

# Ultrasound—A Clinical Procedure to Motivate Preclinical Medical Students to Learn Embryology

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## Abstract

A fundamental understanding of human embryology is an essential skill for the majority of practicing physicians. However, its perceived difficulty, in context of the constant competition for time needed to learn other basic science disciplines, makes teaching embryology in undergraduate medical education a universal challenge. Sonography is now commonly used in standard prenatal care because it allows safe, noninvasive imaging of early embryos and fetuses. Two-, three- and four-dimensional and Doppler ultrasound provide an astonishing arsenal of techniques to evaluate a pregnancy and screen for abnormalities. We are developing an international collaboration with ultrasound experts to introduce sonography into the teaching of embryology to preclinical medical students. The objective is to motivate students and facilitate learning by providing clinical relevance and online images that will help them visualize embryonic development. We invite members of the Ian Donald School of Ultrasound and editors and readers of the Journal to participate in this project.

**Keywords:** Ultrasound, embryology, undergraduate medical education.

## INTRODUCTION

*In utero* development, especially embryology, is an essential knowledge base for the vast majority of practicing physicians, especially in Obstetrics and Gynecology, Pediatrics, Family Medicine, Internal Medicine, and Radiology. Official statements from the American Association of Medical Colleges support this assertion.<sup>1</sup> In addition, the Educational Affairs Committee of the American Association of Clinical Anatomists has published recommended embryology learning objectives for inclusion in US Medical School curricula.<sup>2</sup> This committee offered the following succinct and accurate rationale: “An understanding of human developmental anatomy provides a fundamental framework for the accurate diagnosis and proper treatment of patients with congenital clinical entities, a significant population of any medical practice”.

Unfortunately, teaching embryology to preclinical medical students represents a universal challenge for medical educators. Anecdotally, most embryology professors seem

to agree that the principal reason centers on time. Preclinical medical students profess recognition of the importance of embryology and want to learn it. However, when faced with the massive amounts of information from concurrent courses such as anatomy, biochemistry, and histology, students make pragmatic decisions to allocate most of their study time to those “major” disciplines. The push to other subjects is intensified also by the fact that, upon matriculation into medical school, most students have a basic comprehension of the “major” disciplines such as anatomy and biochemistry, but not of embryology. Thus students perceive embryology as more daunting and hopelessly insurmountable than the other subjects.

Educators can counter this universal problem if they are able to effectively motivate students to learn the subject and provide learning materials that facilitate learning. The key ideas here are “motivation” and “facilitation”. As we present below, sonography provides a means to both motivate and facilitate learning embryology.

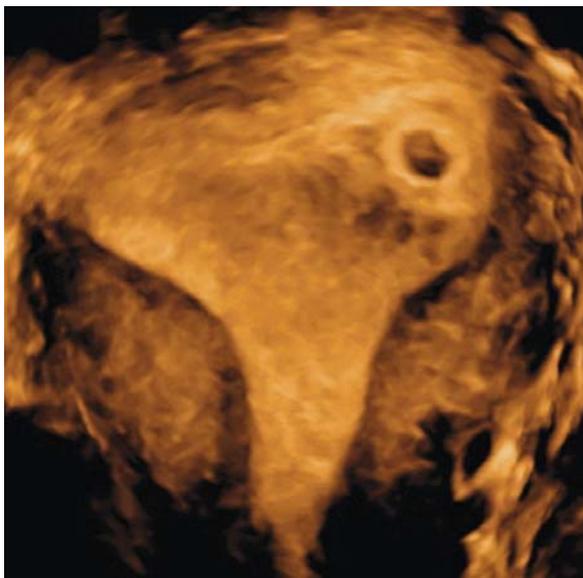
Effective strategies for motivating medical students include assessment and presenting clinical relevance. Indeed, assessment is one documented strategy for motivating students to learn and can certainly be applied to embryology.<sup>3</sup> The number of questions focused on a given topic on a typical medical school exam is in proportion to the number of contact hours devoted to that topic in class. However, one can argue that the number of questions should be in proportion to the significance of that topic. For example, approximately half of all birth defects involve the heart. However, often only one or two embryology lectures are devoted to heart development, whereas the medical importance of the topic would demand more attention in terms of the number of related questions on an assessment. Knowing that students will invest study time if they think that they will be tested extensively, faculty should attempt to construct assessments according to some measure of relevance.

The other important motivating force behind student learning is realized when faculty present new information in the context of compelling clinical relevance.<sup>4,5</sup> Sonography has become commonplace in obstetrical care and is thus clinically relevant. For example, routine sonography as part of prenatal care reveals key events such as the presence of a gestational sac (the conceptus) as early as the third week of development (postfertilization; Fig. 1); and the heartbeat and blood flow can be detected by Doppler

in early and late fourth week, respectively. Three-dimensional ultrasound is easily and safely used to evaluate the embryo and fetus for the presence of a wide range of abnormalities (Figs 2 to 16).

We believe that sonography can be a cornerstone of motivation by providing students with tangible examples of clinical relevance and by facilitating learning through sonograms made available online. By putting sonograms online one is freed from the constraints of dimension and time. A printed image (such as those presented in this paper) is static and constrained to two dimensions. Online, they can show the remaining two dimensions, depth and time. Accordingly, we are implementing a pilot project that introduces sonography into the teaching of embryology. The strategy is to provide access to a database of sonograms via a publicly available web server. The database will be searchable to facilitate rapid retrieval of both normal and abnormal images. The digital nature makes possible the presentation of three-dimensional and four-dimensional images that can be rotated or played over time, to illustrate a heartbeat by two-dimensional ultrasound or a color Doppler visualization of blood flow. The following still images illustrate a module centered on illustrating fetal heart, umbilical and placental circulation (Figs 11 to 13).

We will evaluate the effects of this pilot project on students' knowledge skills and behaviors related to



**Fig. 1:** Coronal plane of the uterus demonstrating an early gestational sac (three weeks after implantation)



**Fig. 2:** Surface rendering of the normal fetal cranial sutures, chest and arm



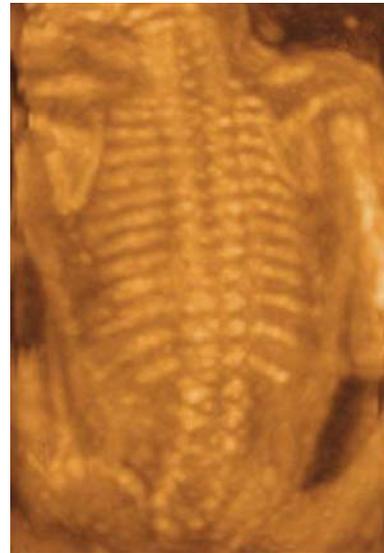
**Fig. 3:** Sagittal view of a normal fetal head demonstrating the corpus callosum



**Fig. 6:** Clear visualization of a unilateral cleft lip and palate by the surface rendering mode



**Fig. 4:** Surface rendering of normal fetal fontanelles and cranial sutures



**Fig. 7:** 3-D ultrasound of a normal fetal spine and ribs



**Fig. 5:** Clear visualization of a normal fetal face by the surface rendering mode



**Fig. 8:** 3-D ultrasound of an angular defect of the left wrist



Fig. 9: 3-D ultrasound of clubfoot at 28 weeks' gestation

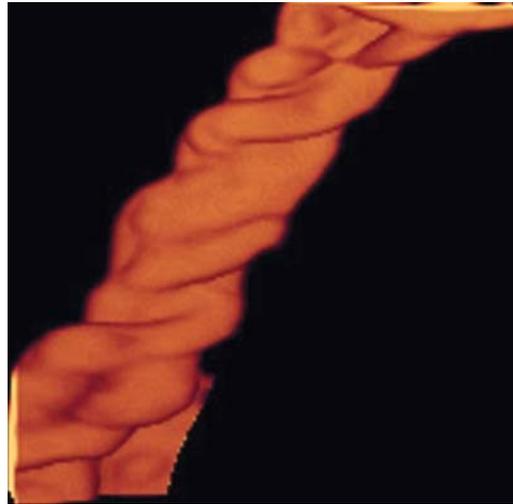


Fig. 12: 3-D power Doppler image of the arteries and vein in the umbilical cord

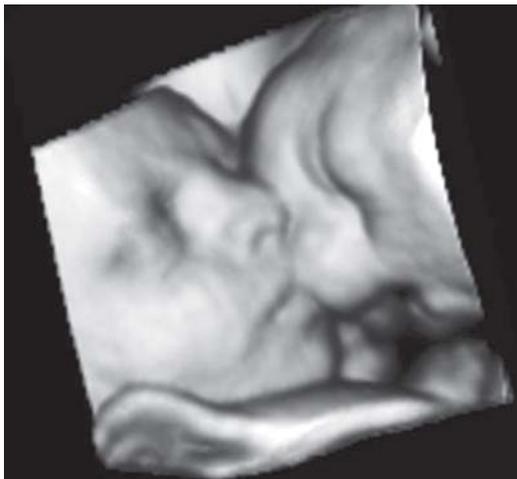


Fig. 10: 3-D ultrasound of monozygotic monoamniotic twins

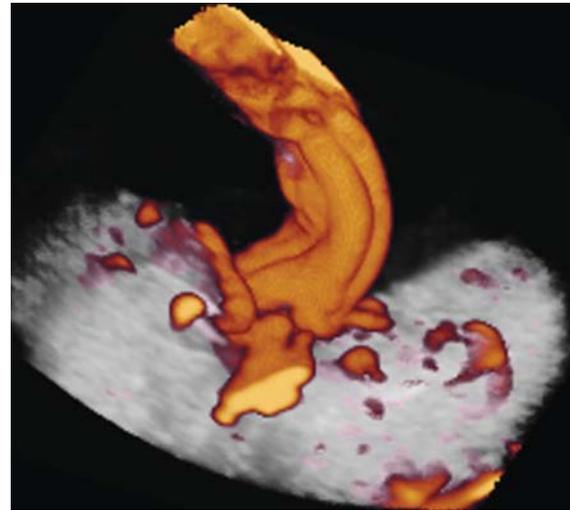


Fig. 13: 3-D power Doppler scan of the placental insertion of the umbilical cord

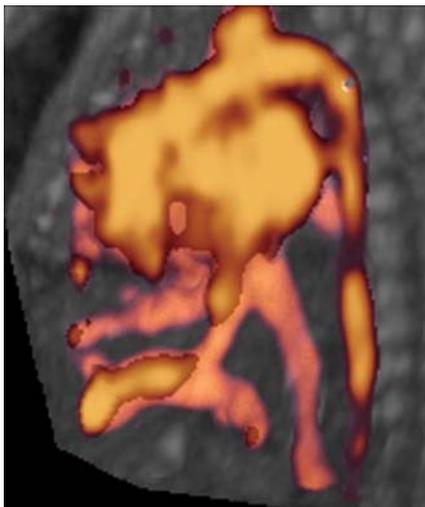


Fig. 11: 3-D power Doppler image of the fetal circulatory system



Fig. 14: Normal male external genitalia depicted by 3-D ultrasound at 30 weeks' gestation



Fig. 15: Normal female genitalia depicted by 3-D ultrasound at 29 weeks' gestation



Fig. 16: A collage of fetal facial images obtained by 3-D ultrasound

embryology during the coming months. Experts with an interest in contributing to this project are invited to contact the authors.

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