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ENDOUROLOGY
Invited Review

Simulation models and training curricula for training in endoscopic enucleation of the prostate: A systematic review from ESUT

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ABSTRACT

The introduction of endoscopic anatomical enucleation of the prostate created a new educational field. We investigated the current literature for simulators, phantoms, and other training models that could be used as a tool for teaching urologists alone or within the boundaries of a course or a curriculum. A systematic review was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-analyses statement and the European Association of Urology Guidelines office's recommendations for conducting systematic reviews. Seven out of 51 studies met our inclusion criteria and are presented in the current review. The VirtaMed UroSim™ HoLEP (Holmium Laser Enucleation of the Prostate) Simulator achieved excellent scores for face, content, and construct validity, and participants agreed that it could be used for training. In addition, this simulator offers the opportunity for morcellation training. The Kansai University model for HoLEP does not support morcellation simulation and has only demonstrated face and content validity. The CyberSim (Quanta System, Solbiate Olona, VA, Italy) has not been yet evaluated, but it seems that it can be used for training without tutoring. Only one training curriculum was revealed from the search. The Holmium User Group-Mentorship Program has been proposed since 2005 for training urologists for HoLEP. Simulators and courses or curricula based on a simulator could be valuable learning and training tools. The existent models seem efficient but have not been widely evaluated and accepted yet. It seems that the training field for transurethral enucleation of the prostate will be rapidly developed soon.

Keywords: Curriculum; EEP; laser; simulation training; simulator; enucleation; prostate.

Introduction

Symptomatic bladder outlet obstruction due to prostate hyperplasia (BPH) constitutes a significant healthcare burden worldwide.[1] The transurethral resection of the prostate (TURP), especially in large prostates, becomes a tedious procedure with significantly increased complication rates, like post-operative bleeding[2] and irrigation fluid absorption.[3] The advantages of the enucleation technique compared to the classic TURP are that the whole adenoma can be removed, and the possibility of recurrence of BPH in the long term is minimized.[4] Compared to the open adenomatectomy, the endoscopic enucleation of the prostate (EEP) using lasers (Holmium or Thulium) or bipolar electrocautery is related to lower blood loss. In addition, endoscopic enucleation requires a minimal hospital stay.[5] Long- and short-term efficacy has been proven.[6,7] Nevertheless, despite the high efficacy of EEP, the rate of post-operative stress urinary incontinence (4.9-12.5%) is generally higher than TUR-P (2%) and open prostatectomy (3-9%).[8] In addition, its wide distribution has been delayed, probably due to its steep learning curve,[9] which can be reached after completion of approximately 20-70 cases.[10–12] As with every newly introduced technique, the EEP needs to be learned correctly and safely to urologists who are interested in adopting it.[13] However, the absence of a structured training program leads many centers to abandon or not to continue with the technique.[11] Moreover, residents struggle to receive adequate training, mainly due to changes in working hours.

The training models and courses allow urologists to train themselves in realistic conditions and provide the medical community with a surgical education standard. The old-fashioned "see one-do one" teaching model used to prepare the surgeons for their first cases does not keep up with the modern training approach utilizing technological advancements.[14] We herein systematically review the literature to elucidate the current status of the training models-simulators and protocols for EEP and, if possible, propose the most appropriate model or curriculum.

Material and Methods

Evidence Acquisition

Search Strategy, Eligibility Criteria, and Endpoints

A systematic search of the literature was conducted in November 2020. This study complied using the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) statement and the European Association of Urology Guidelines office's recommendations for conducting systematic reviews.[15,16] The testing of different simulators alone or as part of courses and curricula as a tool of a faster, safer, and better way of teaching urologists was the fundamental question of this review. The protocol was based on simulation trainers and/or curricula for EEP, referring to Cadaveric, in vivo, ex vivo, in vitro, and virtual reality models using bipolar electrocautery or laser. Evaluation and reporting of results were related to efficacy, learning curve, impact to training, face/content/construct validation, and cost-effectiveness. The study protocol was published online in August 2020 in (OSF) Free and open source project management platform (www.osf.io) and can also be reviewed in Table 1.

Main Points

- Surgical simulators play an essential role in EEP training.
- Simulation-based training in EEP is nowadays based on virtual reality simulators, the main being the The UroSim for HoLEP and the CyberSim™ for Thulium laser Enucleation of the Prostate (ThuLEP).
- The Kansai HoLEP simulator is the only synthetic model used in EEP training.
- The only training curriculum for EEP is the one created by the Holmium User Group.
- Only one training course in EEP has been identified.

Data Extraction

The studies were screened by two reviewers independently (AP and GO). Relevant data on study characteristics and outcomes were extracted using a standardized pro forma. The databases used for the search were PubMed, Scopus, and Cochrane. Abstracts from major congresses European Association of Urology (EAU), World Congress of Endourology (WCE), American Urological Association (AUA), and Societe Internationale D'Urologie (SIU) in English were also considered. Any discrepancies among the reviewers were solved by the senior investigators (PK and TT).

Evidence Synthesis

Included Studies

This search identified 4,075 records (Figure 1). After excluding duplicate references, we reviewed 3,822 unique references by title or abstract. Eligible studies known to the authors but not identified by the search were also evaluated for inclusion, adding 19 unique records. After the screening of 51 publications, seven studies were considered eligible to be included in the review. A total of seven unique references were included in the qualitative synthesis. Five assessed the validity of an EEP simulator, one assessed an EEP training course, and one presented an EEP training curriculum. Due to study heterogeneity and the nonstandardized quality appraisal, we performed a narrative synthesis.

Characteristics of Included Studies

Included studies are presented in Tables 2-4. We identified five studies about different EEP simulators. Four different Holmium Laser Enucleation of the Prostate (HoLEP)[17–20] and one Thulium laser enucleation of the prostate (ThuLEP)[21] simulators or models have been studied. Two virtual reality (VR) simulators, one for HoLEP[18–20] and one for ThuLEP,[21] are illustrated in Table 1. Additionally, one bench-top synthetic HoLEP model was identified.[17] We also identified one HoLEP training curriculum[22] and one HoLEP training course[23] study.

Results and Discussion

VR HoLEP Simulator

The UroSim HoLEP simulator (VirtaMed, Zurich, Switzerland)[18–20] is the first VR platform for HoLEP training. The simulator consists of a camera, a scope, a fiber, and a laptop with a pedal. It has six different operational cases and prostate adenomas varying from 55 to 100cc, with some variations regarding the prostate's anatomy. It also provides haptic feedback during the operation. After the surgery, the simulator provides information about the operational time, the enucleated

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adenoma percentage, and the surgery's efficiency. Besides, it provides information about patient safety, like accidental sphincter dissection. The participants were 34. Five of them were experienced HoLEP surgeons, 13 were experienced in endourology but not in HoLEP, and 16 were novices. They all received lectures and videos with instructions and experts' surgeries. The participants also had 15 minutes to familiarize themselves with the simulator, including a middle lobe enucleation task. After that, they should complete a HoLEP surgery of a 60cc prostate. The simulator metrics measured the participants' performance, and they also completed a questionnaire for face and content validity. As for construct validity, the expert group was more efficient than the two other groups. Efficiency was measured by grams of prostate adenoma enucleated per hour. As for face validity, the participants completed a set of questions on a 10-point scale. The components were instrumentation, tactile feedback, prostate model, laser–tissue interaction, irrigation, and bubbles, and irrigation had the best score of all. As for content validity, most of the participants believed that training for HoLEP is essential that HoLEP is a compelling choice of treatment for BPH (95%), and that simulation training programs are essential for patient safety (87%). Also, most of them believed that a validated HoLEP simulator has a vital role in this kind of training (88%).[19]

The Virtamed UroSim was also evaluated in a prospective, comparative, observational multi-institutional study in the United Kingdom as part of a HoLEP curriculum. The participants of this study were 53 urologists who were divided into three groups: HoLEP experts (n = 11), intermediates (n = 24), and novices (n = 18). All the participants received lectures and videos with instructions and experts' surgeries. The participants also had 15 minutes to familiarize themselves with the simulator, including a middle lobe enucleation task. A complete HoLEP surgery of a virtual 60cc prostate followed. The simulator metrics measured the participants' performance, and they also completed a questionnaire for face and content validity. Regarding face validity, the participants (except for novices and intermediates) completed a 10-graded scale questionnaire assessing some aspects of the procedure's realism. All aspects of the simulator except for the haptic feedback (mean score: 4.2) were graded above 5 out of 10. The instrumentation was the most realistic character of the simulator (mean score: 7.9), and the overall experience was rated just above the acceptance threshold (5 out of 10) with a mean score of 5.6. As for content validity, most participants believed that HoLEP is a practical treatment choice for BPH (87%), and that simulation training programs are essential for the patients' safety (86%). In addition, 87% of participants believed that a validated HoLEP simulator has an important role in training programs, and 94% are essential to train for HoLEP. As for construct validity, the efficiency (Grams enucleated per hour) matched the participants' experience. The experts had a better score than intermediates, and intermediates had a better score than novices, 99.8 g h^{-1}, 57.1 g h^{-1}, and 24 g h^{-1} enucleated, respectively.[18]

The evaluation of the UroSim HoLEP virtual simulator was the aim of another prospective observational study. The participants were 39 urologists. Sixteen of them were novices, 17 were endourological trainees, and six were HoLEP experts. They all received lectures with instructions and videos from experts' surgeries. They also had 15 minutes to familiarize themselves with the UroSim HoLEP virtual simulator. After

Table 1. Protocol Presentation Based on PICO

Question: Simulation options for training in endoscopic enucleation of the prostate		
Strategy	P	Simulation trainers and/or curricula for endoscopic enucleation of the prostate Cadaveric, in vivo, ex-vivo, in vitro and virtual reality Non-technical skills training
	I	Bipolar electrocautery or laser-assisted endoscopic enucleaton of the prostate
	C/O	Evaluation and reporting of results related to: • Efficacy- Learning curve – impact to training • Face/content/construct validation • Cost-effectiveness
Search Options	• Databases to search: Pubmed, Scopus, Cochrane. • Manual search is acceptable. Articles in peer reviewed journals and abstracts from major congresses (EAU, WCE, AUA, SIU). • Languages: English	
Eligibility Criteria	Any study evaluating Cadaveric, in vivo, ex-vivo, in vitro and virtual reality simulators and/or curricula for training in endoscopic (laser-assisted or bipolar) enucleation of the prostate.	
Search Keywords	Simulat*, train*, curricull*, transurethral, TUR*, enucleation	

that, they should complete a "virtual" HoLEP surgery of a 60cc prostate. As for construct validity, the group of experts had a better score (grams enucleated per hour) than the other two groups. Eighty-seven percent of the participants believe that a validated HoLEP simulator is essential for training, and 82% believe that simulators should be a part of training programs (content validity). Of them, 86% think that simulation training programs enhance the operational safety of the patients. Regarding face validity, 61% of the participants stated that simulation experience was close to real-life surgery conditions.[20] Amongst disadvantages, although the simulator has demonstrated construct validity, the authors did not perform an external assessment of operative skill by expert HoLEP surgeons using a validated procedural assessment such as the Objective Structured Assessment of Technical Skills tool. Furthermore, the simulator's significant disadvantages include the absence of a real holmium laser, irrigation fluid, or experience practicing an effective laser safety protocol.

Bench-top HoLEP Simulator

The Kansai Medical University HoLEP Simulator[17] includes a prostate model that consists of an inner and an outer layer,

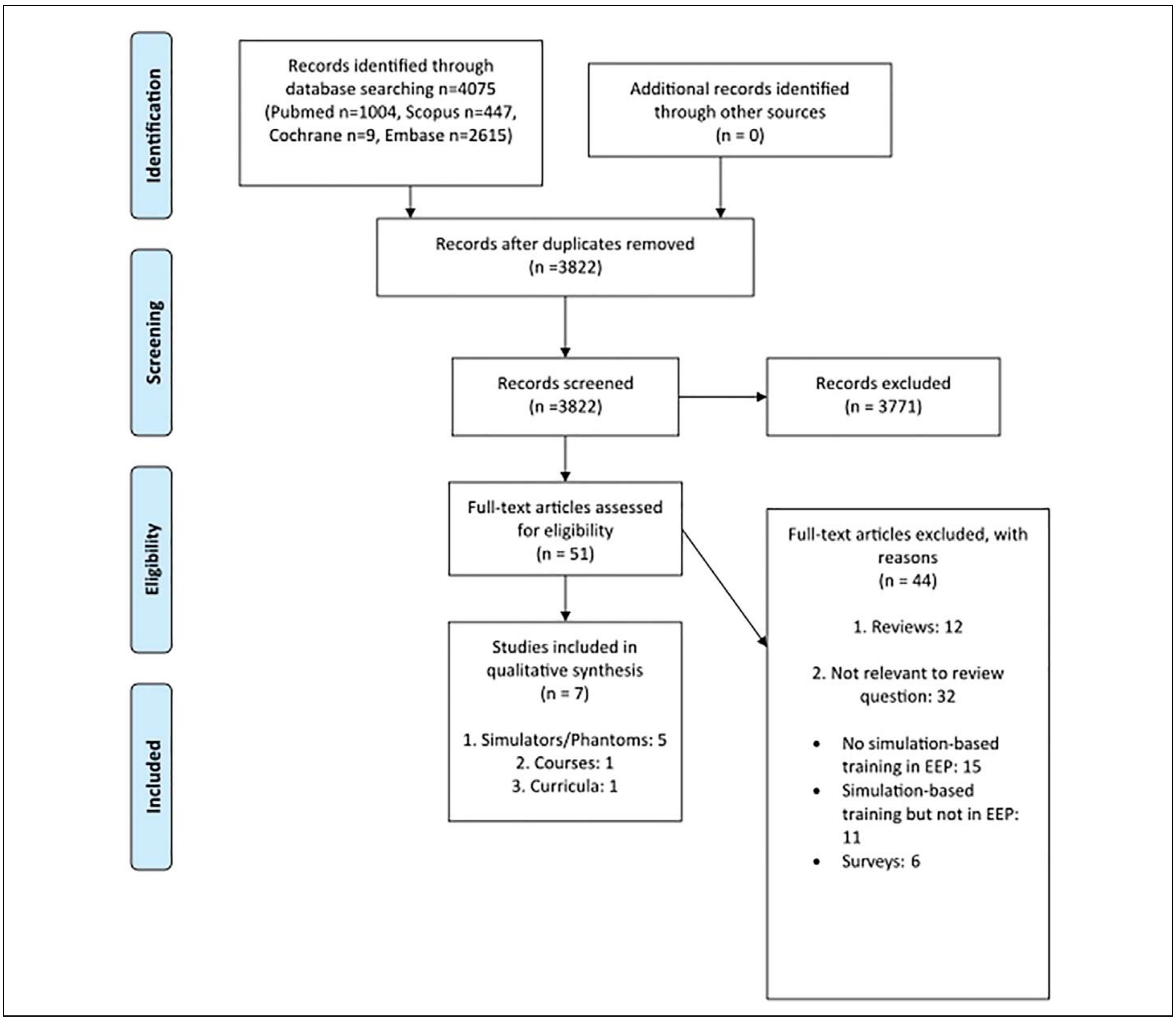

Figure 1. Flow chart of included studies

Table 2. Overview of Different Simulators for Enculeation Procedures. VR (Virtual Reality), HoLEP (Holmium Laser Enucleation of the Prostate), ThuLEP (Thulmium Laser Enucleation of the Prostate)

Simulator	Specifications	Participants	Design and structure	Structure	Evaluation	Face Validity	Content Validity	Construct Validity	Simulator specific features and results	Author, Year of Publication
Kansai Medical University HoLEP Simulator	Bench model Prostatic hyperplasia model with 2 layers – enlarged adenoma with outer membrane – combined with laser and morcellator (Lumenis VersaPulse PowerSuite Holmium 20-W laser, VersaCut Morcellator system)	Overall n=36 -trainees (n=13) -senior urologists (n=23)	Prospective, observational, comparative	-2-day modular teaching course -30 minutes tutorial followed by 45 minutes simulation session -1:1 monitoring	Qualitative and quantitative survey	✓	✓		Face validity: -simulator is realistic: 74% yes -instrumentation: mean 9/10 -tactile feedback: mean 7,86/10	Aydin et al.[15] 2014
UroSim™ HoLEP simulator (VirtaMed, Zurich, Switzerland)	VR Anatomy visualization and cystoscopy module, six operative cases with various degrees of prostatic hyperplasia – each with slightly different anatomical variations	Overall n=34 -experts n=5 -trainees n=13 -novices n=16 Overall n=53 -experts n=11 -intermediates n=24 -novices n=18 Overall n=39 -experts n=6 -intermediates n=17 -novices n=16	Prospective, observational, comparative Prospective, multi-institutional, observational, comparative Prospective, observational, comparative	-self-learning by educational package (didactic lecture, use of instruments, technique description, instructional video, real HoLEP enucleation video performed by expert) -15 minutes familiarization exercise (visualization, middle lobe enucleation) -full 3-lobe enucleation on 60cc prostate	Quantitative survey and in-built simulator metrics: -procedure time -percentage of prostate enucleated -amount of capsule enucleated -enucleation efficiency -breaching of safety parameters (damage to external sphincter, verumontanum, ureteral orifices, undermining of bladder neck)	✓ ✓ ✓	✓ ✓ ✓	✓ ✓ ✓	- Face validity (evaluated by experts): -overall 5,6/10 -instrumentation 7,9/10 -haptic feedback 4,2/10 -realism 5,6/10 Construct validity: -enucleation efficiency (grams/hour) experts vs. intermediates (p=0,003), experts vs. novices (p<0,001), intermediates vs. novices (p=0,001) -amount of capsule enucleated increased with experience between groups -experts with higher rate of verumontanum and bladder neck damage as well as capsule enucleation Face validity: -61% thought that the overall experience was similar to the real life setting for HoLEP training Construct validity: -enucleation efficiency experts vs. other groups (p<0,001)	Kuronen-Stewart et al.[17] – abstrac, 2014 Kuronen-Stewart et al.[16], 2015 Kuronen-Stewart et al.[18] – 2015
CyberSim™ (Quanta System, Solbiate Olona VA, Italy)	VR Prostatic adenomas of different volumes and shapes, different lengths of prostatic urethra, customizable median lobe morphology Laser and morcellator for in-vivo learning curve evaluation: -Cyber TM 150 Thulmium:YAG laser (Quanta System, Solbiate Olona VA, Italy) with 600 and 800 μm end-firing fibers -Piranha morcellator (Wolf, Knittlingen, Germany) n=95 -DRILLCUT morcellator (Karl Storz, Tutlingen, Germany) n=5	Overall n=2 (both ThuLEP naïve) -surgeon A (>25 years of experience in endourology) -surgeon B (about 15 years of experience in endourology)	Prospective, observational, comparative (2 surgeons) Simulator based followed by in-vivo surgery, no tutoring aid	-clinical visits to centers with experience in HoLEP and ThuLEP - 2 weeks practice on simulator - followed by 48 cases (surgeon A) and 52 casese (surgeon B) over 15 months Enucleation technique: 2-lobe (in absence of middle lobe) and 3-lobe Inclusion: -patients with prostatic adenomas 30-150ml Exclusion: -IPSS <7 -urodynamic evidence of neurogenic acontractile bladder detrusor -history of prostate surgery	In-built simulator metrics (resection rate, graphical visualisation of residual adenoma, errors [e.g. capsule perforations, sphincter lesions	n/a	n/a	n/a	Characteristics and results: Age: mean 68,8 years (52-85, median 69) Prostatic adenoma volume: mean 61,2ml (30-130ml) Surgical duration: -surgeon A: 34-160min (median 92min) -surgeon B: 40-127min (median 86min) Laser emission time and energy: -surgeon A: 16-58,4min (median 28min), 84,82-386,92kJ (median 165,65 kJ) -surgeon B: 19-37,1 min (median 24min), 87,54-358,327kJ (median 163,445 kJ) Intraoperative complications (all in-between first 60 procedures): -surgeon A: bladder perforation (n=1), bleeding requiring 2nd procedure to complete morecellation (n=1) -surgeon B: bladder perforation (n=1) Reoperations: -surgeon A: TUR-P due to chronic retention after 6 months (n=1) -surgeon B: haemostatic TUR-P for massive postoperative bleeding 24h after surgery (n=1), 2nd look morcellation due to urinary retention after incomplete morcellation after 1 month (n=1), urethrotomia due to urethral stenosis after 9 months (n=1) Statistical analysis: Linear regression analysis of laser emission time and prostatic adenoma volume: r=0,856 -increase of 0,3232min of laser emission/ml of prostate adenoma volume Correlation of laser emission time (normalized by prostate volume) with prior ThuLEP procedures: not significant for both surgeons	Saredi et al.,[21] - 2015

Table 3. Overview of Existing HoLEP Mentorship Programs. HoLEP (Holmium Laser Enucleation of the Prostate), HUG (Holmuim User Group), HUG-MP (Holmium User Group Mentorship Program)

Curriculum name	Aim	Mentor qualifications	Mentee qualifications and obligations	Aiding tools for mentee	Structure	Author, Year of Publication
HUG-MP (Holmium User Group Mentorship Program)	Provide mentoring during the initial learning curve of HoLEP so that the mentee can become a mentor herself/himself after completing the curriculum and collecting further experience.	Performed more than 100 HoLEP cases Attended at least one previous HUG HoLEP course Prepared to teach HoLEP within the framework of the HUG-MP HoLEP technique has been verified by at least 1 existing HUG mentor HoLEP outcomes are as expected for an expert	Attendance of one HUG HoLEP course Completion of recognised laser safety course Completion of all requirements in the mentee checklist	HoLEP educational kit:HoLEP instrument checklist (mentee is required to provide required instrumentation) Troubleshooting guide and information on disposables Outline of surgical modules (3 sets from easy to difficult): -set 1: bladder neck incision and median lobe enucleation -set 2: enucleation of lateral lobes with detachment from the external sphincter -set 3: tissue morcellation within the bladder HoLEP DVDs (step-by-step description of procedure with drawings and animations) Requirements for mentorship case selections (to maximize educational effect during mentor visits) List composition (guidance for case selections for the two mentorship visits) HUG database entry fields (for continuous auditing of outcomes)	Self-study according to the educational kit ⇩ First mentor visit: Day 1: two <30cc cases and two 40-60cc cases Day 2 (half day): one 40-60cc case ⇩ Continuation of mentee on her/his own (at least 10-15 cases) with regular frequency (1/week) from easy (middle lobe) to difficult (40-60cc 3-lobe) ⇩ Second mentor visit (within 6 months of first visit): 1 full day: three 40-60cc cases	Aho et al.[22] - 2015

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Table 4. Overview of Existing HoLEP Courses in the Literature. HoLEP (Holmium Laser Enucleation of the Prostate), TURP (transurethral Resection of the Prostate), BNI (Bladder Neck Incision)

Participants	Simulator	Course structure	Evaluation	Results	Author, Year of Publication
HoLEP naïve urologists n=40 -specialists n=34 -residents n=6	Kansai Medical University HoLEP Simulator (Prostatic hyperplasia model with 2 layers – enlarged adenoma with outer membrane – combined with real HoLEP laser generator, real endoscopic instruments, and laser fiber)	20-minute lecture introducing Holmium laser physics basics, surgical instruments and the 3-lobe technique ↓ Observation of live surgery of a 60cc prostate performed by a urologist who had performed more than 50 HoLEP cases ↓ 10-minute video explaining the prostate enucleation with the simulator ↓ Full enucleation on simulator with aid of mentor	Descriptive questionnaire (age, experience, prior TURPs, laparoscopic procedures) Face and content validity survey Ranking of difficulty levels for each of the 14 surgical steps after simulation	Content validity: -role for validated HoLEP simulation in training -simulation-based training and assessment is essential for patient safety -simulation should be implemented into training programs Face validity: mean 8,4 (8,1-9,0) -instrumentation: mean 9,0 -laser-tissue interaction: mean 8,6 -irrigation: mean 8,4 -bubbles: mean 8,4 -tactile feedback: mean 8,3 -overall experience: mean 8,3 -prostate model: mean 8,1 Level of difficulty of surgical steps: Stage 1: (1) Positioning fibre: 2.3 (1-5) (2) BNIs at 5 and 7-o'clock 2.3 (1-5) (3) Join BNIs distally 2.8 (1-4) (4) Ease beak of scope under median lobe 3.0 (1-4) (5) Detach median lobe from bladder neck 3.2 (2-5) Stage 2: (6) Hockey stick incisions at apices 2.9 (1-5) (7) Open tissue plane postero-laterally 3.1 (2-5) (8) BNI at 12-o'clock 3.3 (1-5) (9) Drop lateral lobes down from above 3.0 (1-5)7 Stage 3: (10) Divide mucosal bridges distally 3.2 (2-4) (11) Join upper and lower incisions 3.4 (2-5) (12) Open tissue plane around lateral lobes working retrograde to bladder neck 3.1 (2-5) (13) Prolapse lateral lobe into bladder 3.0 (2-5) (14) Detach lateral lobe from bladder neck 3.0 (2-4)	Antunes et al.[23] - 2019

resembling a hypertrophied prostate and its outer membrane. The two layers are connected via adhesives; the whole model fits into a cartridge and is installed into the simulator, a larger plastic chamber. A real Holmium 20-W laser (Lumenis, Yokneam, Israel) has been utilized. The simulator was evaluated by a prospective observational study in the UK to assess the simulator's face and content validity. The participants were 36 urologists (13 trainees and 23 senior urologists). The course was organized by Holmium User Group (HUG), a program organized in the UK to offer a structured HoLEP training. The course lasted 2 days and consisted of three modules: the first included live surgeries and tutorial videos, the second included instrumentation, safety, tips, and risk assessment; And the final module was the HoLEP simulation. Its duration was 45 minutes, and there was assistance from a HUG mentor. The simulator was a two-layered model of a synthetic prostate attached to its outer membrane. This model was in a cartridge and inserted into the simulator. For the simulation, the real HoLEP instruments were used on this prostate model with an adenoma, a capsule, and a surgical plane between them. The participants used a Lumenis 20-W Holmium laser for the operation. For the evaluation of the content validity, the participants answered a questionnaire on a Likert scale. Most participants stated that HoLEP is a practical choice for the treatment of BPH (mean score: 4.45), and that simulation training programs are essential for the patients' safety (mean score: 4.5). In addition, most of them believed that a validated HoLEP simulator has a vital role in this kind of training (mean score: 4.36). The participants completed questionnaires for the assessment of face validity. The components were instrumentation, tactile feedback, prostate model, laser–tissue interaction, irrigation, and bubble formation. All operative parameters succeeded better than the threshold (5 out of 10). Irrigation simulation was the most realistic parameter (9 out of 10). Also, almost all the participants (97%) thought simulation should be a part of the training process.

The Kansai HoLEP simulator was also evaluated in the context of a course. A prospective study was conducted to evaluate the opinion of 40 urologists on the simulator. The participants had experience with TURP and open adenomatectomy but had no HoLEP experience. This study was conducted during a 4-step course. In the first step, they watched a 20-minute introducing video about the HoLEP principles. In the second, they watched a live surgery by an experienced surgeon. In the third, they show a 10-minute video with the simulator. In the fourth and last step, they had a hands-on experience with the simulator, with a mentor's attendance. After the course, the urologists answered a questionnaire to evaluate the content and face validity of the simulator. As for content validity, all the participants believed that a HoLEP simulator is essential for training, and that simulators should be a part of training programs. Ninety-five percent of participants believed that simulation training programs enhance the operational safety of the patients. As for face validity, seven components were analyzed using a 10-scale score: overall experience (8.3), bubbles (8.4), irrigation (8.4), laser–tissue interaction (8.6), prostate model (8.1), tactile feedback (8.3), and instrumentation (9). The mean rate of the above components was 8.4. As for each operational step's difficulty at a 5-score scale, the two easiest steps were positioning the fiber and bladder neck incisions at 5 and 7 o'clock (mean difficulty score 2.3), and the hardest was joining the upper and lower incisions (mean difficulty score 3.4). One year later, eight out of 40 urologists had started using the HoLEP technique. Seven of them answered a follow-up questionnaire. All of them still believed that a HoLEP simulator is important for training, and that simulators should be a part of training programs. Of them, 57% thought that simulation training programs enhance the operational safety of the patients.[23]

Essential advantages include the prostate model's realistic appearance, irrigation, tactile feedback during the procedure, laser–tissue interaction, and subsequent bubbles produced. Also, feasible training and assessment components include anatomy identification, positioning the laser fiber, effective technique, avoiding damage to viscera, instrument damage, and blood loss. The simulator was generally rated as a helpful training tool but has only demonstrated face and content validity. Moreover, a thorough assessment of its cost-effectiveness has not been performed.

VR ThuLEP Simulator

The ability to learn without tutoring was investigated by a comparative study in Italy, using a ThuLEP simulator (CyberSim; Quanta System, Solbiate Olona VA, Italy). In this study, two enucleation-naïve experienced endourologists performed more than 100 ThuLEP operations in the same Italian hospital. Before the beginning of this study, both had the opportunity to train for 2 weeks on the new simulator but had no formal tutoring. The simulator can offer many different variations of adenomas and bleeding conditions during surgery. In addition, it has a system that calculates the resection rate and reports possible mistakes (sphincter section and capsule perforation). As for the patients, the mean age was 69 years, and the prostate size range was from 30 to 130cc. Both surgeons had an experience of around 50 ThuLEPs. Their operational time was similar. After the ThuLEP, patients had a follow-up at 2 and 6 months. The second follow-up included Prostate Specific Antigen (PSA) measurements, uroflowmetry, measuring post-void by ultrasound, and a new International Prostate Symptom

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Score (IPSS) score. Most of the patients had a smooth postoperative recovery, and the two surgeons had a very low incidence of complications (five cases). This study showed that the learning curve for ThuLEP is 30 cases. The results were encouraging, but the simulator was not adequately evaluated, and further verification of these results in larger-scale studies is deemed necessary.[21]

Curricula—Courses

The only curriculum revealed from the current search was organized by the HUG. It was created in 2006 to develop a HoLEP training course for urologists in the United Kingdom. In 2010, the HUG-MP (Mentorship Program) was created as an improvement of the previous course. The number of participants is not defined. This program consists of three different modules. The first module is for prostates less than 30cc, and it includes enucleation of the medial lobe and bladder neck incisions at 5 and 7 o'clock. The second module is for the lateral lobes' enucleation, and the third one the morcellation of the floating lobes in the bladder. Before the course, a set of videos was sent to the participants to prepare themselves step by step for a HoLEP surgery. After the course, a mentor visits a mentee to his hospital to operate together. The mentor is present in the operating room and can help if needed. Two 30cc cases and three 40-60cc cases are preferred for the first visit. The mentor's second visit is 6 months later, and the cases preferred are three 40-60cc prostates. The Kansai and VirtaMED simulators were used for the last six courses, but the authors do not define which simulator was used in the previous courses. The course participants found that VirtaMED is less realistic than the Kansai model, but it can be moved easily and includes a morcellation phase, which is an essential phase for the completion of the surgery. More than 30 urologists continue to practice HoLEP surgeries via this course, and some of them are now mentors.[22]

Only one study describing an EEP course could be identified.[23] Forty HoLEP naive urologists underwent a structured HoLEP course ending with a 3-lobe enucleation on a simulator model. Face and content validity were evaluated on a Likert scale from 1 to 10. Almost all participants thought that HoLEP simulation is essential and should be implemented in surgical training to improve patient safety. The difficulty of 14 surgical steps during 3-lobe HoLEP was evaluated and divided into three main stages. Each step's difficulty was ranked from 1—very easy to 5—very hard and evaluated by the participants. When comparing stage 1 to stage 2 and stage 1 to stage 3, difficulty scores were significantly different—$P = .14$ and .005, respectively. Stage 1 was judged as the easiest part of the procedure. Difficulty levels of step 3 and step 10 were significantly different between residents and specialists—$P = .006$ and .38, respectively. Median lobe detachment from the bladder neck, mucosal bridge division distally, and joining the upper and lower incisions were the most difficult steps during 3-lobe HoLEP.

Conclusion

Current evidence offers limited information about simulation-based training in EEP. Nevertheless, it seems that simulators and technology-assisted techniques could help urologists familiarize themselves with EEP and reduce learning curves, limiting the operational time and the possible surgical complications. In that way and when used as a part of a course, they could upgrade the surgical education level. Additionally, the use of training simulators, as part of training curricula and training courses, can create a new standard of quality for young urologists' education and clinical practice.

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