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Skills Comparison in Pediatric Residents Using a 2-Dimensional versus a 3-Dimensional High-Definition Camera in a Pediatric Laparoscopic Simulator

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INTRODUCTION: Advantages in 3-dimensional (3D) laparoscopy are mostly described in adults for better depth perception, precise visualization of anatomical structures, as well as for complex surgical maneuvers in small spaces. Using Visionsense III stereoscopic endoscopy system (Neuromed Spa), we performed a comparative study between surgical skills achievements using 2-dimensional (2D) and 3D laparoscopic equipment in a pediatric laparoscopic surgery simulator model.

MATERIALS AND METHODS: Three skills were evaluated both in 2D and 3D modalities. Pediatric residents ($n = 20$) without any previous laparoscopic experience were randomly divided in 2 groups and evaluated doing the established tasks in a laparoscopic simulator validated for pediatric surgery. Switching the type of vision from 2D to 3D or vice versa, we evaluated bimanual dexterity, efficiency, and efficacy. Three tasks were proposed—task 1: transfer of objects (6 pegs transferred one-by-one on a pegboard); task 2: pattern cutting (cutting a paper, following a circular dotted line); and task 3: threading eyelet (transfer, twisting and passing through a eyelet-shaped support, a specific 3D object). Performance was measured using a scoring system rewarding precision and speed. Any physical discomfort related to the 3D vision was recorded.

RESULTS: Of the 20 participants included, 10 began the skills in the 2D modality and then performed them in 3D, and the other 10 began in 3D and ended in 2D. Overall task 1 performance (time and number of errors) was significantly better using stereoscopic compared with monoscopic visualization. Both groups experienced a 35.6% decrease in the time needed to complete the peg transfer using 3D instead of 2D. In task 2, the 3D performance was superior (less time to correctly cut the paper along the dotted line), but did not reach statistical significance. In task 3, the residents experienced with 3D a 31.7% decrease in the time necessary to complete the passage of the object trough the eyelet. Most participants (65%) "subjectively" defined 3D laparoscopy easier overall; 6 participants (30%) did not experience any issue related to the use of 3D technology; and 1 person (5%) of group 1 found more difficulties using 3D compared with 2D. Headache (25%), nausea (20%), and visual disturbance (1%) were the most common issues reported by the students during 3D procedures. Finally, the results show that residents achieved significantly better results working with 3D vision rather than with 2D vision.

DISCUSSION: As other studies have demonstrated, there was improvement in the overall performance using the 3D laparoscope. This was the first attempt to verify 3D skills in naive subjects, directly on a simulator conceived exclusively for pediatric surgery; therefore, bias was limited by using a population without surgical experience.

CONCLUSIONS: 3D laparoscopic surgical skills showed superior to 2D, with higher percentages of tasks completion, less time in performing them, and a shorter learning curve. Our results indicate that 3D was subjectively easier than 2D in performing complex tasks in the skills laboratory setting.

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INTRODUCTION

Technology has driven important advances in the field of minimally invasive pediatric surgery over the past two decades and laparoscopy has become a standard technique for a wide range of surgical indications in pediatric surgery.

However, acquisition of laparoscopic skills can be challenging: the monocular, 2-dimensional (2D) visualization obtained with current mini-invasive systems, lacks of depth perception and this significantly reduces the surgeon's ability to determine the size and the precise localization of anatomical structures, thus impairing the ability to operate efficiently.

When viewing a 2D conventional laparoscopic image, both eyes see exactly the same image, missing the physiological binocular horizontal disparity (stereoscopy), which is at the basis of depth perception.

Industry has recently developed novel 3-dimensional (3D) systems for laparoscopic surgery, where the depth perception is achieved by different unique images received by each eye and merged together in the cortical areas.

Some examples are represented by Conmed 3D HD Vision System (Conmed Corp., Utica, NY), Olympus Endoeye Flex 3D Videoscope (Olympus America Corp.), Aesculap EinstenVision 3D System (Aesculap, Tuttlingen, Germany), and Storz Image1 S 3D (Karl Storz, Tuttlingen, Germany).

These camera systems are all mounted on 10-mm scopes, very useful for adult surgery but sometimes too big for neonatal or infantile procedures.

Advantages in 3D laparoscopy are, moreover, mostly studied and described in adults for better depth perception, precise visualization of anatomical structures, as well as for complex surgical maneuvers in small spaces, while research is lacking in pediatric general surgery.

The aim of this study was to determine the benefit of the 3D technology in pediatric laparoscopic surgery (PLS) in naive subjects in a PLS simulator[1] and to record their subjective perception regarding 3D laparoscopy.

MATERIALS AND METHODS

Using Visionsense III Stereoscopic Endoscopy System (Neuromed Spa, Turin, Italy), a 3D HD camera with a 4-mm scope, Food and Drug Administration and European compliance (CE) approved for pediatric surgery, we performed a comparative study between surgical skills achievements using 2D and 3D laparoscopic equipment in a laparo-trainer conceived exclusively for pediatric surgery.

A total of 20 pediatric residents without any laparoscopic experience were randomly divided in 2 groups and evaluated doing object transfer and simple surgical maneuvers. Each student was then asked to fill out a small questionnaire answering 2 questions regarding their 3D experience.

One question was related to the subjective perception of their surgical performance (*Compared to standard 2D laparoscopy, you feel that 3D laparoscopy is: overall easier, approximately the same, overall more difficult?*) and the other was related to the side effects experienced during the exercises (*Did you experience any issue by using 3D laparoscopy: headache, nausea, visual disturbances, others?*).

The PLS (endotrainer box) had internal dimensions of 18 cm (length) × 10 cm (width) × 9 cm (height) as described by Nasr et al.[1] (Fig. 1).

We used two 3-mm working ports and a 5-mm camera port in a typical triangle-shaped position.

Both the 2D and 3D optical systems were mounted to a holding arm and held in a fixed position showing the complete area of interest within the box trainer.

Pediatric residents ($n = 20$) were randomly divided in 2 groups—group 1 ($n = 10$), in which the participants started with 2D first and group 2 ($n = 10$), in which the participants started with 3D first.

The study design was explained to each of them, and they gave their consent to participate. The students then were given a short time (3 min) to become familiar with the instruments and in case of the 3D group to get comfortable with 3D vision.

Each participant was assessed during the performance of 3 tasks, using both 2D and 3D vision, under the guidance of a tutor, who was not blinded to the type of laparoscopy being used.

Each tutor was assigned to a working station and was instructed to observe the participant performing the assigned task by looking at a screen, either a standard HD-2D screen or an HD-3D screen (in this case, using glasses).

Switching the type of vision from 2D to 3D or vice versa, we evaluated bimanual dexterity, efficiency, and efficacy; performance was measured using a scoring system rewarding precision and speed.

Visionsense miniature stereocamera physically resembles standard monocular cameras but allows through sensors the generation of true stereovision. The system is composed by a 3D HD camera, with remote control buttons and a rod to change focus; a 3D scope with size diameter less than 0.4 cm; a coupler to attach all 2D scopes available on the market; autofocus from 0.5 to 5 cm; a console (PC-based unit); and a