Hands-on Gross Anatomy Instruction Improves Clinical Imaging Skills Among Cardiovascular Fellows

JM O'Leary[1], DE McNeely[2], JA Damp[1], QS Wells[1], L Nanney[3] and L Mendes[1]

[1]Division of Cardiovascular Medicine, Vanderbilt University Medical Center, Nashville, TN, USA. [2]Cardiology Department, Greenville Health System, Greenville, SC, USA. [3]Department of Cell and Developmental Biology, School of Medicine, Vanderbilt University, Nashville, TN, USA.

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ABSTRACT

INTRODUCTION: Multi-modality imaging is a crucial component of cardiovascular (CV) fellowship training and requires knowledge of CV anatomy for interpretation. We hypothesized that hands-on anatomy education would improve the imaging interpretation skills of CV fellows.

METHODS: The first-year CV fellowship class completed a hands-on cadaveric anatomy session correlated with clinical imaging. Fellows' ability to identify CV structures on cardiac imaging was assessed using a 30-question assessment tool administered at baseline and 1 week and 6 months post intervention. Advanced CV fellows (second or third year) who had not attended the session were also tested. Scores were expressed as median [interquartile range].

RESULTS: Among 9 first-year fellows, the majority reported no formal anatomy training since medical school (N = 7) and rated their knowledge of CV anatomy as fair or poor (N = 7) prior to the intervention. The median assessment score was higher 1 week after intervention vs baseline (24 [23-25] vs 19 [17-21]; $P = .013$) and remained higher than baseline at 6 months (26 [26-28] vs 19 [17-21]; $P = .009$). The 6-month post-intervention score for first-year fellows was not significantly different than that of senior fellows (n = 10) not exposed to the intervention (26 [26-28] vs 26 [23-27]; $P = .434$).

CONCLUSIONS: Gross anatomy instruction improved first-year CV fellows' interpretation of CV imaging. Anatomic instruction may be a useful adjunct to multi-modality imaging education.

KEYWORDS: anatomy, cardiovascular fellowship, imaging

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CORRESPONDING AUTHOR: JM O'Leary, Division of Cardiovascular Medicine, Vanderbilt University Medical Center, Nashville, TN 37232, USA. Email: jared.oleary@vumc.org

Introduction

Advances in technology have greatly increased the usage of medical imaging techniques in clinical cardiology.[1] Cardiovascular imaging is a crucial component of cardiovascular (CV) fellowship training and is rapidly expanding to incorporate multiple modalities,[2] including nuclear imaging, echocardiography, computed tomography (CT), magnetic resonance imaging (MRI), and vascular ultrasound.[3–8] Accurate interpretation of imaging findings requires robust knowledge of CV anatomy. Most CV fellows only receive formal anatomy training in medical school, typically 3 to 5 years prior to beginning fellowship. In addition, recent updates to medical curricula across the country have condensed gross anatomy education and, at times, eliminated gross anatomy instruction in favor of computerized learning formats.[9,10] In fact, in some countries, cadaveric dissection has been eliminated completely.[11] The objective of this pilot study was to determine whether hands-on anatomy education during CV fellowship would improve the imaging interpretation skills of CV fellows.

Methods

The entire first-year CV fellowship class at our institution (n = 9) completed a 2-hour hands-on cadaveric anatomy session. Prior to the session, fellows completed a self-assessment of their baseline CV anatomy and CV imaging knowledge. For the session, the anatomical specimens were provided by the Vanderbilt Center for Experiential Learning and Assessments (CELA). The session was proctored by faculty highly skilled in gross anatomy and CV imaging (including authors L.N. and L.M.).

Anatomical dissections were correlated with clinical imaging during the session. Each fellow was assigned a portion of CV anatomy (great vessels, external cardiac structures, etc.) to review and present to the group. Anatomical dissections were correlated with pertinent clinical imaging after each presentation. Images reviewed were, in general, of normal anatomy with additional examples of common abnormalities encountered for that particular structure (eg, CT and MRI images of carotid stenosis). Fellows' ability to identify CV structures on cardiac imaging was assessed using a 30-question knowledge assessment tool (Supplemental Material). Ninety seconds were allotted for each question, allowing a total of 45 minutes for administration of the tool. The tool contained images from clinical CV imaging modalities, including: coronary and vascular angiography, CT and CT angiography, echocardiography, carotid ultrasound, and MRI and magnetic resonance angiography. The tool was administered to all 9 fellows from the first-year class at baseline

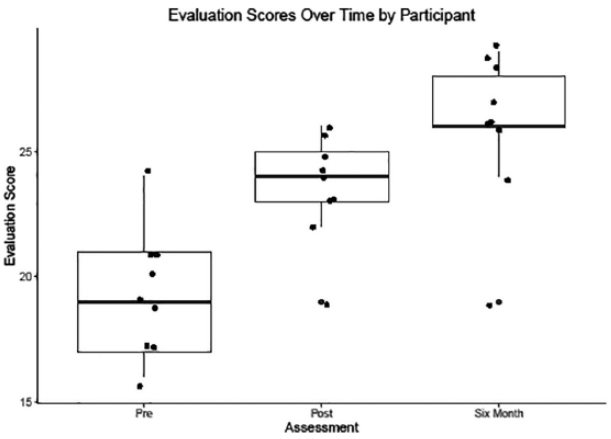

Figure 1. Evaluation scores over time by participant.

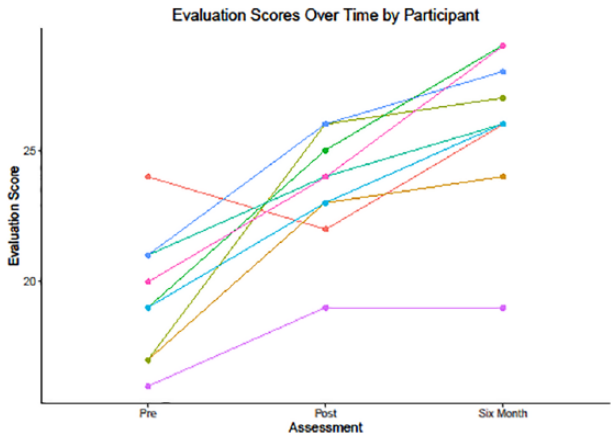

Figure 2. Evaluation scores over time by participant.

and 1 week and 6 months post intervention. Advanced CV fellows (second or third year) (n = 10) who had not attended the anatomy session were also tested at 6 months. The testing tool was administered in a proctored, closed-door setting. A different 30-question tool was administered for the post-test. This was constructed of 30 similar questions with a similar mix of imaging modalities: CT, echocardiography, MRI, etc. For each administration of the test (before or after), the question sequence was varied. The answers were withheld from the participants until the entire study period was completed for all participants. Scores were expressed as median [interquartile range], and comparisons were made using Wilcoxon signed rank test with Bonferroni adjustment for multiple testing.

Results

All 9 first-year CV fellows (100%) at our institution participated in the study. Among first-year fellows, the majority (n = 7) reported no formal anatomy training since medical school and rated their knowledge of CV anatomy as fair or poor (n = 7) prior to the intervention. The median assessment score was higher 1 week after the intervention vs baseline (24 [23-25] vs 19 [17-21]; $P = .013$) and remained higher than baseline at 6 months (26 [26-28] vs 19 [17-21]; $P = .009$) (Figure 1). The 6-month post-intervention score for first-year fellows was not significantly different than that of senior fellows not exposed to the intervention (26 [26-28] vs 26 [23-27]; $P = .434$). Eight of the nine first-year fellows improved their score from before to after intervention (Figure 2). One fellow did not improve their score post intervention; however, the 6-month follow-up score was higher than baseline.

Discussion

This pilot study suggests that a focused gross anatomy session during fellowship may improve the multi-modality clinical CV imaging skills of first-year CV fellows. The intervention, a 2-hour hands-on anatomy session, was well received by the participating fellows and relatively resource efficient, as the anatomic specimens had been obtained for other means prior to usage by the CV fellowship. The effect of the session appears to be durable out to at least 6 months. This study highlights the importance of reinforcement of the basic sciences in medical training at times when they can be directly linked to clinical skills. A similar approach has been used in surgical training, but has not been described in CV fellowship training.[12,13]

The modern medical education environment contains 2 competing elements, increased pressure to condense gross anatomy education in medical school[9] and increased usage of CV imaging techniques, which require accurate knowledge of CV anatomy for interpretation.[1] In one study, nearly half of all graduating students felt that their anatomy education was inadequate.[10] In addition, Mori et al[14] beautifully describe the utility of cross-sectional imaging and virtual dissection to demonstrate clinically relevant anatomy and orientation, highlighting the importance of a synergy between gross anatomy knowledge and clinical imaging. In our novel study, a gross anatomy "refresher" was used during fellowship, at a time when trainees were simultaneously learning various imaging techniques for which the nuanced anatomy would be most salient. To interpret complex CV imaging, it is necessary to have a clear 3-dimensional understanding of CV anatomy. Direct viewing of the normal CV anatomy and the surrounding structures in the intact body aids this understanding. As such, we believe this experience can be a useful adjunct when teaching CV imaging to fellows and, in fact, may accelerate fellows' learning.

This was a pilot study containing a limited number of subjects, thus caution must be taken before expending the resources to expand such a program to all trainees. However, our study is an important proof-of-concept study suggesting such an approach may be beneficial. Our study did not have a control group, so we were not able to control for other educational factors that may have contributed to the improvement we saw in the first-year fellows' scores. In addition, this study did not compare our methods to other forms of anatomical review that use computer-based learning and/or simulation. For programs with limited resources or that lack access to gross anatomy

laboratories, this type of CV anatomy review may achieve similar results. Further testing in larger groups of trainees with various learning modalities may be helpful to determine the best method to learn CV anatomy for imaging interpretation.

Conclusions

Gross anatomy instruction improved first-year CV fellows' interpretation of CV imaging. The effect of the intervention was durable over 6 months. The intervention raised first-year fellows' scores on the assessment tool to a range equivalent to that of much more experienced fellows. Anatomic instruction may be a useful adjunct to multi-modality imaging education.

Author Contributions

JMO, DEM, JAD, LM were involved in the design, implementation, data collection, data analysis and manuscript drafting process.

QSW was involved in the design, data collection, data analysis and manuscript drafting process.

LN was involved in the design, implementation, data collection, and manuscript drafting process.

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