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Original Article

A fruit-tissue (apple) based training model for transurethral resection of prostate: face, content and construct validation

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Abstract: Aims and objectives: To establish face, content and construct validity of an innovative fruit-tissue (apple) based transurethral resection of prostate (TURP) training model devised at our institute. Method and material: Six consultants, three fellows and 16 residents performed TURP on the new fruit-tissue (apple) based TURP model for ten minutes after watching a demo-video. The procedure was videographed. At the end, participants answered a set of questionnaires regarding their experience. The video and the apple both were examined by blinded separate assessors based on pre-decided parameters. Statistical analysis was done to find out the face, content and construct validity of the training model. Results: Participants were divided into two groups, expert and novice, based TURP surgery experience. The model was positively rated (lowest median value 4) by all novice for its 'realism' and 'acceptability'. The expert group also felt that the model reproduced real TURP experience (lowest median value 4). Thus, both face and content validity were established. The expert group resected more tissue (18.3±2.5 gm vs 10.3±3.4 gm; P<0.001) with less irrigation fluid (1566.6±187.0 ml vs 2112.5±344.2 ml; P<0.001) removing more chips (39.8±6.2 vs 25.6±3.0; P<0.001) and orientated themselves faster (63.3±12.2 sec vs 90.3±12.7 sec; P<0.001). The assessors' subjective evaluation of videos and apples both favored the experts. The model can differentiate 'expert' from 'novice', thus establishing 'construct validity'. Conclusion: The new fruit-tissue (apple) based TURP model is a realistic and acceptable TRUP training model with proven face, content and construct validity.

Keywords: TURP, training model, validation study

Introduction

Modern era has witnessed a paradigm shift in the way the young surgical residents are trained. The traditional century-old "Halstedian" apprenticeship model of 'see one, do one, teach one' [1, 2] allows residents to learn surgical skills in operating theatre upon patients under the guidance of an experienced senior surgeon. But in the current scenario, with the growing awareness of patient safety, medical litigations and the ethical issues, the "Halstedian" model has faced several challenges. Instead, several training models and simulating systems have been devised for various surgeries that helped residents to develop surgical skills without risking patient's safety. Such training models, from the beginning of its inception in the early nineties, have significant contribution to decrease the learning curve and reduce surgical technique related complications. Overall, these have helped in mastering specific technical skills, particularly in developing good hand-eye-coordination along with regular practice to use instruments [3]. The use of various minimally invasive techniques are probably maximum in urology [4, 5]. Lastly, not to forget that repeated practice of the same thing fine-tunes that skills.

Lower urinary tract symptoms (LUTS) in ageing male due to benign prostatic hyperplasia (BPH) are extremely common [6]. Although pharmacological advancement has reduced the rate of surgery for BPH, still surgery in the form transurethral resection of prostate (TURP) is often considered the gold standard treatment of choice [7, 8]. The need for well-designed training

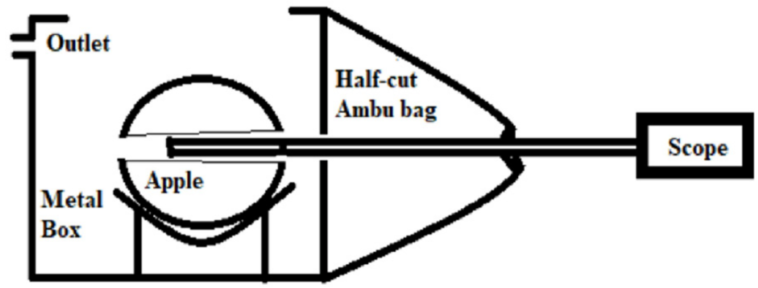

Figure 1. Schematic representation of the training model.

model to practice TURP, specifically for the residents is still very demanding. This particularly is essential in low-volume training centers [9]. It is also important that new model should have a positive learning effect that must be reciprocated during real surgery. Such effective model can also be introduced into urology resident training programs. Attempts have been made by various researchers to artificially create TURP training models and also by various instrument manufacturer companies to simulate TURP scenarios [10-13]. All models have their own pros and cons including availability of facilities and issues related to cost. We at our institute have prepared a simple yet effective fruit tissue (apple) based TURP training model which is easy to arrange and can be practiced by residents to learn the basic surgical skill of TURP. Any new device or model needs validation to prove its reliability and effectiveness [14]. In this study, we aimed to establish the face, content and construct validity of our training model.

Method and materials

Model design

A rectangular metal box was taken. The top lid was removed. A circular hole was made on the centre of the front wall. A half-cut Ambu bag was attached to the front wall in a water tight manner. One outlet was made on a side-wall near the upper edge of the box. A 26 Fr tunnel was bored through the centre of the apple so that a 26 Fr resectoscope passes snuggly across it. A curved metal plate was riveted inside on floor of the box. The apple was fixed with rubber bands on the riveted plate [**Figures 1**, **2**]. The Ambu bag opening, central hole on the front wall of the box and the tunnel in the apple were all in the same straight line. Thus, when resectoscope was passed, the pulp of the apple resembled the prostatic tissue [**Figure 3**]. A black color marking was done in the apple pulp near the scope-entry side to denote the verumontanum. Irrigation fluid (distilled water) passed along the scope into the box and came out of the outlet. The entire apple always remained submerged in the irrigation fluid. Monopolar cautery was used.

Evaluation of the model

All consultants, fellows and residents at our institute in the Department of Urology participated in the study. The demographic data of the participants were tabulated in terms of age, designation, years of urology practice, number of TURP performed lifetime as well as in last one year. We considered urologists as 'exert' when the number of TURP performed in lifetime were more than 50 with at least more than 10 TURP performed in last 12 months. A 3-minute video demonstrating TURP in the model were shown to all. Total 10 minutes were allotted to each participant to perform TURP and were asked to remove as many chips as possible. The TURP procedures were also videographed. Based on expertise, participants were given a questionnaire to fill-up after performing in the model. Each post-TURP-apple was also kept for review.

Messick's frame-work [15] was used to assess the validity of the model. The 'realism' and 'acceptability' of the device were assessed by twelve-point questionnaires in Likert's scale of 1 to 5 [**Table 1**] filled by the novice. This was used to assess the 'Face Validity' of the model. The 'Content Validity' of the model were evaluated by five-point questionnaires in Likert's scale of 1 to 5 [**Table 2**] specifically filled up by the experts. The performance of the participants was observed by two separate assessors, one assessing the post TURP model and other assessing the video of the participants. Assessment was based on a predetermined criterion [**Tables 5**, **6** respectively]. The 'Construct validity' of the model was evaluated by comparing the performance of the novice and expert.

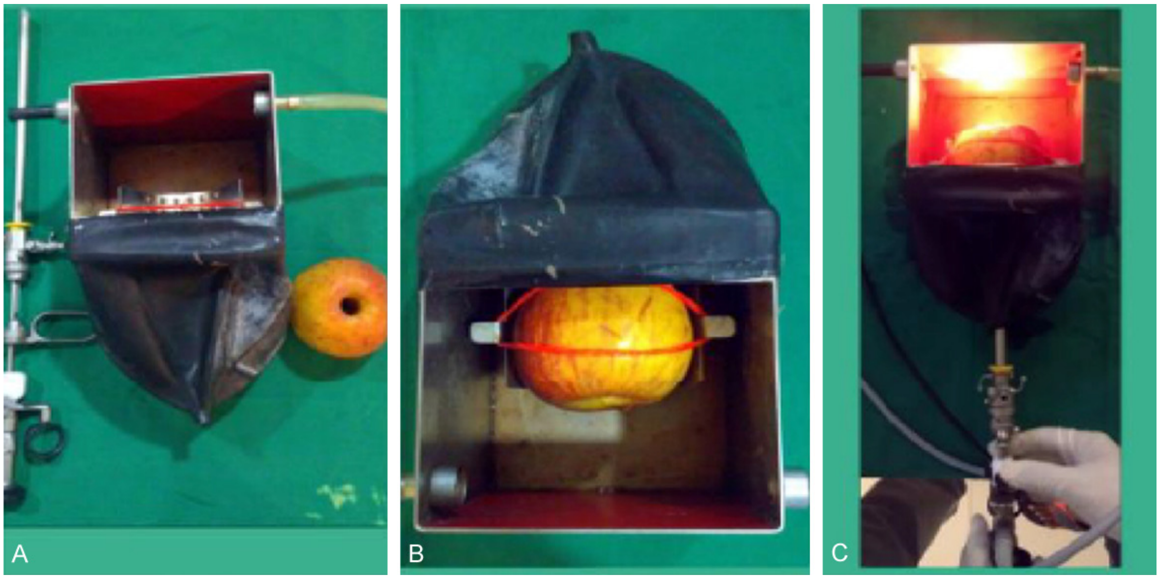

Figure 2. The TURP training model. A. Ambu-bag fixed with the metal box, apple with central groove made, metallic riveted plate seen within the box. B. Apple is fixed with the riveted plate by a rubber band. C. Scope passed across the Ambu-bag through the apple and light is seen coming out thought the central hole of the apple from the opposite end.

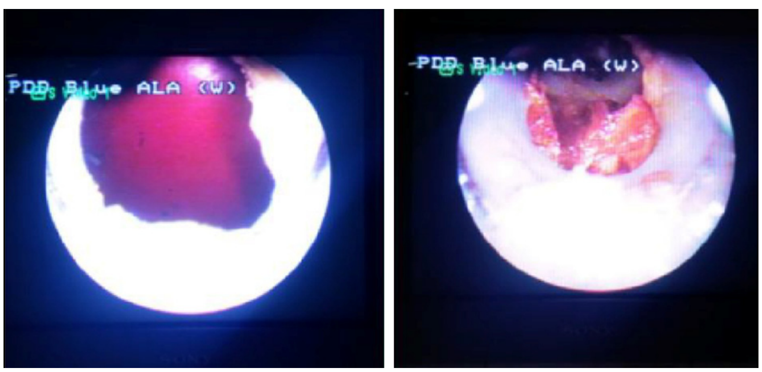

Figure 3. Endoscopic vision of the fruit-tissue (apple) based TURP training model.

Statistical analysis

Descriptive statistics were used to analyze the tabulated data. For test of significance, Mann-Whitney U test and the independent 't' test were used for the ordinal data (Likert Scale) and continuous data respectively. Value of $P<0.05$ was considered statistically significant. All analysis was done using SPSS v.23.

Results

A total of six consultants, three fellows and 16 residents participated in the study. All consultants and fellows had performed more than 50 TURP and also had done more than 10 TURP in last 12 months and were considered as 'expert'. Sixteen residents, at various stage of their residency course, participated in the study and none fulfilled the criteria to be an 'expert' and were considered 'novice'.

Face validity

Novice participants filled the twelve-point questionnaires of **Table 1** related to 'realism' and 'acceptability' of the new device and the median value of none of the parameters were less than 4 (in Likert scale of 1 to 5). All participants were clearly in the opinion that the model served the purpose for which it was built. Thus 'Face Validity' was established.

Content validity

The expert group filled the five-point questionnaires of **Table 2** containing issues pertinent to TURP and the median value of none of the parameters were less than 4 (in Liker scale of 1 to 5). The experts were strongly in the opinion that the fine intricacies of TURP could be properly reproduced and practiced with this model.

Table 1. Analysis of twelve-point Questionnaires filled by novice in Likert Scale (of 1 to 5 with 1 denoting least satisfying experience and 5 denoting most satisfying experience) for 'Face Validity'

	Median (50th Percentile)	Mean (± S.D.)
"Realism" Criteria		
1. Virtual Realism	4	4.3±0.47
2. Tactile Realism	4	4.13±0.61
3. Auditory Realism	5	4.63±0.50
4. Orientation	4	4.00±0.51
5. Instrumentation	4	4.06±0.44
6. Chips	4	4.13±0.61
7. Overall 'realism'	4	4.31±0.47
"Acceptability" Criteria		
1. As learning tool	4	4.19±0.54
2. Confidence gain	4	4.06±0.68
3. As warm-up tool	4	4.31±0.60
4. Ease of model set-up	4.5	4.50±0.51
5. Should incorporate in program	4	4.31±0.70

Table 2. Analysis of five-point Questionnaires filled by expert in Likert Scale (of 1 to 5 with 1 denoting least satisfying experience and 5 denoting most satisfying experience) for 'Content Validity'

	Median (50th Percentile)	Mean ± S.D.
1. TURP cutting reproducibility	4.00	4.44±0.52
2. Chip pushing reproducibility	4.00	3.67±0.50
3. Hand-eye-foot paddle co-ordination	5.00	4.78±0.44
4. Complication management	4.00	3.56±0.52
5. Incorporation in resident training	4.00	4.22±0.83

Construct validity

Tables 3 and **4** described the comparison of performance of the novice and experts. In post-TURP apple assessment, 18.3±2.5 gm of tissue was resected by experts using 1566.6±187.0 ml of irrigation fluid whereas novice participants resected only 10.3±3.4 gm of tissue ($P<0.001$) using 2112.5±344.2 ml ($P<0.001$) of irrigation fluid. On examination of the specimen, experts scored more points (statistically significant) for all parameters except bladder neck intactness (**Table 4**). 'Orientation time' of the experts (63.3±12.2 sec) were less than the novice (90.3±12.7 sec) with $P<0.001$. Similarly, for the 'cutting time' (448.8±25.7 sec vs 325.6±33.6 sec; $P<0.001$) and 'no of chips removed' (39.8±6.2 vs 25.6±3.0; $P<0.001$), experts performed significantly better (**Table 3**) than the novice. In terms of assessor's video evaluation, in all the fields of assessments (in Likert's scale), the experts performed significantly better (**Table 4**) than the novice. Thus, the model has the ability to differentiate the expert from the novice, and has established its construct validity.

Discussion

The history of surgical training using human cadaver or animal model as simulator dates quite long back [16]. A large number of laparoscopic and endourological commercial training models are also available for uro-surgical training. In fact, Schout BM et al [17] in 2008 described a total of 30 endourological models in their review. Training in various models definitely improves the dexterity, hand-eye coordination, assessment of depth perception and overall surgical skill in a stress-free way away from the operating theatre [18]. The cognitive learning is also an important aspect which an ideal training model should render [19]. Animal models, although provide higher fidelity and better tissue feel, have major drawbacks that include cost, limited availability, specialized facilities and ethical concerns. Thus, there is a growing need for artificial physical training model for basic motor skill development, at least in the early part of the career of a urologist [20, 21]. A review by Sistla Bobby Viswaroop et al [22] emphasized the need of incorporation of a training model in the resident training program irrespective of the fidelity of the simulator. Nayahangan et al [23] even prioritized a list of urological procedures for incorporation in urology training.

TURP involves use of resectoscope with cutting and coagulation current. Precise movement of resectoscope is needed to avoid injury to urethra, bladder, ureteric orifices and most importantly to achieve adequate hemostasis. Thus, besides motor skills development, there is al-

Table 3. Comparison of performance between novice and experts (continuous variables)

	Experience [E: expert (n=9), N: novice (n=16)]	Mean ± SD	p (two tailed)
'**Table 5**' content			
Tissue resected (gm)	E	18.33±2.50	p<0.001
	N	10.31±3.40	
Irrigation fluid (ml)	E	1566.67±187.08	p<0.001
	N	2112.50±344.23	
'**Table 6**' content			
Orientation time (sec)	E	63.33±12.24	p<0.001
	N	90.31±12.71	
Cutting time (sec)	E	448.89±25.71	p<0.001
	N	325.63±33.65	
No. of chips	E	39.89±6.23	p<0.001
	N	25.63±3.05	

Table 4. Comparison of performance between novice and experts (Likert scale parameters)

	Experience [E: expert (n=9), N: novice (n=16)]	Mean ± SD	p (2 tailed)
'**Table 5**' content			
Channel clearance	E	4.22±0.44	<0.001
	N	2.94±0.68	
Channel smoothness	E	3.56±0.52	0.039
	N	3.00±0.63	
Capsule intact	E	3.67±0.50	0.005
	N	2.75±0.85	
Sphincter intact	E	3.33±0.50	0.037
	N	2.75±0.68	
Bladder neck intact	E	3.78±0.44	0.151
	N	3.38±0.71	
'**Table 6**' content			
Instrument handling	E	4.56±0.52	<0.001
	N	3.19±0.75	
Chip size adequacy	E	4.11±0.33	0.001
	N	2.88±0.88	
Cutting always under vision	E	4.67±0.50	<0.001
	N	3.19±0.75	
No unnecessary cautery use	E	4.78±0.44	<0.001
	N	3.38±0.61	
Verumontanum/Bladder Neck resection	E	4.56±0.52	<0.001
	N	3.25±0.57	

so a need to judge and manage complications as well. An ideal training model for TURP should provide ample scope to practice both of these aspects. Our newly devised fruit-tissue (apple) based TURP training model provides an easy set-up to practice the technique of TURP by the residents (motor skill development). It also provides the essence of real tissue feel. Chips can be pushed into the box after cutting as if pushing the chips in the bladder. The permanent marker color denotes the verumontanum that provides surgical landmark to the

Table 5. Form for post TURP apple tissue evaluation (For Assessor 1)

Post TURP apple tissue evaluation
Answers in continuous scale
1. Prostate tissue removed (measured by weighing apple before and after the procedure) (gm)
2. Irrigation fluid used (ml)
Answer in Likert's scale (5 for best, 1 for worst)
1. Channel adequacy
2. Channel lining smoothness
3. Capsule (apple skin) intactness
4. Sphincter preservation (marker color intactness)
5. Bladder neck region (visual adequacy of bladder end of apple)

Table 6. Form for Video evaluation (For Assessor 2)

Video Evaluation
Answers in continuous scale
1. Orientation time (sec)
2. Cutting time (sec)
3. No of chips cut
Answer in Likert's scale (5 for best, 1 for worst)
1. Instrument handling
2. Chip dimension adequacy
3. Cutting under vision
4. Appropriate cautery use (e.g. no firing in space)
5. Appropriate cutting near verumontanum/bladder neck

user. However, it lacks the bleeding manifestation of real life.

Any new training model needs validation in terms of face, content, concurrent and construct validity [14]. Validations of TURP simulator studies [24] were published in literature earlier as well. 'Face validity' finds out whether the tool does what it is intended to do and is usually determined by the response of the novice. In our study, we broadly divided the criteria of face validity (**Table 1**) into two parts. Firstly, to check whether the model is realistic enough or not and secondly, to see whether it is well accepted by the novice as a training model or not. R. Sweet et al [24] in their studies used similar criteria as well. When it comes to 'content validity' which by definition aims to find out the usefulness of the tool by the experts in the concerned field, we deliberately used a different questionnaire (**Table 2**) that specifically reflects the details of the surgical procedures and the intricacies associated with that. Our model has both face and content validity which was established in this study. We took a meticulous step to find the 'construct validity' involving two independent blinded assessors filling up the **Tables 5**, **6** anonymously. Expert surgeons can work faster resecting more prostate tissue in shorter interval of time using less irrigation fluid and the resultant prostatic fossa visually looks smoother with lesser probability of complications like capsule breach or bladder neck injury or verumontanum injury. Similarly, experts can orient in the prostatic urethra with the resectoscope faster, their movements are supposed to be less clumsy, resection will be mostly under vision and cautery use will be safer and judicious with minimum inadvertent cautery-paddle press. Our model has successfully discriminated the novice from the experts and has proved its 'construct validity'. Technically, the model can also be used as a tool to decide whether the residents are prepared for real surgery.

Innovative TURP physical training models have been published in the literature in the past. James Brewin et al [13] in their study validated the Bristol TURP model training, which is a synthetic prostate model with latex-made bladder, however, they concluded that the design lacks the bleeding components like our model. Prostate resection trainer was evaluated by Ebbing et al [11]. They found that the trainer was an effective and suitable alternative to virtual trainer that helped in marked improvement in the resection speed and faster learning curve. However, proper validation was pending. Using porcine kidney as prostate Hou S et al [12] also developed a TURP training model with realistic out-look. The model was also validated in literature. Recently Nur Rasyid et al [10] devised a food-based TURP training model using costly 3D printing technique. Although the texture was similar to prostate but the model lacked important landmark like verumontanum. To our knowledge, this fruit-tissue (apple) based TURP training model is the first of this kind with appropriate validation. The training model is easy to construct, realistic, portable, lightweighted, reusable with just the need of a fresh apple. It can be easily made even at home with simple metal box and used Ambu bag at a cost of less than 8$ (<550 INR). Use of real instruments makes it more closure to real TURP and in particular the tissue feel puts it ahead of the virtual simulator. Recording of performance by the trainees may also help to introspect the mistakes. The psychomotor development [25] of hand, eye and foot co-ordination can be achieved. Overall, we strongly feel the model is suitable for basic motor skill development for TURP particularly for the novice urology residents before real surgical procedures. It can also be used as a warm-up device before the real surgery.

The main drawback of this model is the lack of bleeding which the virtual simulator can mimic. Thus, basic motor skills and maneuverability can be improved but handling of bleeding and complications cannot be mastered in this model. Surgeon will not face the anatomical and physiological variations during training particularly, problems which are often encountered with a large median lobe. The predictive validity or proof of application of the learned-skill in the real surgery is missing in this study which may be an important negative consideration for incorporation of this model in the resident training programme. Lastly, the shortcoming of this study may be the limited number of participants taking part in the study.

Conclusion

The fruit-tissue (apple) based TURP model has well established face, content and construct validity. Model preparation is very easy. It will be useful for practicing TURP procedure for the novice surgeons and may be considered for incorporation in the resident training programs.

Disclosure of conflict of interest

None.

Abbreviation

TURP, Trans urethral resection of prostate.

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