Assessment of urology postgraduate trainees' competencies in flexible ureteroscopic stone extraction

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Abstract

Introduction: We aimed to assess flexible ureteroscopic stone extraction skill of urology postgraduate trainees (PGTs) at an Objective Structured Clinical Examination (OSCE) and to determine whether previous experience in the operating theatre or practice on the simulator correlated with performance.
Methods: After obtaining ethics approval, PGTs from postgraduate years (PGYs) 3–5 were recruited from all four Quebec urology training programs during an OSCE. After a short orientation to the UroMentor™ simulator, PGTs were asked to perform Task 10 for 15 minutes, where two small stones from the left proximal ureter and renal pelvis were extracted using a basket. Competency of PGTs in performing the task was assessed using objective assessment from the simulator and subjective evaluations using Ureteroscopy-Global Rating Scale (URS-GRS). Simulator performance reports and URS-GRS scores were analyzed.
Results: Thirty PGTs (9 PGY-3, 11 PGY-4, 10 PGY-5) participated in this study. PGTs had performed a mean of 55.9 semi-rigid and 45.7 flexible ureteroscopies prior to the study. Mean URS-GRS score of the participants was 20.0±4.4. Using norm-referenced method with three experts, cutoff score of 19 on the URS-GRS was determined to indicate competency. Sixty percent (18/30) of PGTs were competent. All eight PGTs who had practiced on the simulator were competent. Previous experience in the operating theatre and PGY level did not correlate with performance.
Conclusions: This study confirmed the feasibility of incorporating the UroMentor at OSCEs to assess competency of urology PGTs in ureteroscopic stone extraction skill. PGTs who practiced on the simulator scored significantly higher than those who did not practice; however, the software needs to be updated to improve its face validity and to include more complex tasks, such as holmium laser lithotripsy. Future studies with larger sample sizes and more complex cases are needed to confirm these results.

Introduction

Nephrolithiasis is a common medical problem affecting 1 out of 11 people [1]. Flexible ureteroscopic lithotripsy is considered the gold standard for management of most ureteral and some renal stones [2, 3]. Therefore, achieving competency in flexible ureteroscopic lithotripsy is crucial for urology Post-Graduate Trainees (PGTs). Simulators provide a safe environment and objective assessment of PGTs' performance. Accordingly, several simulators have been incorporated in Objective Structured Clinical Examinations (OSCEs) to assess competency of PGTs in minimally-invasive urological procedures [4-10]. However, there are no studies examining competency of PGTs in performing flexible ureteroscopic stone extraction at OSCEs.

UroMentor^{TM} simulator (*Simbionix, Cleveland, Ohio, USA*) is a virtual reality simulator which incorporates a physical model with computer interface. Previous studies have shown face [11], content, construct [12], concurrent [13], and predictive validity [14] of the UroMentor^{TM} simulator for flexible ureteroscopy. We have previously used the validated Ureteroscopy-Global Rating Scale (URS-GRS) tool to demonstrate that skills obtained on the UroMentor^{TM} simulator (task #10) could be transferred to the operating room (OR) (predictive validity of the URS-GRS score when combined with the UroMentor^{TM} simulator)[15, 16]. However, there are no studies examining the use of this simulator in assessing competency of PGTs in performing flexible ureteroscopic stone extraction at OSCEs. Therefore, the first aim of the present study was to assess whether the UroMentor^{TM} simulator could be used during an OSCE to assess flexible ureteroscopic stone-extraction skill of urology PGTs. The second objective was to determine whether previous experience in performing this task on the simulator or in the OR would correlate with performance at OSCEs.

Methods

This study was conducted after obtaining ethics approval (No. A11-E86-14A) and informed consents from all participants. During a semi-annual OSCE held on October 29, 2016, urology PGTs from Post-Graduate Years (PGY) 3 to 5 from all four Quebec urology training programs were recruited to participate in this study. The OSCE consisted of 15 stations of 17 minutes each, one of which was a station to assess flexible ureteroscopic stone-extraction skill using the UroMentor^{TM} simulator.

At the start of the simulator station, each participant filled out a questionnaire regarding age, gender, handedness, training program, PGY level, previous experience in performing endourologic procedures, and previous practice on the UroMentor^{TM} simulator. All PGTs had previous operative experience in flexible ureteroscopy. Nevertheless, the simulator was introduced to all participants to orient them. Then, written instructions were presented to PGTs to perform Task 10 for 15 minutes. Task 10 requires the use of a rigid cystoscope to enter the bladder and place a guidewire into the left ureteral orifice (UO). Next, under fluoroscopic guidance, a flexible ureteroscope is used to extract two small stones from the left proximal ureter and renal pelvis with a stone basket, which is operated by an assistant (Figure 1). Finally, a complete examination of the left renal calyces is performed. Several objective parameters were generated by the simulator, such as operative time, fluoroscopy time, and number of ureteral traumas. In addition, the validated URS-GRS tool was used by a single rater (MA) to assess the competency of participants in performing task 10 during the OSCE [16]. This tool assesses seven parameters, including respect for tissue, instrument handling, endoscope handling, time and motion, forward planning, use of assistants, and knowledge of the procedure [16]. Each parameter is scored on a Likert scale from 1 to 5, thus the maximum score is 35 and the minimum is 7. At the end of Task 10, participants received formative feedback in terms of URS-GRS scores and objective measurements from the simulator. To define competency, three attending endourologists performed Task 10 on the UroMentor™ simulator and were rated by the same rater (MA). Norm-referenced method was used to calculate the competency cut-off score as defined by the mean URS-GRS score of experts minus one standard deviation (SD) [17, 18].

To assess face validity and usefulness of the UroMentor™ simulator as a training tool, all participants including experts were asked to rate 3 questions on a Likert scale of 1 to 10, where 1 is the least favorable and 10 the most favorable. The following 3 questions were asked: 1) How closely does this simulator approximate a real-life ureteroscopic experience for you? 2) How useful do you think this simulator is as an educational tool in a urology training program for novice PGTs? 3) Do you think this simulator is a useful tool in assessing PGTs' competency in ureteroscopic stone extraction skill?

Statistical analysis

Data gathered from the questionnaires, the UroMentor™ simulator, and intra-operative variables were analyzed. The Statistical Package of Social Sciences for Windows (SPSS, Chicago, IL) software version 20 was used. Descriptive data are presented in numbers, means and standard deviations (SD). Student T-test and ANOVA were used to find statistically significant differences between competent and non-competent PGTs and differences between PGTs with and without practice on the UroMentor™ simulator. Moreover, Pearson's correlation coefficient was used to determine associations between PGY level, previous experience in the OR, simulator objective parameters and URS-GRS scores at the OSCE. Significance was considered when two-tailed p-value was <0.05.

Results

The UroMentor™ simulator was successfully incorporated into the semi-annual OSCE to assess flexible ureteroscopic stone-extraction skill of urology PGTs. All thirty PGTs (9 PGY-3, 11 PGY-4, 10 PGY-5), who participated in the OSCE, consented to participate in the study. The mean age of participants was 29.1±3 years. Twenty-nine were right-handed and there were 12 female PGTs. Prior to the study, PGTs had performed a mean of 277.9 cystoscopies, 55.9 semirigid ureteroscopies, and 45.7 flexible ureteroscopies.

At the OSCE, mean URS-GRS score of PGTs was 20.0±4.4, mean operative time was 10.9±2.1 minutes, mean fluoroscopy time was 7.0±4.9 seconds, and mean number of mucosal traumas was 10.8±3.8. There were no ureteral perforations. While previous ureteroscopies performed in the OR correlated weakly with the number of mucosal traumas at the OSCE ($r=0.4$, $p=0.017$), previous ureteroscopies and PGY level did not correlate with URS-GRS scores at the OSCE ($r=-0.260$, $p=0.155$ and $r=0.009$, $p=0.961$, respectively). In addition, there was no significant correlation between previous ureteroscopies and objective parameters recorded by the simulator including fluoroscopy time ($r=-0.200$, $p=0.290$) and operative time ($r=0.189$, $p=0.318$).

Mean URS-GRS score of the expert group performing Task 10 on the simulator was 26.0±6.9. Therefore, competency cut-off for URS-GRS score was set at 19. Accordingly, 18 (60%) PGTs were competent and performed task 10 significantly faster than non-competent PGTs (12.1 vs. 10.1 min; $p=0.01$). The number of competent PGTs in urology training program A was significantly higher than other programs (p=0.03) (Table 1). However, there was no significant difference between both competent and non-competent PGTs in terms of PGY level, operative experience and other objective parameters measured by the simulator (Table 1).

Eight PGTs (3 PGY3, 2 PGY4, and 3 PGY5) had practiced on the UroMentor™ simulator prior to the OSCE. They were not aware that flexible ureteroscopic stone extraction skill would be assessed during this OSCE. All 8 PGTs who had practiced on the simulator were found to be competent at the OSCE (Table 1). When compared with PGTs who did not practice, PGTs who had practiced prior to the OSCE performed the task significantly faster (11.5 vs 9.4 min; p=0.01) and obtained significantly higher URS-GRS scores (18.3 vs 24.6; p<0.001) (Figure 2). While there was a significant difference in URS-GRS scores among experts, PGTs with training and PGTs without training (26.0±6.9 vs 24.63±3.02 vs 18.36±3.60; p=0.001), there was no significant difference in mean URS-GRS scores between experts and PGTs with previous practice (p=0.77). PGTs with previous training had a mean URS-GRS score of 26.0±7.2 on their last practice trial on the simulator. Although there was a positive correlation between URS-GRS scores at the last training session and at the OSCE, this did not reach significance (r=0.641, p=0.086) (Figure 3).

PGTs and experts evaluated the UroMentor™ simulator for its face validity and their mean score on a Likert scale of 1 to 10 was 5.3±1.4. In addition, usefulness of the simulator in training PGTs for the ureteroscopic stone extraction skill was rated at a mean of 6.8±1.9. Finally, usefulness of the simulator in assessing competency of PGTs was scored at a mean of 5.3±2.4.

Discussion

Assessment of competency as part of Competency-Based Medical Education (CBME) provides objective evidence for readiness of a PGT to practice independently. Virtual reality simulators provide immediate formative feedback useful for training and assessment of PGTs [5, 7, 10, 19]. While the validity of UroMentor™ as a virtual reality simulator has been demonstrated in training medical students and PGTs, it has not been used to assess competency of urology PGTs in performing flexible ureteroscopic stone extraction skill during an OSCE [20, 21].

The current study demonstrated that the UroMentor™ simulator could be successfully incorporated into an OSCE station of 17 minutes. Based on a competency cut-off score of 19 on the URS-GRS scale, 60% of urology PGTs were found to be competent in performing ureteroscopic stone extraction. When compared with non-competent PGTs, competent PGTs were significantly faster (more efficient) (12.1 vs 10.1 min, p=0.01) and performed the task better with significantly higher URS-GRS scores (15.6 vs 23.0, p<0.001). When training programs were compared, urology training program A had significantly higher proportion of competent PGTs (Table 1). This training program was the only one that had the UroMentor™ simulator available and PGTs in this training program had the chance to practice on this simulator during the year prior to the OSCE. Indeed, all eight PGTs who had practiced on the simulator were competent (Table 1). Therefore, it is not surprising that training program A had significantly more competent PGTs in performing task 10. Fluoroscopy time, on the other hand, was not significantly different between competent and non-competent PGTs. One explanation for the lack of difference is that non-competent PGTs may not have used fluoroscopy as much as they needed to perform ureteroscopy safely.

The current study did not show a significant correlation between performance at the OSCE and previous experience in the operating theatre or PGY level. These results are congruent with our previous studies on competency assessment of basic endourologic skills at OSCEs [7, 8, 10]. One explanation why competency in ureteroscopic stone extraction at this OSCE did not correlate with PGY level is that we are assessing basic endourologic skills such as cystoscopy, guidewire placement in the ureteral orifice and flexible ureteroscopic stone extraction. These skills are developed in junior PGTs during PGY level 2 and 3, whereas senior PGTs in the PGY-4 and 5 no longer participate in these procedures. Therefore, senior PGTs may have lost their ureteroscopic skills unless they kept practicing on the UroMentor^{TM} simulator. The only competency that correlated with PGY level was the competency in basic robotic skills where all competent PGTs were from the PGY-5 level [6]. This is because none of the PGTs had access to the da Vinci Surgical Skills Simulator to practice prior to the OSCE.

Previously, Knoll et al. found that experienced urologists who had performed >80 URS cases in the OR performed the laser lithotripsy task faster on the simulator (12.3±2.2 vs. 18.5±1.8 min; $p<0.05$) with higher stone disintegration rate compared with experienced urologists who had performed <40 URS cases [22]. One reason why previous URS experience did not correlate with operative time at the OSCE in the present study could be that PGTs had performed significantly less URS (mean of 45.7 flexible URS cases) than the 20 experienced urologists who were recruited for the Knoll et al study with up to 153 flexile URS case experience [22]. Another reason could be that in the previous study, urologists were arbitrarily divided into groups based on their URS experience (<20, 20-40, 40-60, 60-80, 80-100, 10-120, >120) whereas in the present study the number of URS cases were correlated with continuous variables such as operative time and fluoroscopy time [22]. A third explanation rests in the way the flexible ureteroscope is set up on the simulator. The flexible ureteroscope attached to the UroMentor^{TM} has a reverse deflection lever whereas flexible ureteroscopes used in clinical practice in Quebec has standard deflection lever, which may have mixed up the PGTs during the OSCE. Therefore, PGTs, who may have been competent to perform the task in the OR, were not able to demonstrate their competency on the simulator. Fourth explanation lays in the lack of practice at the OSCE. Whereas the Knoll et al provided the simulator to the experienced urologists for 10 minutes of practice prior to their assessment, there was no opportunity for practice at the OSCE due to the limited amount of time (17-minute station) [22]. Finally a questionnaire was used on the day of the OSCE to determine the number of previously performed procedures in the OR. This may have introduced recall bias in recollecting the exact number of URS cases performed in the OR prior to the OSCE. Using case-logs may been more accurate. Nevertheless, our previous work showed that competency in basic endourologic skills at OSCEs did not correlate with previous operative cases [6-8, 10]. This is because PGTs may scrub into endourologic procedures and log them into their case logs but they may not perform the critical components of the procedure. A great example is when PGTs scrub into percutaneous nephrolithotomy cases and log them, but they may not obtain the access. Therefore, developing competencies by practicing on simulators for specific tasks (intracorporeal knot tying, percutaneous renal access, ureteroscopic stone extraction) are more important than logging the number of cases that they may have scrubbed. Therefore, the fact that competency did not correlate with number of previously performed ureteroscopies nor PGY level goes along with CBME, which is based on learning outcomes rather than time spent in the learning environment such as the operating room [23].

Another interesting finding was that previous ureteroscopic experience had a positive weak correlation with the number of traumas in the OSCE (r=0.4, p=0.017). This could be explained by the fact that PGTs with more experience in the OR would be more confident on the simulator and would have a quicker handling of the ureteroscope leading to more traumas whereas inexperienced PGTs would be slower and more careful leading to fewer traumas. Another possibility is that there is a trick in passing guidewire into the UO. This is one of the weaknesses of the simulator, which does not provide a realistic experience for this part of the procedure. Therefore, experienced PGTs may have made more traumas, while PGTs who had previously practiced on the simulator may have learned the trick in getting the guidewire into the UO.

Compared with those who did not practice, PGTs who had practiced received significantly higher GRS-URS scores at the OSCE (18.3 vs 24.6; p<0.001) and performed the task significantly faster (11.5 vs 9.4 min; p=0.01) (Figure 2). While not significant, PGTs who had practiced on the simulator used less fluoroscopy (7.6±5.6 vs. 5.2±1.6 seconds; p=0.24) and made less traumas (11.4±2 vs. 9.3±1.6; p=0.17) during the OSCE (Figure 2). This means that PGTs who had practiced were faster and better than those who did not.

There was a positive correlation between the last URS-GRS scores during practice and at OSCE (r=0.641, p=0.086) (Figure 3). In addition to the small sample size, several factors may have weakened the statistical significance. First, excessive time passage from training on the simulator to the OSCE where one PGT's scores deteriorated from practice since it was almost a year earlier than the OSCE. Second, another PGT had worse performance at the OSCE due to a shoulder injury. Finally, the UroMentor simulator was one of 15 stations at the OSCE; hence, fatigue may have played a role.

The validated UroMentor simulator was used in the present study to assess competency of urology PGTs in the ureteroscopic stone extraction skill. Although it is a great tool to train PGTs, it may not be the best simulator for assessment their competency for several reasons. First, its high cost (about 100K CAD for the combined PercMentor™ and the UroMentor™). Second, it does not provide a global score. Therefore, a validated subjective assessment tool such as the URS-GRS tool was used to determine competency cut-off point. Finally, there were software glitches in getting the guidewire into the UO and grasping the second stone within the renal pelvis, where the basket often went through the stone rather than grabbing it. These software issues may have led to the low face validity reported in the present study (5.3/10). This is similar to the face validity of 3.14/5 or 62.8% reported by Dolmans et al where 56 expert urologists and 33 PGTs were recruited [20]. Similarly, the scores for the usefulness of the UroMentor simulator in training PGTs and their assessment were lower in the present study when compared to those published by Dolmans et al (68% vs. 83% vs and 53% vs. 68.8%, respectively [20]. The survey by Dolmans et al. was administered to volunteers during a conference whereas in the present study PGTs were surveyed during a stressful exam environment, which, in addition to software issues, may have negatively influenced the views of PGTs towards the simulator. Therefore, the software used in the UroMentor™ simulator needs to be updated to improve its face validity and to include more complex tasks such as Holmium laser lithotripsy.

This study is not without limitations. First, despite recruiting all urology trainees (PGY 3-5) from all four Québec training programs with 100% participation rate, the sample size was small.

Second, the high cost of the UroMentor™ may be prohibitive to use in all urology programs. For example, it was available for training and assessment only in program A. Third, just like any virtual reality simulator, the UroMentor™ simulator suffers from software malfunction, where the second stone in the renal pelvis could not be captured by the stone basket. This may have contributed to the low face and content validity scores in the present study. Finally, all GRS-URS evaluations were performed by one rater (MA), who was not blinded to PGY level. Therefore, the halo effect could have introduced bias. However, there was no evidence of bias playing a role since PGY level did not correlate significantly with URS-GRS scores. Nonetheless, this is the first prospective study to assess competency of urology PGTs in flexible ureteroscopic stone extraction skill during an OSCE and demonstrated that competency in this skill correlated with practice rather than number of cases performed.

Conclusion

This study confirmed the feasibility of incorporating the UroMentor™ simulator at OSCEs to assess competency of urology PGTs in ureteroscopic stone-extraction skill. However, the software needs to be updated to improve its face validity and to include more complex tasks such as Holmium laser lithotripsy. Future studies with larger sample sizes and more complex cases are needed to confirm these results.

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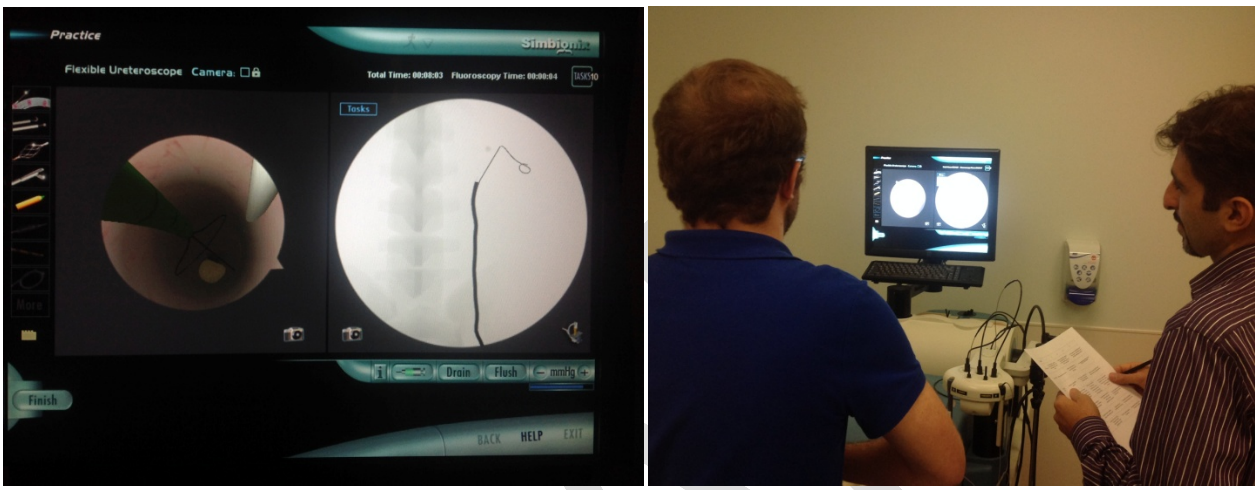
Figures and Tables

Fig. 1. (A) Task 10 requires placement of a guidewire into the left ureteral orifice. Next, under fluoroscopic guidance, a flexible ureteroscope is used to extract two small stones from the left proximal ureter and renal pelvis with a stone basket. ***(B)*** The stone basket was operated by an assistant who was also assessed PGTs using URS-GRS tool.



A **B**

Fig. 2. Differences between PGTs with and without previous practice on the UroMentor™ simulator. OSCE: Objective Structured Clinical Examination; PGTs: postgraduate trainees; URS-GRS: Ureteroscopy Global Rating Scale.

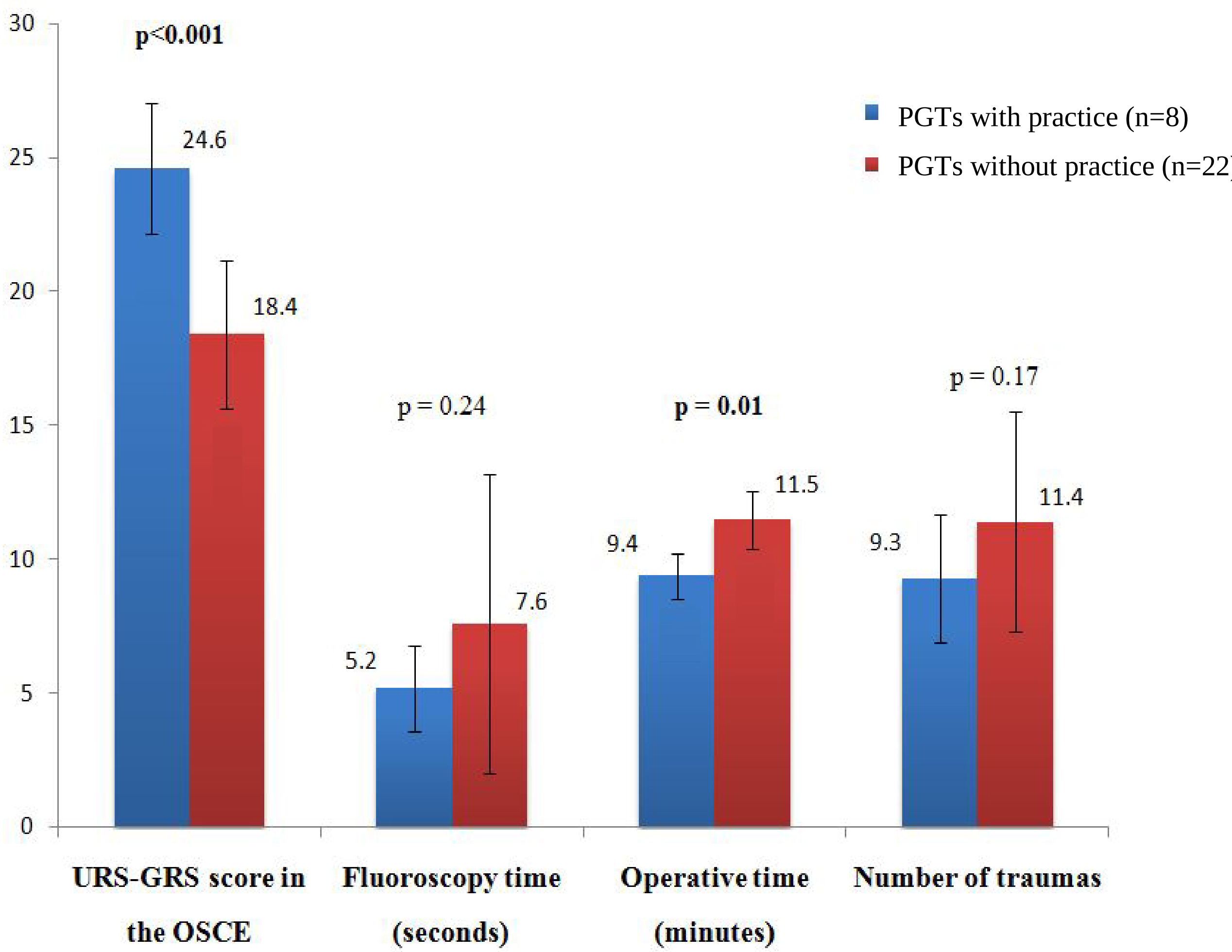


Fig. 3. Correlation of URS-GRS scores at the last practice session and at OSCE (r=0.641; p=0.086). OSCE: Objective Structured Clinical Examination; URS-GRS: Ureteroscopy Global Rating Scale.

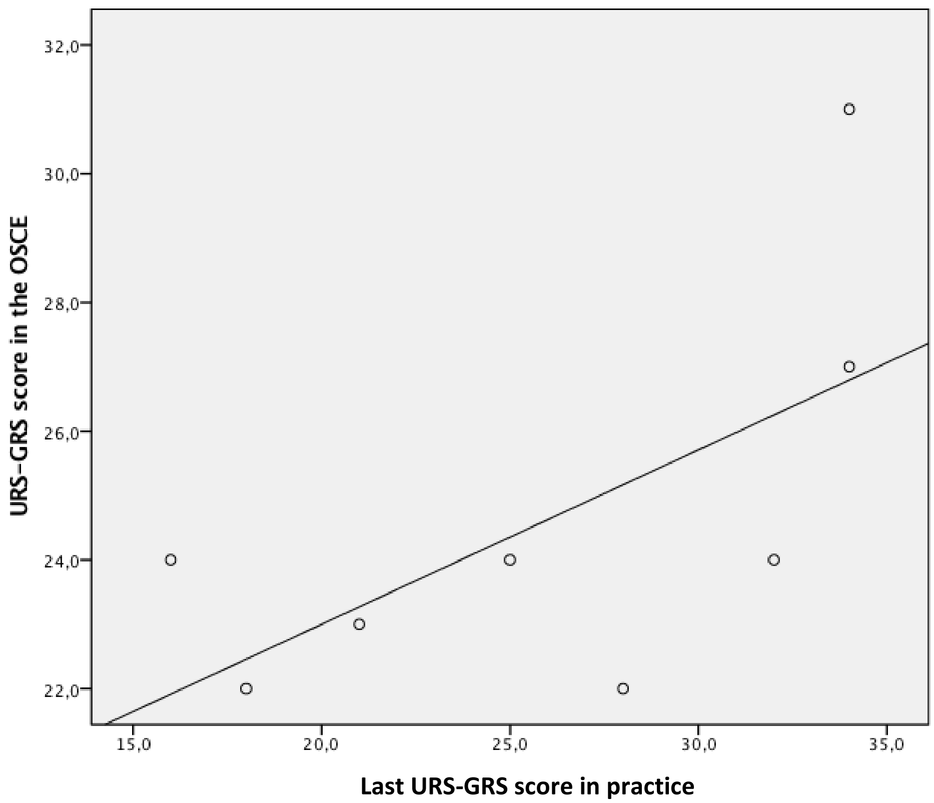


Table 1. Differences between competent and non-competent PGTs in performing flexible ureteroscopic stone extraction on the UroMentor™ simulator at the OSCE

Variables		Competent PGTs (n=18)	Non-competent PGTs (n=12)	p
Age (years)		29.2±2.5	29.0±3.9	0.8
Female PGTs		6 (33.3%)	6 (50%)	0.4
Urology program	A	9 (50.0%)	1 (8.3%)	**0.03**
	B	4 (22.2%)	8 (66.7%)	
	C	4 (22.2%)	2 (16.7%)	
	D	1 (5.6%)	1 (8.3%)	
PGY level	3	6 (33.3%)	3 (25.0%)	0.5
	4	5 (27.7%)	6 (50.0%)	
	5	7 (38.9%)	3 (25.0%)	
Previous experience (number of procedures)	Cystoscopies	267.0±313.7	293.3±192.3	0.8
	Flexible URS	40.5±30.4	53.5±58.3	0.4
	Semi-rigid URS	51.8±37.6	62.1±55.2	0.5
	TURBT	45.8±27.0	65.8±54.4	0.2
	TURP	30.2±28.1	47.0±53.4	0.3
	HoLEP	3.1±7.2	1.6±3.1	0.5
	PVP	6.1±12.4	3.6±5.3	0.5
PGTs with experience on a virtual simulator		9 (50.0%)	2 (16.7%)	0.1
PGTs with previous training on UroMentor™		8 (44.4%)	0 (0.0%)	**0.01**
Operative time (min)		10.1±1.7	12.1±2.3	**0.01**
Fluoroscopy time (sec)		6.1±2.8	8.3±7.0	0.2
Number of mucosal traumas		10.1±3.2	11.8±4.4	0.2
Number of times cystoscope was introduced into bladder		1.4±0.6	2.3±1.6	0.06
Number of attempts to insert wire into UO		2.3±2.1	9.0±14.3	0.06
Time introducing the wire into the UO (sec)		20.4±24.4	28.7±13.7	0.3
Time moving wire to renal pelvis (sec)		15.1±7.6	26.7±28.4	0.1

Time moving ureteroscope to UO (sec)	14.2±8.7	14.2±7.5	1.000
Time moving ureteroscope from UO to iliac vessels (sec)	15.6±6.3	21.0±10.1	0.08
Time progressing from the UO to stone (sec)	15.8±5.9	17.1±6.5	0.6
Number of residual stones	0.8±0.4	0.8±0.4	0.72

HoLEP: holmium laser enucleation of the prostate; OSCE: Objective Structured Clinical Examination; PGTs: postgraduate trainees; PVP: photoselective vaporization of the prostate; TURBT: transurethral resection of bladder tumour; TURP: transurethral resection of the prostate; UO: ureteric orifice; URS-GRS: Ureteroscopy Global Rating Scale.