Autopsy Brain Removal Training Using Virtual Reality Simulation

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ABSTRACT

Hospital autopsy is important for diagnosing neuro-degenerative disease in deceased patients. Despite its importance, training autopsy brain removal is challenging for autopsy assistants due to lack of availability of real specimens, initial hesitation to perform the procedure because of proximity to the face, and limited teaching tools. To address these deficits, a virtual reality (VR) simulation was created to teach proper methods to perform the steps of the procedure. This simulation features real-time visual feedback of user performance during the step of opening the cranium with an oscillating saw in order to assist in skill improvement. It also provides an immersive VR interactive experience using realistic virtual patient models, sound effects, and haptic responses.

INTRODUCTION

Autopsy Brain Removal Procedure

This procedure is performed to obtain brain specimen from deceased patients. To perform the step of opening the cranium correctly, the angulation of the saw blade should be perpendicular to the skull surface.

Limited Teaching Materials

Current teaching materials for the hospital autopsy procedure are limited to: (a) simplistic pen and ink diagrams (fig. 1), (b) color photographs, and (c) direct observation of deceased patients. Physical practice of the procedure is not involved in these materials.

Fig. 1 Pen and ink diagrams (Hutchins, Grover M. An Introduction to Autopsy Technique. Northfield, IL: College of American Pathologists, 2005.)

Research goal

To develop a novel method of teaching the brain autopsy procedure through the use of a VR training modality. With the ability to precisely handle virtual instruments to perform actual steps on a virtual patient with real-time feedback of user actions, it provides users unlimited attempts in training. It is postulated that a virtual 3D simulation environment will augment and facilitate training of future autopsy prosectors.

Audience

Autopsy assistants, Pathology and Neuropathology residents and fellows.

MATERIALS & METHODS

1. Creation of a Patient Model from 3D Scans

To add further realism to the simulation, a 3D model of a mock patient's head and neck was captured using an Artec3D Space Spider scanner and processed using Artec3D Studio 13 Professional software (fig. 2).

Fig. 2 3D scanning the Patient Model to Create a Virtual Patient Model.

2. Creation of Autopsy Suite Environment

The autopsy suite environment was designed using digital-collaged images of the autopsy suite in the Johns Hopkins Hospital autopsy suite projected onto 3D walls in simulation. This adds realism and prevents the users from distraction by having unnecessary 3D objects (fig. 3).

Fig. 3 Two Original Photos of Autopsy Suite.

3. VR Interaction with User Interface (UI)

UI menu was designed to provide the user the freedom to start training with any step of the procedure. To allow interaction with the menu panel, a laser pointer extending from the pointer finger was added.

4. Visual, Sounds and Haptic Feedback

During the step of opening the cranium, real-time feedback is provided during simulation using a text element to aid learning experience. To add extra realism to the simulation of cutting, sound effects and cutaneous haptic feedback in the form of vibration was added to the oscillating saw activity (fig. 4).

Fig. 4 Oscillating Saw.

RESULTS & DISCUSSION

1. 3D Models: Patient, Anatomy and Autopsy Environment

Several 3D models were created to complete this simulation (Fig. 5 and 6).

Fig. 5 Patient models were created in three different dissection stages: normal, scalp and incised and reflected, and brain exposed (left to right).

Fig. 6 Completed Autopsy Suite with Patient.

RESULTS & DISCUSSION - continued

2. VR Interaction and Simulation During Procedural Steps

a. Choosing Step

Fig. 7 UI Interactions Using Three Buttons to Load and Hide Appropriate Patient Model for Each Step.

b. Patient Positioning

Fig. 8 Patient Positioning Step: (left) Beginning, (right) the block was placed to support patient's head prior to scalp incision.

c. Real-time Feedback in Text format

Evaluation of the angulation of the saw blade against the skull is provided using three different colors. Green: Correct (85-95), Yellow: Acceptable (80-84 or 96-100) and Red: Incorrect (<79 or >101).

Fig. 9 Angle Feedback Provided Using Three Different Colors During Cutting Cranium.

Fig. 10 Angle Feedback Displayed on Cut Cranium.

3. Future Considerations

Simulating all other nine sections of hospital autopsy, plus prenatal and female patients may be considered. As a transition between VR training and real life autopsy service, practicing the cutting using 3D printed models are being considered.

Fig. 11 3D Printed Model of Patient's Head.

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