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Original Article

The MAVID heart holder: a demonstration device to anchor cadaver hearts for surgical simulation and practical education*

Constantine Mavroudis,[1] Rachid Idriss,[2] Kristen E. Klaus[1]

[1]*Johns Hopkins University School of Medicine, Johns Hopkins Children's Heart Surgery, Florida Hospital for Children, Orlando, Florida;* [2]*Chicago, Illinois, United States of America*

Abstract Performing open heart surgery involves learning challenging techniques and a need for realistic training models to achieve and maintain a high level of surgical skills. The MAVID heart holder is an organ holder primarily designed to hold the heart in its anatomic position for the purpose of surgical simulation and education, thereby closing the gap between surgical performance in the laboratory and in the operating room. The device is simple to use, can be adjusted to organ size, and has the necessary instrumentation to be used with any solid organ. The MAVID heart holder also provides a platform for presentation and assists in advancing the research sphere. The advantage over other existing models is that the MAVID heart holder uses real tissue and does not distort the organ at the attachment sites. Further, it offers superior stability as well as the ability to manipulate the organ during presentation and dissection. Training with the MAVID heart holder has the potential to shorten training time to acquire surgical skills and proficiency before performing these techniques in the operating room and in so doing enhance patient safety.

Keywords: Surgical training; surgical proficiency; solid organ simulation

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Open heart surgery can be challenging even for well-trained cardiac surgeons. Before operating on live patients, surgeons must be well trained in order to achieve sufficient skills initially and then continuous practice to maintain surgical excellence. There is a need for realistic training models to achieve this,[1,2] but there remains a gap between using simulators and practising the art of cardiovascular surgery. Skills learnt in an animal-based laboratory are noted by Reuthebuch et al[3] as being limited and restrictive because of animal protection organisations. Use of the operating room for training is now being closely evaluated to advance patient safety, and the quality and efficiency in the development of surgical skills is key before performing surgical intervention on patients.[4–7] The ability to transfer skill sets between simulation and human surgery depends on the similarity between the two environments.[8] A few cardiovascular training models exist today. Mostly, these models are artificial and represent only parts of the heart.[9–18] There are few models that allow the learner to practise on the heart in its entirety while holding the heart in place as is found in the human body. The purpose of this paper is to introduce the MAVID heart holder, a superior model for resident training, demonstration purposes, and use in surgical research.

Background

The MAVID heart holder can position a cadaver heart in place in a way that one would find in the human body, thereby providing the opportunity to practise cardiovascular techniques approximating the

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Correspondence to: Dr. C. Mavroudis, MD, Johns Hopkins Children's Heart Surgery, Florida Hospital for Children, 2501 N Orange Ave, Suite 540, Orlando, FL 32804, United States of America. Tel: 407 303 3697; Fax: 407 303 3634; E-mail: constantine.mavroudis.md@flhosp.org

complexity and difficulty as if in the operating room. Examples of operative exposure can be seen in Figures 1–6. The system display of the MAVID heart holder, as seen in Figure 1, is established with a cadaver heart. The MAVID heart holder comprises four right-angled posts attached to a metal plate with multiple holes to account for variations in heart size and exposure. Right-angled posts can be attached to the inferior caval vein, superior caval vein, pulmonary arteries, and aorta by simple sutures to stabilise the heart for a procedure that can be performed by the learner. The aortotomy is shown in Figure 2. The ventriculotomy and aortic valve exposure can be seen in Figure 3, and the coronary artery exposure is seen in Figure 4. A right atrial view, as seen in Figure 5, is the most frequently used approach to atrial septal defects, perimembranous ventricular septal defects, and all defects opening to the inlet of the right ventricle.[19] A left atrium and mitral exposure is seen in Figure 6.

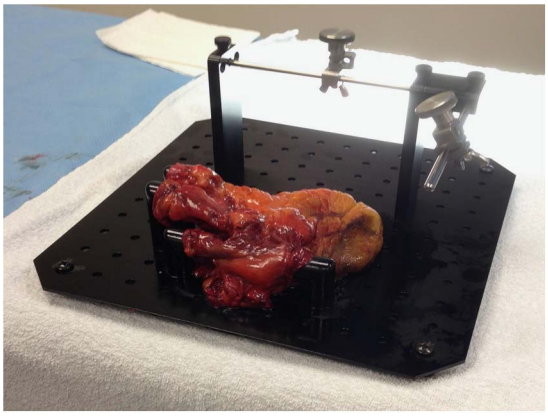

Figure 1.
MAVID heart holder system display.

The MAVID heart holder is a series of retractors and studs embedded into a metal platform by which a cadaver heart may be secured in place in a way that one would find in the human body.[20] Various devices are available to assist in the training of surgeons. Kutschka[18] uses a box-type platform to secure artificial organs; Loor[15] presents a portable box-type platform simulating complexities of cardiothoracic suture and in the practice of tying. Chamberlain[13] uses an animated silicon model, whereas Liu et al[11] work with a pneumatic artificial simulator, and Ramphal et al[16] work with a computer-controlled tissue-based simulator. These and other simulators have provided realistic learning environments for improvement; however, it is desirable to have as realistic a model as possible to approximate the complexity of human physiology.[21] A formal cardiac surgery simulation curriculum was found to be feasible based on needs assessment.[22] Training could be further advanced in a stepwise manner to include proficiency-based training with the above-mentioned simulators, with the ultimate progression to training on the MAVID heart holder, and finally to perform procedures on live patients.

The advantage over other existing methods is that the MAVID heart holder uses real tissue and does not distort the organ at attachment sites. It offers superior

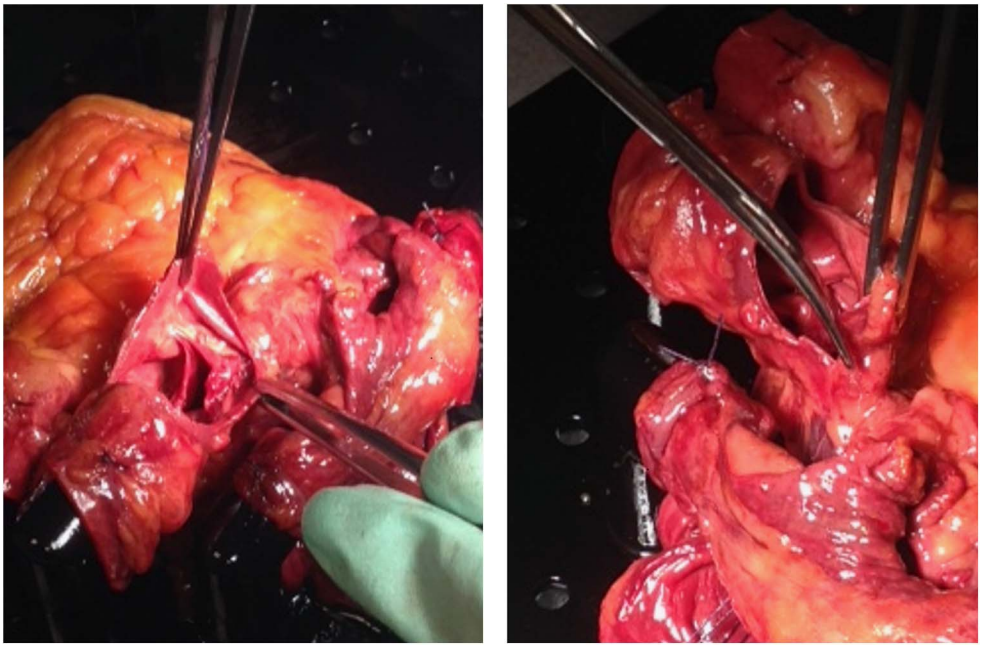

Figure 2.
MAVID heart holder operative exposure: aortotomy.

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stability as well as the ability to manipulate the organ during presentation and dissection for the most realistic training before performing in the operating room.[20] The MAVID heart holder can be used with other solid organs such as the lung, liver, and kidney. The principles are the same – namely, to fix the structures in place and simulate real physiologic conditions. In order to achieve this, repositioning of the retractors and struts can be implemented with different structures on the board.

Training with the MAVID heart holder has the potential to shorten learning time to acquire skills and achieve proficiency before live cases, enhance levels of patient safety and outcomes, and reduce costs. McGaghie et al[23] found simulation-based medical education with deliberate practice to have better results than traditional clinical education alone. The use of surgical training by way of organ procurement produced statistically significant improvements in the knowledge of anatomy and technique.[24] The use of vascular tissue models also produces statistically significant improvements in comfort levels, and sessions have been rated as highly worthwhile.[7]

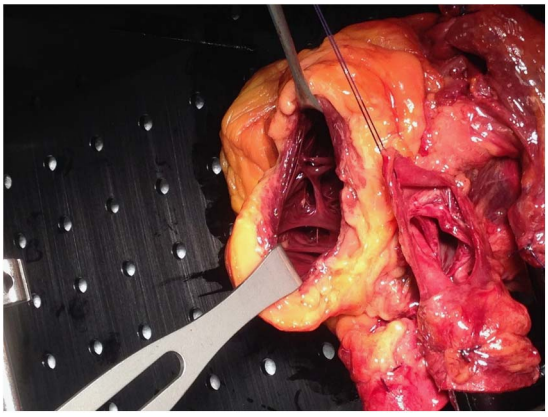

Figure 3.
MAVID heart holder operative exposure: ventriculotomy and aortic valve exposure.

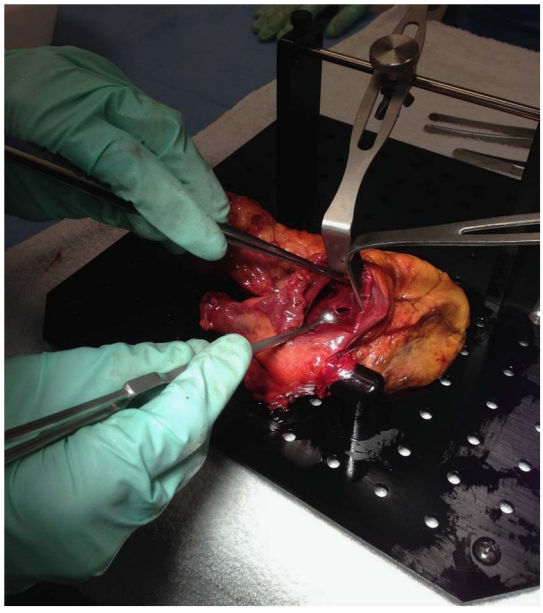

Figure 5.
MAVID heart holder operative exposure: right atrial view.

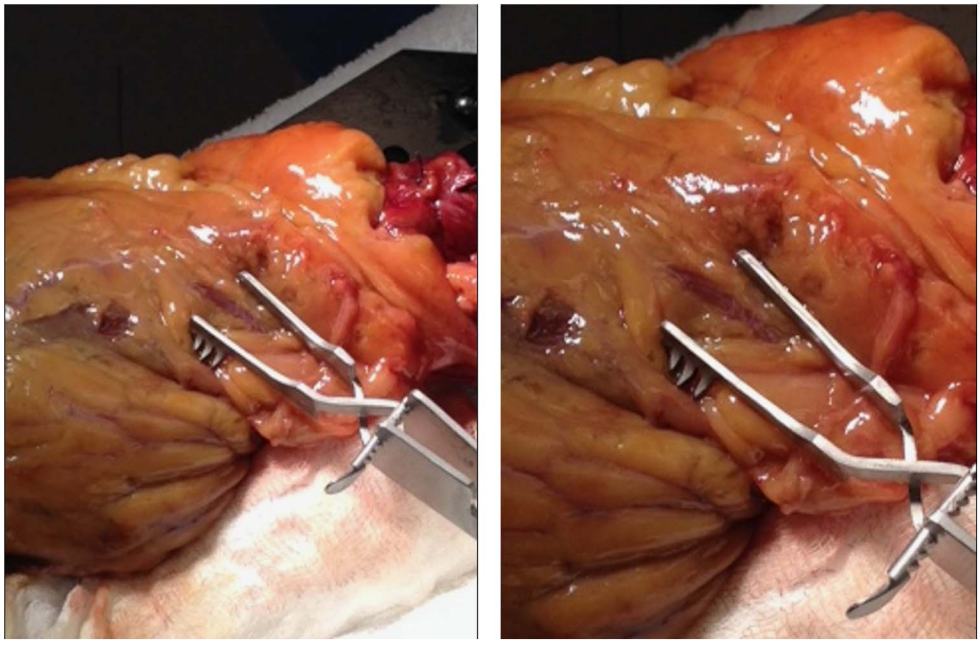

Figure 4.
MAVID heart holder operative exposure: coronary artery exposure.

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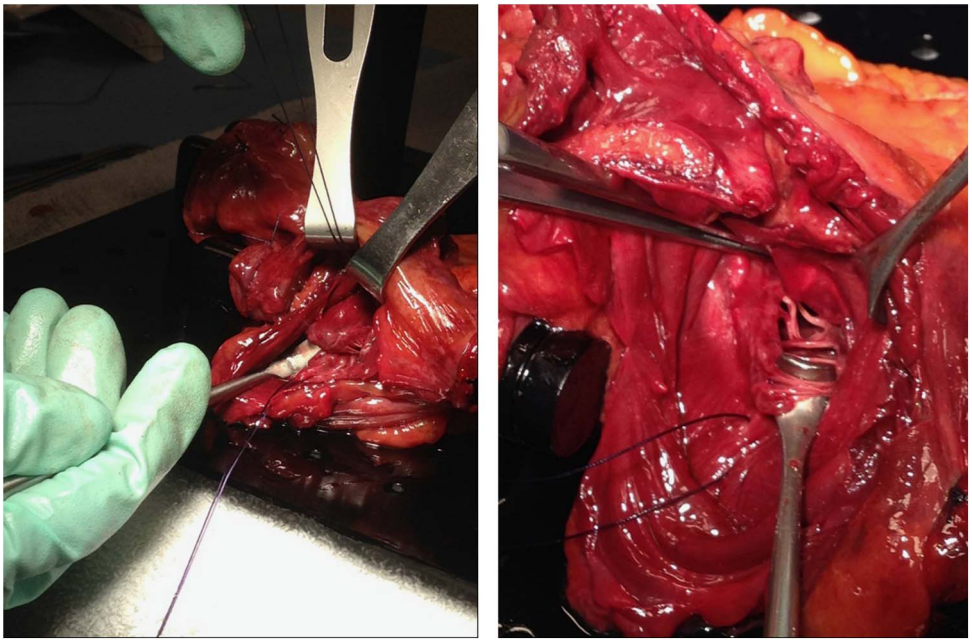

Figure 6.
MAVID heart holder operative exposure: left atrium and mitral exposure.

Concerns for patient safety, service, and outcomes are at the forefront of our healthcare system. At a time when cardiovascular procedures are becoming increasingly complex and training methods are becoming more restrictive, a surgical training programme outside the operating room is a vital necessity.[25] Simulation-based learning will become integral to enhancing training and education[26] and in providing valuable experience for both novices and experts because tissue-based simulation is the closest to live surgical cases.[27]

Summary

The MAVID heart holder is an organ holder primarily designed for holding the heart in an anatomic position for the purpose of surgical simulation and education. The device is simple to use, can be adjusted to organ size, and has necessary instrumentation for surgical simulation and education with any solid organ. The MAVID heart holder will help to close the gap between surgical performance in the laboratory and that in the operating room by providing the most realistic learning to achieve surgical proficiency before performing procedures on live patients while enhancing patient safety and outcomes.

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