems (pre-operative)	8.28 ± 3.17	8.56 ± 3.21	8.30 ± 2.87	8.42 ± 2.06	0.959
Additional problems (1 week PO)	8.12 ± 2.80	8.08 ± 2.95	7.26 ± 1.52	6.64 ± 1.01	**0.002***
Additional problems (2 weeks PO)	8.12 ± 1.83	8.04 ± 2.75	7.30 ± 1.02	6.60 ± 1.2	**0.002***
Post hoc *P* value					
	Control vs Tamsulosin	**Control vs Solifenacin**	**Control vs Mirabegron**	**Tamsulosin vs Solifenacin**	**Tamsulosin vs Mirabegron**	**Solifenacin vs Mirabegron**
Additional problems (1 week PO)	1.000	0.330	**0.006***	0.401	**0.009***	0.981
Additional problems (2 weeks PO)	1.000	0.329	**0.006***	0.403	**0.009***	0.993

Bold and asterisk indicates statistically significant data

P values less than 0.05 were considered as statistically significant, *PO* post-operative, *SD* standard deviation

treating SRSs [16]. There are currently published open-label trials comparing mirabegron to hydration and the combination of tamsulosin and solifenacin [3]. A control-controlled single-blinded study compared mirabegron to tamsulosin [17].

In the present study, patients in solifenacin group had significantly lower urinary symptoms scores 1 week post-operative as well as 2 weeks post-operative when compared with patients in control group ($P < 0.001$ for both). In agreement with our study, Dellis et al. [17] reported that patients receiving solifenacin expressed significantly lower urinary scores when compared with control group.

We noticed that patients in solifenacin group had significantly lower urinary symptoms scores 1 week post-operative as well as 2 weeks post-operative when compared with patients in tamsulosin group ($P < 0.001$ for both). In line with our study, El-Nahas et al. [18] demonstrated better efficacy in alleviating stent-related symptoms when compared with tamsulosin, while Dellis et al. [17]; Abdelaal et al. [19] studies revealed that solifenacin

and tamsulosin had equivalent outcomes in urinary index score.

The effectiveness of combining tamsulosin and solifenacin in treating SRS is becoming more and more clear. According to Jian et al. [20] meta-analysis, the most effective treatment for treating urinary symptoms was a combination of tamsulosin and solifenacin, followed by solifenacin and tamsulosin monotherapy.

Moreover, patients in mirabegron group in the current study had significantly lower urinary symptoms scores 1 week post-operative as well as 2 weeks post-operative when compared with patients in control group ($P<0.001$ for both). In agreement with our study, Galal et al. [12] in their study that compared patients who received mirabegron with patients who received no treatment as control group reported that the mirabegron group had significantly lower daytime frequency, nocturia and urgency.

Otsuki et al. [21], in contrast to our research, showed no significant difference for frequency and nocturia, and urgency levels in the USSQ urine symptom subscore were not substantially lower in the mirabegron group as compared to the control group. The authors hypothesized that increasing water consumption may have had an impact on patients undergoing ureteroscopy and having an indwelling ureteric stent, and that the accompanying polyuria may have decreased the reaction to the medication.

In the current study, patients in mirabegron group had significantly lower urinary symptoms scores 1 week post-operative as well as 2 weeks post-operative when compared with patients in tamsulosin group ($P<0.001$ for both). Also, patients in mirabegron group had significantly lower urinary symptoms scores 1 week post-operative as well as 2 weeks post-operative when compared with patients in solifenacin group ($P=0.002$ for both).

In agreement with our research, Sahin et al. [3] verified mirabegron as a single treatment with superior outcomes in treating OAB symptoms associated with DJ stents than other medications, since postoperative OAB-q levels in the tamsulosin group were greater than in the mirabegron group. The postoperative OAB-q value in the oral hydration group was 29, tamsulosin 23 and mirabegron 18, respectively. Their results also demonstrate that mirabegron can improve OAB-q results.

Regarding comparison between mirabegron and tamsulosin, Yavuz et al. [16] control-controlled study reported that while mirabegron has no impact on ureteral stent-related symptoms, it does reduce the demand for analgesics. Tamsulosin only alleviates urine symptoms caused by the ureteral stent while increasing the need for analgesics.

Our results do not line up with those of Chandna et al. [14], who found mirabegron to be on par with solifenacin and tamsulosin in terms of urine index score at 10 days and 4 weeks after ureteric stent installation. But when the urine index score's subscores for storage symptoms were evaluated, mirabegron and solifenacin both showed considerably lower scores than tamsulosin at the second visit and over the course of four weeks, indicating their superiority. The discrepancy may be ascribed to the research by Chandna et al. [14] having a longer period of follow-up.

In disagreement with our study, Alexander et al. [22] reported that in groups with tamsulosin 5 mg/day treatment compared with mirabegron 50 mg/day gives a good effect in lowering the complaint score lower urinary tract symptoms for four weeks post-installation of double-J (DJ) stent, urinary symptoms concluding that tamsulosin therapy compared with mirabegron can effectively cure complaints of post-installation lower urinary tract symptoms. The difference can be attributed to smaller sample size in Alexander [22] study (25 patients in each group in Alexander study [22] vs 50 patients in our study).

We noticed that patients in solifenacin group had significantly lower body pain 1 week post-operative as well as 2 weeks post-operative when compared with patients in control group ($P<0.001$ for both). In line with our study, Dellis et al. [17] reported that patients receiving solifenacin expressed significantly lower pain when compared with control group.

We found that patients in mirabegron group had significantly lower body pain 1 week post-operative as well as 2 weeks post-operative when compared with patients in control group ($P<0.001$ for both). This was in line with what Galal et al. [12] reported, as for stent-related pain, mirabegron group had significantly less flank and abdominal pain. Additionally, Yavuz et al. [16] discovered that the control group's analgesic need was higher than that of the mirabegron group's. Furthermore, mirabegron reportedly reduced body and total pain ratings, according to Tae et al. study [15].

Patients in solifenacin group in the present study had significantly lower body pain 1 week post-operative as well as 2 weeks post-operative when compared with patients in tamsulosin group ($P=0.026$ for both). In line with our study, El-Nahas et al. [18] reported superiority of solifenacin over tamsulosin in relieving pain, albeit.

In contrast, Chandna et al. [14] reported comparable pain index score at both visits across mirabegron, solifenacin and tamsulosin groups. The difference can be attributed to longer duration of follow-up in Chandna et al. [14] study.

Moreover, solifenacin was found to be comparable with tamsulosin and alfuzosin in Jian et al. [20] meta-analysis.

Moreover, we found that patients in mirabegron group had significantly lower body pain 1 week post-operative

as well as 2 weeks post-operative when compared with patients in tamsulosin group ($P=0.012$ for both). In agreement with our study, Yavuz et al. [16] reported that patients in mirabegron group had less need for analgesics when compared with patients in tamsulosin group. Moreover, a significant improvement in pain index score for mirabegron over control was noted by Tae et al. [15]. On the other hand, Yavuz et al. [16] demonstrated comparable pain index score scores but lower analgesic requirement for mirabegron and tamsulosin over control.

In discordance with our study, Alexander et al. [22] reported that in groups with tamsulosin 5 mg/day treatment compared with mirabegron 50 mg/day gives a significantly better effect in lowering the pain. The difference can be attributed to the smaller sample size in Alexander study [22].

In the present study, patients in solifenacin group had significantly lower general health index scores 1 week post-operative as well as 2 weeks post-operative when compared with patients in control group ($P=0.003$ for both). In agreement, Dellis et al. [17] reported that patients receiving solifenacin expressed significantly lower general health index scores.

In the current study, no significant difference was reported between patients in solifenacin and tamsulosin groups regarding general health either 1 week or 2 weeks post-operative. Similarly, superiority of solifenacin over tamsulosin was not observed in Chandna et al. [14] study. On the contrary, Jian et al. [20] demonstrated lower general health index score with solifenacin monotherapy over tamsulosin.

Patients in mirabegron group in the current study had significantly lower general health index scores 1 week post-operative as well as 2 weeks post-operative when compared with patients in control group ($P<0.001$ for both). On the contrary, Tae et al. [15] found no significant differences in the general health index score between mirabegron and control groups.

Moreover, we found that patients in mirabegron group had significantly lower general health index scores 1 week post-operative as well as 2 weeks post-operative when compared with patients in tamsulosin group ($P=0.012$ for both). This was in agreement with Chandna et al. [14] study, patients in the mirabegron group illustrated significantly better general health index score in Chandna et al. [14] study, at the 1st visit and over 4 weeks of follow-up as well as well as less side effects as compared to the other drugs may account for better general health in these patients.

In our study, patients in mirabegron group had significantly lower work performance scores 1 week post-operative as well as 2 weeks post-operative when compared with patients in control group ($P<0.001$ for both). In line with our finding, Galal et al. [12] reported that mirabegron versus control group showed significant difference in mean quality of life scores during the stenting period. On the contrary, Tae et al. [15] found no significant differences in the work performance score between mirabegron and control groups.

Moreover, the current study reported that patients in mirabegron group had significantly lower work performance 1 week post-operative as well as 2 weeks post-operative when compared with patients in solifenacin group ($P=0.050$ for both). In concordance with our study, Palinrungi [23] reported that when mirabegron 50 mg/day and therapy with 5 mg/day of solifenacin were compared, the latter had significantly superior results in terms of reducing work activity score (2.08 vs. 2.04, $P=0.044$).

Patients in mirabegron group had significantly lower work performance 1 week post-operative as well as 2 weeks post-operative when compared with patients in tamsulosin group ($P<0.001$ for both). In discordance with our study, work performance index score was comparable across the mirabegron, solifenacin and tamsulosin groups in Chandna et al. [14] study. The difference can be attributed to the longer duration of follow-up in Chandna et al. [14] study (4 weeks).

According to the present study, patients in solifenacin group had significantly lower sexual scores 1 week post-operative as well as 2 weeks post-operative when compared with patients in control group ($P=0.001$ for both). This was in line with what Dellis et al. [17] reported, as sexual life was positively influenced in patients receiving solifenacin.

Moreover, we noticed that patients in mirabegron group had significantly lower sexual scores 1 week post-operative as well as 2 weeks post-operative when compared with patients in control group ($P<0.001$ for both). The mirabegron group scored lower than the control group in Tae's et al. [15] research when comparing sexual activity to the percentage of stent-related sexual abstention, although the difference was not statistically significant. The Tae et al. [15] research's lack of statistical significance may be attributable to its lower sample size than our investigation (only 45 patients).

According to the present study, patients in mirabegron group had significantly lower sexual performance 1 week post-operative as well as 2 weeks post-operative when compared with patients in tamsulosin group ($P<0.001$ for both). Moreover, patients in mirabegron group had significantly lower sexual performance 1 week post-operative as well as 2 weeks post-operative when compared with patients in Solifenacin group ($P=0.004$ for both). Contrary to our research, the research by Chandna et al. [14] found that sexual scores and other factors

were similar among the three groups. At 10 days, sexual abstinence was noted in 83.3 percent of tamsulosin arm patients, 69.6 percent of solifenacin arm patients and 57.7 percent of mirabegron arm patients, with no discernible difference between the 3 groups.

Subjects in mirabegron group in the current study had significantly lower additional problems 1 week post-operative as well as 2 weeks post-operative when compared with patients in tamsulosin group ($P=0.009$ for both). In disagreement with our study, Alexander et al. [22] reported superiority of tamsulosin over mirabegron in reduction of additional problems. The difference can be attributed to the smaller sample size in Alexander study [22].

Furthermore, additional matters were comparable across the mirabegron, solifenacin and tamsulosin groups in Chandna et al. [14] study. The difference can be attributed to longer duration of follow-up in Chandna et al. [14] study.

5 Conclusion

In comparison with tamsulosin, solifenacin and mirabegron significantly lowered urinary symptoms scores, and body pain score 1 week post-operative as well as 2 weeks post-operative. In comparison with tamsulosin, mirabegron was found to significantly lower additional problems, sexual performance scores, general health index scores and work performance scores 1 week post-operative as well as 2 weeks post-operative. Finally, mirabegron was found to be superior to solifenacin in lowering urinary symptoms scores, sexual performance scores and work performance scores 1 week post-operative as well as 2 weeks post-operative that makes its use a good alternative choice for SRSs when tamsulosin or solifenacin is ineffective or not tolerated.

Abbreviations

DJS	Double-J stents
IPSS	International Prostate Symptom Score
LUTS	Lower urinary tract symptoms
OAB	Overactive bladder
OAB-q	Overactive bladder questionnaire
PO	Post-operatively
SD	Standard deviation
SRS	Stent-related symptoms
USSQ	Ureteral Stent Symptom Questionnaire
UTI	Urinary tract infections
VAPS	Visual analogue pain scale

Acknowledgements

Not applicable.

Author contributions

AL helped in sampling, performing the experiments, data analysis, preparing the first draft of the manuscript. AE was involved in supervision and revision of the manuscript. OE contributed to supervision, data analysis and revision of the manuscript. TRM helped in conceptualization, supervision, data analysis and preparing and revising the manuscript. All authors have read and approved the final manuscript.

Funding

None.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The Research Ethical Committee of Faculty of Medicine, Beni-Suef University, has given the approval on conducting the present research. The written informed consent was obtained from all study patients. All of the study participants received information about the research's protocols as well as information about their ability to decline participation or to withdraw from the study without providing a reason. Participants received a promise of anonymity, and all information was handled in confidence. The necessary administrative requirements were met. Prior to starting the study, the research ethics committee (REC) for the faculty of medicine at Beni-Suef University was consulted.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Received: 10 June 2023 Accepted: 20 May 2024
Published online: 24 June 2024

References

1. Williams KG, Blacker AJ, Kumar P (2018) Ureteric stents: the past, present and future. J Clin Urol 11(4):280–284
2. Geavlete P, Georgescu D, Mulțescu R, Stanescu F, Cozma C, Geavlete B (2021) Ureteral stent complications–experience on 50,000 procedures. J Med Life 14(6):769
3. Sahin A, Yildirim C, Yuksel OH, Ürkmez A (2020) Treatment of ureteral catheter related symptoms; mirabegron versus tamsulosin/solifenacin combination: a randomized controlled trial. Arch Esp Urol 73(1):54–59
4. Rane A, Saleemi A, Cahill D, Sriprasad S, Shrotri N, Tiptaft R (2001) Have stent-related symptoms anything to do with placement technique? J Endourol 15(7):741–745
5. Ho CH, Chen SC, Chung SD, Lee YJ, Chen J, Yu HJ et al (2008) Determining the appropriate length of a double-pigtail ureteral stent by both stent configurations and related symptoms. J Endourol 22:1427–1431
6. Khullar V, Amarenco G, Angulo JC, Cambronero J, Høye K, Milsom I, Radziszewski P, Rechberger T, Boerrigter P, Drogendijk T, Wooning M (2013) Efficacy and tolerability of mirabegron, a β3-adrenoceptor agonist, in patients with overactive bladder: results from a randomised European-Australian phase 3 trial. Eur Urol 63(2):283–295
7. Lee YJ, Huang KH, Yang HJ, Chang HC, Chen J, Yang TK (2013) Solifenacin improves double-J stent-related symptoms in both genders following uncomplicated ureteroscopic lithotripsy. Urolithiasis 41:247–252
8. Vardy MD, Mitcheson HD, Samuels TA, Wegenke JD, Forero-Schwanhaeuser S, Marshall TS, He W (2009) Effects of solifenacin on overactive bladder symptoms, symptom bother and other patient-reported outcomes: results from VIBRANT–a double-blind, placebo-controlled trial. Int J Clin Pract 63(12):1702–1714
9. Lepor H (2016) Alpha-blockers for the treatment of benign prostatic hyperplasia. Urol Clin 43(3):311–323
10. Pelman RS, Capo JP Jr, Forero-Schwanhaeuser S (2008) Solifenacin at 3 years: a review of efficacy and safety. Postgrad Med 120(2):85–91
11. Deeks ED (2018) Mirabegron: a review in overactive bladder syndrome. Drugs 78(8):833–844
12. Galal E, Abdelhamid MH, El-Bab TF, Abdelhamid A (2021) The role of mirabegron in relieving double-J stent-related discomfort: a randomized controlled clinical trial. Central Eur J Urol 74(1):76–80

13. Lange D, Bidnur S, Hoag N, Chew BH (2015) Ureteral stent-associated complications—where we are and where we are going. Nat Rev Urol 12(1):17–25
14. Chandna A, Kumar S, Parmar KM, Sharma AP, Devana SK, Mete UK, Singh SK (2021) Comparison of stent related symptoms in patients taking mirabegron, solifenacin, or tamsulosin: a double blinded randomized clinical trial. Urol J. 03915603211048153.
15. Tae BS, Cho S, Jeon BJ, Choi H, Park JY, Cho SY, Lee KC, Bae JH (2018) Does mirabegron relieve ureteric stent-related discomfort? A prospective, randomized, multicentre study. BJU Int 122(5):866–872
16. Yavuz A, Kilinc MF, Aydin M, Ofluoglu Y, Bayar G (2021) Does tamsulosin or mirabegron improve ureteral stent-related symptoms: a prospective control-controlled study. LUTS Lower Urin Tract Symp 13(1):17–21
17. Dellis AE, Papatsoris AG, Keeley FX Jr, Bamias A, Deliveliotis C, Skolarikos AA (2017) Tamsulosin, solifenacin, and their combination for the treatment of stent-related symptoms: a randomized controlled study. J Endourol 31(1):100–109
18. El-Nahas AR, Tharwat M, Elsaadany M, Mosbah A, Gaballah MA (2016) A randomized controlled trial comparing alpha blocker (tamsulosin) and anticholinergic (solifenacin) in treatment of ureteral stent-related symptoms. World J Urol 34(7):963–968
19. Abdelaal AM, Al-Adl AM, Abdelbaki SA, Al Azab MM, Al Gamal KA (2016) Efficacy and safety of tamsulosin oral-controlled absorption system, solifenacin, and combined therapy for the management of ureteric stent-related symptoms. Arab J Urol 14(2):115–122
20. Jian Z, Chen Y, Liu Q, Liao B, Yang T, Li H, Wang K (2019) Combination of solifenacin and tamsulosin may provide additional beneficial effects for ureteral stent-related symptoms—outcomes from a network meta-analysis. World J Urol 37(2):289–297
21. Otsuki H, Yamasaki T, Hori S, Aoki H, Kosaka T, Uehara S, Fujio K (2020) The efficacy of mirabegron for the relief of ureteral stent-related symptoms. Acta Med Okayama 74(2):145–150
22. Alexander K, Palinrungi AM, Palinrungi MA, Kholis K, Syahrir S, Faruk M (2020) Effectiveness of tamsulosin compared with mirabegron in treatment of double-J stent-related lower urinary tract symptoms. Int J Med Rev Case Rep 4(8):8
23. Palinrungi MA (2020) Effectiveness of using Solifenacin compared to Mirabegron after double-J stent installation for treatment of lower urinary tract symptoms (LUTS)

Publisher's Note