The Role of 3-D Modeling in Patient Education of Facial Pain Syndromes

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Introduction

Technology is increasingly being utilized to educate both surgeons and patients. 3-D printing technology that simulates patient specific anatomy for surgical planning is thought to increase procedural accuracy and aid in determining needed equipment and resources, as well as increasing surgeon confidence. Similarly, this technology will better assist in patient education by allowing the physician to discuss the pathology and surgical treatment with the patient using the model made from the patient's MRI scan. Currently, there are few studies using 3-D printed models to educate patients undergoing surgical interventions in the literature.

Learning Objectives

By the conclusion of this session, participants should be able to: 1) Describe how 3-D models can be used to educate patients 2) Discuss the benefits of using a 3-D model for education of facial pain syndromes 3) Identify other novel applications for 3-D printing technology

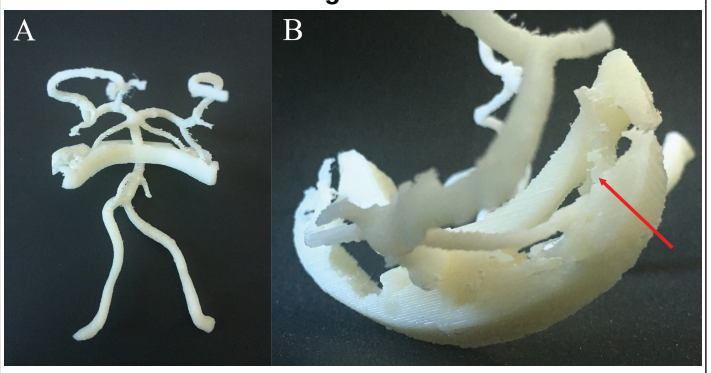
Methods

We utilized 3-D printing technology to create patient-specific, three dimensional models of the brainstem, trigeminal or facial nerve, and any associated vasculature. These models were used to educate the patient about their facial pain condition along with the surgical procedure. Prior to this education, the patients will complete a survey regarding their baseline knowledge of their diagnosis. Patients then fill out a second survey to access their knowledge after the education session and overall satisfaction regarding the use of the 3D model.

Results

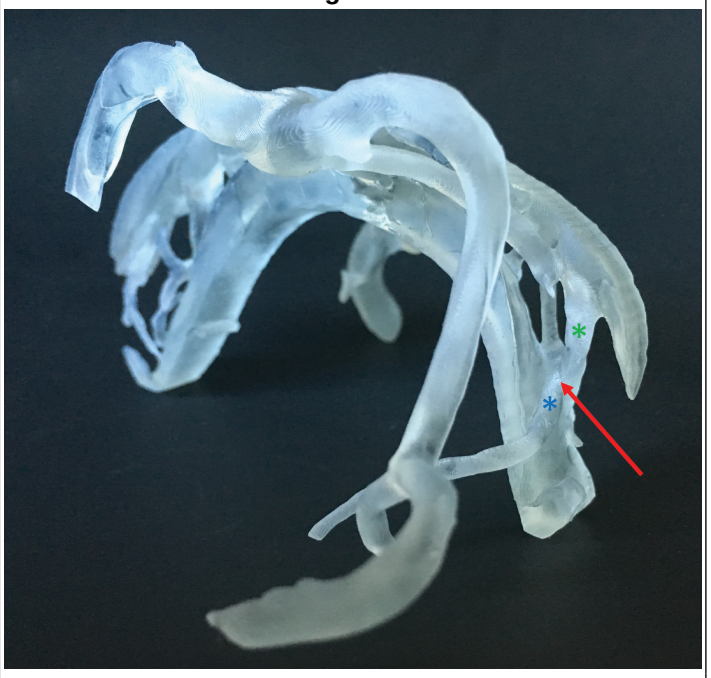
Following education with a patient-specific 3-D model, patients with facial pain syndromes demonstrated improved knowledge regarding their diagnosis, pathophysiology, and treatment options. Similarly, patient satisfaction regarding the use of the model was high.

Figure 1



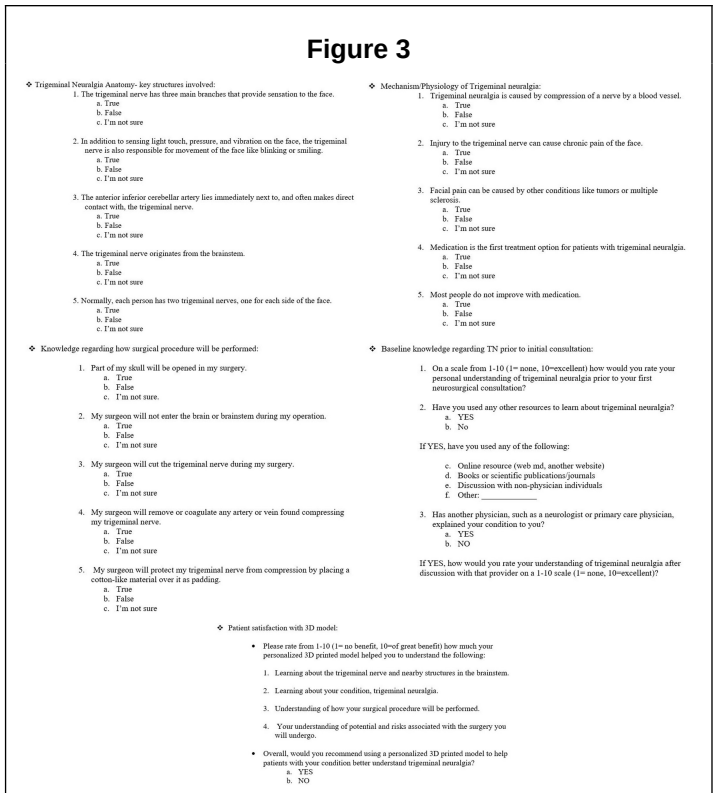
(A) 3-D model of the posterior fossa vasculature, brainstem, and skull base. (B) Arrow demonstrates the superior cerebellar artery compression of the trigeminal nerve near where the nerve exits the brainstem.

Figure 2



3-D model showing compression (red arrow) of the trigeminal nerve (green asterix) by the superior cerebellar artery (blue asterix).

Figure 3



❖ Trigeminal Neuralgia Anatomy- key structures involved:

1. The trigeminal nerve has three main branches that provide sensation to the face.
   a. True
   b. False
   c. I'm not sure
2. In addition to sensing light touch, pressure, and vibration on the face, the trigeminal nerve is also responsible for movement of the face like blinking or smiling.
   a. True
   b. False
   c. I'm not sure
3. The anterior inferior cerebellar artery lies immediately next to, and often makes direct contact with, the trigeminal nerve.
   a. True
   b. False
   c. I'm not sure
4. The trigeminal nerve originates from the brainstem.
   a. True
   b. False
   c. I'm not sure
5. Normally, each person has two trigeminal nerves, one for each side of the face.
   a. True
   b. False
   c. I'm not sure

❖ Knowledge regarding how surgical procedure will be performed:

1. Part of my skull will be opened in my surgery.
   a. True
   b. False
   c. I'm not sure.
2. My surgeon will not enter the brain or brainstem during my operation.
   a. True
   b. False
   c. I'm not sure
3. My surgeon will cut the trigeminal nerve during my surgery.
   a. True
   b. False
   c. I'm not sure
4. My surgeon will remove or coagulate any artery or vein found compressing my trigeminal nerve.
   a. True
   b. False
   c. I'm not sure
5. My surgeon will protect my trigeminal nerve from compression by placing a cotton-like material over it as padding.
   a. True
   b. False
   c. I'm not sure

❖ Patient satisfaction with 3D model:

- Please rate from 1-10 (1= no benefit, 10=of great benefit) how much your personalized 3D printed model helped you to understand the following:
  1. Learning about the trigeminal nerve and nearby structures in the brainstem.
  2. Learning about your condition, trigeminal neuralgia.
  3. Understanding of how your surgical procedure will be performed.
  4. Your understanding of potential and risks associated with the surgery you will undergo.
- Overall, would you recommend using a personalized 3D printed model to help patients with your condition better understand trigeminal neuralgia?
  a. YES
  b. NO

❖ Mechanism/Physiology of Trigeminal neuralgia:

1. Trigeminal neuralgia is caused by compression of a nerve by a blood vessel.
   a. True
   b. False
   c. I'm not sure
2. Injury to the trigeminal nerve can cause chronic pain of the face.
   a. True
   b. False
   c. I'm not sure
3. Facial pain can be caused by other conditions like tumors or multiple sclerosis.
   a. True
   b. False
   c. I'm not sure
4. Medication is the first treatment option for patients with trigeminal neuralgia.
   a. True
   b. False
   c. I'm not sure
5. Most people do not improve with medication.
   a. True
   b. False
   c. I'm not sure

❖ Baseline knowledge regarding TN prior to initial consultation:

1. On a scale from 1-10 (1= none, 10=excellent) how would you rate your personal understanding of trigeminal neuralgia prior to your first neurosurgical consultation?
2. Have you used any other resources to learn about trigeminal neuralgia?
   a. YES
   b. No

If YES, have you used any of the following:

   c. Online resource (web md, another website)
   d. Books or scientific publications/journals
   e. Discussion with non-physician individuals
   f. Other: _____

3. Has another physician, such as a neurologist or primary care physician, explained your condition to you?
   a. YES
   b. NO

If YES, how would you rate your understanding of trigeminal neuralgia after discussion with that provider on a 1-10 scale (1= none, 10=excellent)?

Questionaire for patients with trigeminal neuralgia.

Conclusions

3-D printing technology can facilitate pre-operative surgical education regarding the diagnosis and treatment options for facial pain syndromes.