ORIGINAL REPORT

Low-Cost Training Simulator for Open Dismembered Pyeloplasty: Development and Face Validation

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PURPOSE: Surgical simulation has benefited from a surge in interest over the last decade because of the increasing need for a change in the traditional apprenticeship model of teaching surgery. Open surgery for ureteropelvic junction (UPJ) poses unique training challenges owing to smaller workspaces, and finer sutures used that require increased surgical dexterity when compared with adult analogues. We describe the development and face validation of a low-cost training simulator for open dismembered pyeloplasty.

MATERIALS AND METHODS: The simulator is built with A4 Kraft envelopes, catheter tip syringe filled with 30 mL of air, tape, 260 modeling balloon, and 11-in party balloon. Evaluation of the device is based on an evaluation form including 11 items on a 5-point Likert-type scale. Thirty-one departments of pediatric surgery in France were contacted and received a pack containing 4 to 10 devices, already set up and ready for use, a tutorial and an evaluation form. Candidates were stratified according to their level of expertise.

RESULTS: A total of 180 devices were sent. Procedures on the device were performed 118 times (65%) by expert surgeons ($n = 44$), fellows ($n = 25$), and residents ($n = 49$). Statistically significant difference was noted for 4 items (anatomy, model exposition, UPJ resection, and difficulty) for the 3 levels of expertise. The global score evaluation for realistic items, face validity, and usability was 4.2 (range: 1-5).

CONCLUSION: This low-cost model is evaluated as an efficient tool for UPJ teaching and training. It shows promise as an educational tool. (J Surg Ed ▮:▮▮▮-▮▮▮. © 2017 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: open surgical simulation, pyeloplasty, surgical education, children

COMPETENCIES: Practice-Based Learning and Improvement, Patient Care

INTRODUCTION

Dismembered Anderson-Hynes open pyeloplasty is the gold standard to treat ureteropelvic junction (UPJ). This surgery is technically difficult and involves a long learning curve. It is a suitable procedure for enabling pediatric urology trainees to acquire surgical skills. Yet, cases are not frequent enough to provide sufficient access to maintain the necessary skills and fully master the procedure. Moreover, the development of laparoscopic pyeloplasty has noticeably reduced the caseload of open surgery for children older than 1 year of age.[1,2] Owing to the difficulty of this procedure, public concern for patient safety, and budgetary constraints of medical centers with increased operating room costs, traditional apprenticeship model (by observation and assistance) is no longer the main training method.[3,4] Developing skills in pediatric surgery within an appropriate time of training in operating room has,

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therefore, become a challenge.[5] Surgical simulation allows novice surgeons to acquire and practice surgical skills before operating on their first patient. Training using benchtop model or simulators has already demonstrated its positive effect for basic surgical skills in the operating room.[6-9]

Despite the recent interest in surgical simulation as an adjunct to surgical training, most of the literature focuses on laparoscopic surgical simulation with very few studies scrutinizing the aspects and benefits of open surgical simulation to surgical trainees.[10]

We have developed a low-cost simulator for novice to train surgical skills in open UPJ. The objective of the study is to evaluate realistic items, face validity, and usability of a low-cost UPJ simulator through a multicentric national survey.

METHODS

The study was conducted with the approval of the *Société Francophone d'Urologie Pédiatrique et de l'Adolescent* (*SFUPA*). Pr J. Breaud designed the low-cost simulator in the University of Nice Sophia Antipolis Medical Simulation Center, which is an Accredited Education Institute by the American College of Surgeons. A pack containing 4 to 10 simulators, with tutorial (Fig. 1) and evaluation form (Annex 1) was sent by mail to all the departments of pediatric surgery in France (31 university hospitals). The number of devices sent to each institution was estimated on the number of surgeons involved in pediatric urology for better adequation between the number of devices and participants. The evaluation instrument was conceived and based on previous reports for training models in pediatric surgery.[11,12] To evaluate the model, we used 11 items on a 5-point Likert-type scale. A total of 180 simulators were sent. Candidates were stratified according to their level of expertise: resident, fellow, and expert. Fellows were classified as expert when they performed more than 50 procedures as first operator. To appreciate the construct validity of our simulator, it was evaluated by a duo; an expert or a fellow with a resident. The senior (fellow or expert) started the procedure with the help of the resident and filled the evaluation form. The resident subsequently performed the procedure with the help of the senior and filled the evaluation form.

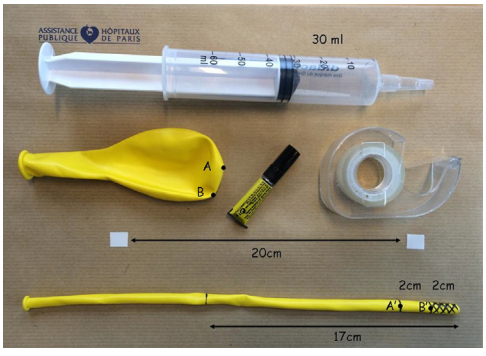

FIGURE 1. Items needed for the assembly of the simulator.

The simulator

The construction of the simulator requires the following: A4 Kraft envelopes, 60 mL catheter tip syringe filled with 30 mL of air, 260 modeling balloon (the ureter), 11-in party balloon (the dilated renal pelvis), strong glue, permanent marker, tape, and ruler (Fig. 1). The use of air to inflate the party balloon is supposed to mimic the collapse of a dilated renal pelvis that would occur in a live surgery. The cost is less than $1 per simulator.

Before inflating the party balloon with 30 mL of air, its extremity is labeled (A) and another point is labeled 2 cm on the edge of the balloon (B). The 260 modeling balloon is labeled at 2 cm (B′), 4 cm (A′), and 17 cm from its tip. Its 2 distal centimeters are hatched. The top end of the modeling balloon is stuck to the B point of the party balloon with strong glue. The segment BB′ simulates the stenosis of the UPJ. The 2 associated balloons are gripped on the Kraft envelope with rubber tape, at a distance of 20 cm. Before starting the procedure, the envelope is stuck to a table to prevent it from moving during anastomosis (Fig. 2A).

Evaluation Form

Eleven questions were designed to determine the perception of the simulator on a 5-point Likert scale (1: poor, 2: marginal, 3: moderate, 4: good, and 5: excellent) (Annex 1). The first question was about the overall impression. Eight questions addressed the realistic items of the low-cost simulator: anatomy, texture, size, the 4 steps of the procedure (exposition, UPJ resection, ureteral spatulation, and anastomosis), and global difficulty. One question evaluated its face validity. The last question evaluated its usability. Participants could make a comment at the end of the survey.

Tutorial

Usual surgical tools (graspers, scissors, etc.) were mandatory for the procedure. The procedure (right-sided pyeloplasty) was performed with surgical gloves and binoculars (Fig. 2). The narrowed segment was removed (Fig. 2B), the party balloon trimmed, and the modeling balloon spatulated. The dismembered Anderson-Hynes pyeloplasty was performed with 6-0 polydioxanone sutures (Fig. 2C). At the end of the procedure (Fig. 2D), the patency of the anastomosis was tested with air or water. There was no limit for procedure duration.