Introduction

Additive manufacturing, or 3D printing, has led to a new renaissance in designing, prototyping and manufacturing of novel products. Microproduction has reached new levels with a streamlined conception-to-production ability, however, medical education continues to be an area where 3D printing has remained limited. When utilizing 3D printing technology, new tools for medical education can be developed in real-time; this may aid in replacing many archaic techniques and tools that remain in the education setting. Our project features a 3D printed Jugular Venous Distention Ruler to aid in the assessment of congestive heart failure. By creating a standardized measuring tool for JVD, preliminary data shows that both validity and inter-rater reliability can be increased. We argue that this novel tool has the potential to assist with optimizing both patient care and clinical judgement in the setting of congestive heart failure.

Purpose

To design and 3D print a cost effective, accurate clinical tool to be used as a standardized, noninvasive measurement of Jugular Venous Distention. This measurement could then be used to extrapolate a noninvasive surrogate for the measurement of Central Venous Pressure, and subsequently used to monitor and manage specific heart failure patients.

Additional Projects

In addition to the JVD ruler, additional tools have been created to help maximize medical education. These include a 3D printing brain model and a 1:1 ratio of human bones including tibias, vertebra, and each bone of the skull.

Methods

Components of the described JVD-Ruler were designed using Blender 2.76 software, prepared using Simplify3D software and printed with a Makerbot Replicator 2 3D Printer. Each component was printed, assembled and held in place with Loctite epoxy. The JVD-Ruler is intended to have the base placed at the level of the sternal angle, with a connected sliding ruler attached to a perpendicular straight edge, determining the vertical height of maximal jugular venous pulsation. The measurement for JVD is calculated by adding 5 cm to the measurement, which can be later be divided by 1.36 to approximate CVP in mmHg.

Results

JVD is a highly sensitive, highly specific clinical measurement in the setting of heart failure.1 4 7 Despite being a useful clinical marker, JVD is often overlooked and measured by “eye-balling” using two arbitrary straight edges to approximate measurement. In light of this, a tool was designed to simplify and standardize measurements to unlock the clinical utility of JVD. Further evaluation of this device will need to be tested against a standard unit of measurement including the current gold-standard of measurement for CVP, pulmonary artery catheterization. If proven accurate, this tool could help in the management of patients with heart failure at a fraction of the cost and save patients from potential complications from a more invasive procedure.

References