Coconut Model for Learning First Steps of Craniotomy Techniques and Cerebrospinal Fluid Leak Avoidance

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■ INTRODUCTION: **Neurosurgery simulation has gained attention recently due to changes in the medical system. First-year neurosurgical residents in low-income countries usually perform their first craniotomy on a real subject. Development of high-fidelity, cheap, and largely available simulators is a challenge in residency training. An original model for the first steps of craniotomy with cerebrospinal fluid leak avoidance practice using a coconut is described.**

■ MATERIAL AND METHODS: **The coconut is a drupe from *Cocos nucifera L*. (coconut tree). The green coconut has 4 layers, and some similarity can be seen between these layers and the human skull. The materials used in the simulation are the same as those used in the operating room.**

■ PROCEDURE: **The coconut is placed on the head holder support with the face up. The burr holes are made until endocarp is reached. The mesocarp is dissected, and the conductor is passed from one hole to the other with the Gigli saw. The hook handle for the wire saw is positioned, and the mesocarp and endocarp are cut. After sawing the 4 margins, mesocarp is detached from endocarp. Four burr holes are made from endocarp to endosperm. Careful dissection of the endosperm is done, avoiding liquid albumen leak. The Gigli saw is passed through the trephine holes. Hooks are placed, and the endocarp is cut. After cutting the 4 margins, it is dissected from the endosperm and removed. The main goal of the procedure is to remove the endocarp without fluid leakage.**

■ DISCUSSION: **The coconut model for learning the first steps of craniotomy and cerebrospinal fluid leak avoidance has some limitations. It is more realistic while trying to remove the endocarp without damage to the endosperm. It is also cheap and can be widely used in low-income countries. However, the coconut does not have anatomic landmarks. The mesocarp makes the model less realistic because it has fibers that make the procedure more difficult and different from a real craniotomy.**

■ CONCLUSION: **The model has a potential pedagogic neurosurgical application for freshman residents before they perform a real craniotomy for the first time. Further validity is necessary to confirm this hypothesis.**

INTRODUCTION

Neurosurgical simulation has gained attention in the past decade, mainly due to working hour restrictions for residents, legal issues, and changing paradigms in surgical education. The idea of seeing one procedure and then performing surgery has been replaced by the idea of doing as many procedures as one can in a simulator before performing the surgery in a real scenario.[1-4]

Craniotomy is a standard procedure in neurosurgical daily practice, and most neurosurgical residencies expose the novice to this technique during the second year of training. Acquiring craniotomy skills before performing the procedure for the first time in the operating room is a recent pedagogical goal related to

Key words
- Coconut
- Craniotomy
- Doing more with less
- Education
- First craniotomy
- First time
- Neurosurgery residency
- Neurosurgical simulation

Abbreviations and Acronyms
CSF: Cerebrospinal fluid

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the improvement of surgical quality results. Craniotomy simulators are pertinent to the actual stage of neurosurgical residencies.[5]

Medical literature describes some models for practicing craniotomies: cadavers, synthetic models, and animals. Each one has its advantages and disadvantages.[1,5-7] A craniotomy simulator that has high fidelity, costs little, and is broadly available would be ideal. Craniotomies are generally done using a drill device. However, old-fashioned craniotomies using a trephine and saw are still in use in low-income countries.[6,8-10] If postgraduate year one (PGY-1) or postgraduate year two (PGY-2) neurosurgical residents could practice craniotomy techniques in a model with cerebrospinal fluid (CSF) leak simulation, they would be more prepared to deal with real situations.

The goal of this paper is to describe an original model for learning craniotomy first steps with CSF leak avoidance using a coconut.

MATERIAL AND METHODS

Coconut Morphology

The coconut is a drupe from *Cocos nucifera L.* (coconut tree). The green coconut has 4 layers, and some similarities can be seen between these layers and the human cranium. The outer layer of the skull bone, diploe, inner layer, dura/arachnoid, and CSF are represented in the model by exocarp, mesocarp, endocarp, endosperm, and coconut water, respectively (Figure 1).

As the coconut gets older, the endosperm gets thicker, making older coconuts more suitable than the young ones for performing a craniotomy simulation without water leak.

The coconut has 3 faces and 2 poles. The procedure has to be performed on the pole without the stalk and on a face where the layer's width is more similar to that of the human cranium (see Figure 1). The mesocarp is fibrous and typically 1–5 cm thick, but at the stalk end it can reach 10 cm. The other layers have around 7 mm of thickness.[11]

Craniotomy Material

Two craniotomy techniques were used in the coconut model: manual craniotomy with Gigli saw and pneumatic drilling craniotomy. The same materials used in the operating room for neurosurgical procedures were used in this simulation (Figure 2).

In both techniques, the coconut was placed in the head holder of a neurosurgical theater operating room table and the craniotomy proceeded. Coconut trepanation used a tissue forceps, scalpel handle, scalpel, Hudson trephine, dissector, bone rongeur, dissector, hook handle for a wire saw, conductor, and Gigli saw (Figure 3). Motor drill trepanation used a pneumatic drill, burr, dissector, bone rongeur, scalpel handle, scalpel, and tissue forceps (Figure 4).

Technique

With the coconut on the head holder, trepanation points were drawn with a pen. The trepanation should be performed where the mesocarp is thinner. These markings are placed on 1 of the 3 coconut faces next to the pole without the stalk.

Manual trepanation with a Hudson trephine is performed from exocarp to endocarp at all 4 points previously selected. The dissector is used to separate the mesocarp and endocarp. The Gigli saw and saw conductor are passed through the holes. The hook handle is connected, and the exocarp and mesocarp are cut. After cutting all 4 sides, the exocarp and mesocarp are removed in 1 piece.

Manual trepanation is performed again in 4 points through the endocarp until the endosperm is reached. The endosperm should be dissected form the endocarp carefully without water leak. The saw conductor and Gigli saw are passed through the holes, and the endocarp is cut. After cutting all 4 sides, the endocarp is

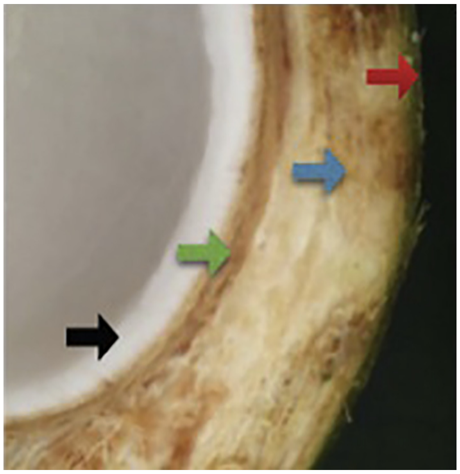

Figure 1. Coconut layers: exocarp (*red arrow*), mesocarp (*blue arrow*); endocarp (*green arrow*), and endosperm (*black arrow*).

Figure 2. Coconut craniotomy simulation surgical setup.