Effects of the physical and VR 3D Anatomical models produced for the simulation of the functional urological surgeries on UroAnatomy Knowledge

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Hypothesis / aims of study

Surgical Anatomy education has been usually based on the Halstedian methodology of “see one, do one, teach one” for decades. But there is a lack of wide scale availability of materials for learning surgery operations. Thus, there is definitely a need for new solutions for training on young surgical fellows. Even though cadavers have been used for ages, many problems including organizational and logistic factors such as the need for trained personnel, the lack of efficient number of corpses available for dissection to prevent student overload, the high cost for maintaining dissection labs, and health risks due to prolonged exposure and contact with corpses, that prevent their widespread usage. it is also necessary to develop novel training modalities in surgical anatomy education to overcome the limitations of traditional training, which has many difficulties such as residency work hour restrictions, patient safety conflicts and lack of hands-on workshops. These educational limitations provide a room for improvement of medical and surgical training using digital simulations, 3D medical applications such as Virtual Reality (VR) and 3D printed models. Finalized projects (MedTRain3DModsim, Erasmus+ KA203HED project done by Hacettepe, Rome 3, Charles and Chosun Universities and Hellenic Urological Association between 2016-2018 and EuroSOMT, Erasmus+ KA203HED project done by Hacettepe, Katholic Leuven, Perugia, Chosun Universities and ICS between 2020-2022) of our working group aimed to extract and reconstruct 3D realistic anatomical models from radiological DICOM images with various software packages and to 3D print or digitally simulate them in 3D for educational purposes. The aim of this study to evaluate if any effect of the physical and VR 3D Anatomical models produced for the simulation of the functional urological surgeries on UroAnatomy Knowledge.

Study design, materials and methods

The study was carried out during 3 different learning, teaching & training events held in Hacettepe and KU Leuven Universities with 72 participants. More than 10 different physical and VR (digital) anatomical models were determined from DICOM images for different functional urological surgeries. MIMICS Innovation suite was used for the segmentation and digital anatomical model production. FormLabs 3B and other FDM based 3D printers used for 3D printing. In the first year of the study, 3D modeling, 3D medical processes and related studies were carried out and in the second year, training was given to the trainees in 3 separate events. Before and after each learning, training and teaching events, the participants answered 30 anatomy questions. Sample questions can be seen in Figure 1.

27. Indicate the option in which the following structures are in the correct order from the skin to the pelvis.
I. Bulbospongious M.
II. Sphincter urethra M.
III. Perineal membrane
IV. Deep perineal (investing or Gallaudet’s) fascia
V. Levator Ani M.

a) I, II, III, IV, V
b) IV, I, III, II, V
c) III, II, I, V, IV
d) II, III, IV, V, I

Correct Answer: B

28. Which oft he followings is not directly related with deep perineal space in female?

a) Sphincter urethrovaginalis M.
b) Compressor urethralis M.
c) Perineal membrane
d) Round ligament

Correct Answer: D

29. Which of the following structures is found between the tendinous arch of levator ani and the tendinous arch of pelvic fascia on the lateral pelvic wall?

a) Obturator fascia
b) Iliac fascia
c) Superior fascia of pelvic diaphragm
d) Transvers cervical (Cardinal) ligament

Correct Answer: C

30. Which of the following structures occurs as a result of lateral condensation of the pubocervical fascia?

a) tendinous arch of pelvic fascia
b) tendinous arch of levator ani
c) Transvers cervical (Cardinal) ligament
d) Uterosacral ligament

Correct Answer: A

Figure1. Surgical Anatomy Question samples from questionnaire

Comparison of correct marking rates of each question by participants for pre- (72 participant) and post-test (70 participant)

Question Number	Pre-Test (%True)	Post-Test (%True)	Question Number	Pre-Test (%True)	Post-Test (%True)
1.	20,27	33,33	16.	33,77	42,86
2.	31,08	35,71	17.	28,37	33,33
3.	35,14	45,23	18.	37,82	47,62
4.	37,84	42,85	19.	49,98	57,14
5.	31,08	47,61	20.	24,31	38,1
6.	40,53	38,09	21.	35,12	40,48
7.	40,53	42,85	22.	37,82	50
8.	24,32	45,23	23.	40,53	47,61
9.	54,04	64,28	24.	28,37	45,23
10.	45,93	57,14	25.	49,98	66,66
11.	25,66	26,19	26.	28,37	42,85
12.	36,47	47,61	27.	32,42	28,57
13.	49,98	47,61	28.	44,58	47,61
14.	44,58	45,23	29.	27,02	28,57
15.	32,42	40,47	30.	31,07	40,47

Figure2. Comparison of correct marking rates of each question by the participants

Results

Comparison of correct marking rates of each question by the participants can be seen in Figure 2. There was an approximately 35% of positive improvement between the post-test and pre-test results.

Interpretation of results

We experienced ‘hybrid surgical anatomy education’, using 3D digital and printed models. The use of physical printed and/or digital VR 3D anatomical models in the anatomy education provided content and increased the quality of using that content. It also provided variety and diversity to the limited educational materials because of the aforementioned cadaveric restrictions.

Concluding message

As a conclusion, we believe that the customized 3D physically printed or digital VR anatomical model produced from real patient’s radiological data with anatomical accuracy have a positive impact on general UroAnatomy Knowledge.

References

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