# Animating External Magnetic Guidance of Intrathecally Delivered Gold-Coated Nanoparticles to Treat Intramedullary Spinal Tumors


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## Abstract


Intramedullary spinal cord tumors (IMSCTs) are rare neoplasms in the central nervous system (CNS), accounting for 2-4% of all CNS tumors.[1] Astrocytomas, a common type of IMSCT, are infiltrative and do not have a clear plane of dissection, making surgical removal difficult. Due to limitations in current surgical options, along with adverse effects of chemotherapy and radiotherapy, the use of external magnets to guide intrathecally delivered gold-coated nanoparticles has been proposed as a less invasive treatment for eliminating astrocytomas.[1,2]

An animation was developed to create a new resource providing an overview of the procedure and to teach grant committees, surgical residents, and surgical faculty. A qualitative survey was administered to provide residents, faculty, and researchers at the University of Illinois at Chicago (UIC) Neurosurgery and Neurology Departments an opportunity to provide comments. Likert scale questions and qualitative comments confirmed that the animation was effective in accurately portraying the technique and is a valuable visual aid for neurosurgeons. This new resource will continue to help introduce and explain the procedure for anticipated upcoming clinical trials.


## Purpose

The purpose of this project is:

**1. To increase awareness of a minimally invasive treatment for intramedullary cancers that are extremely difficult to treat.**

**2. To educate those in the Neurosurgery and Neurology fields about the innovative technique and to provide an overview of how it is performed.**

**3. To provide a concise overview of the treatment taking into account cognitive load and the theory of dual processing to aid in funding the research to promote further testing in clinical trials.**

Previous surgical research has shown animation as an effective method to introduce new surgical techniques. Several studies have concluded that educational animations are paramount to augment both traditional textbooks and conventional surgical videos to develop mental models of relevant anatomical structures, and to demonstrate the technical skills required to perform the procedure.[3,4]

This project created a novel animation to explain the use of magnetic drug targeting (MDT) with a gold-coated nanoparticle system to treat intramedullary spinal tumors. It served as a didactic resource for future grant applications and for patient education in anticipated upcoming clinical trials.

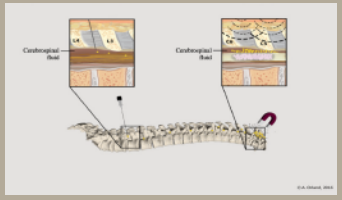


**Figure 1.** Overview of Magnetic Drug Targeting of Gold-Coated Magnetic Nanoparticles. The left inset depicts the injection of nanoparticles to the lumbar spine. The right inset depicts the use of magnets to concentrate nanoparticles at the site of the tumor. Not drawn to scale.

## Materials & Methods

### Animation Development

Storyboard

Dr. Ankit Mehta in the Department of Neurosurgery at UIC and committee members provided insight to create a storyboard depicting the technique on magnetic drug targeting (MDT) using a nanoparticle system to treat intramedullary spinal tumors.

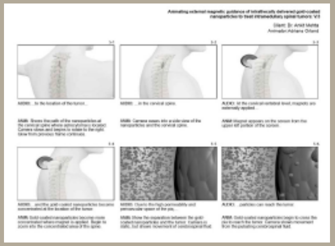


**Figure 2.** Storyboard page 5. Depicting the use of an external magnet to concentrate gold-coated nanoparticles containing anti-cancer drug, Doxorubicin, at the site of the tumor in the cervical spine.

### Creating the Animation

3D models for the animation were created using Poser Pro 11, Autodesk 3ds Max, and Pixologic ZBrush. All models were procedurally textured and animated in 3ds Max. Rendered footage was composited in Adobe After Effects and exported from Adobe Media Encoder. Adobe Photoshop and Illustrator were used to create backgrounds and 2D assets in After Effects. Visual Molecula Dynamics was used to visualize the structure of anti-cancer drug Doxorubicin.

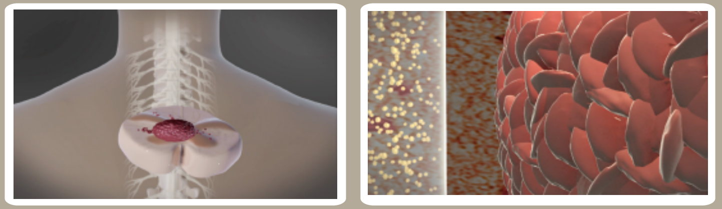


**Figure 3.** Still Frames from Final Animation. These two images give a glimpse of the final animation created to teach individuals in the Neurosurgery and Neurology fields about an innovative neurosurgical technique.

### Methods of Inquiry

To test overall effectiveness, the final animation was shown to Dr. Mehta's lab and colleagues for review. Participants were administered a survey using Qualtrics and evaluated the animation based on several criteria using a Likert Scale and had the opportunity to provide comments.

### Population/sampling methods

This animation was evaluated by members of Dr. Ankit Mehta's lab at the University of Illinois at Chicago.

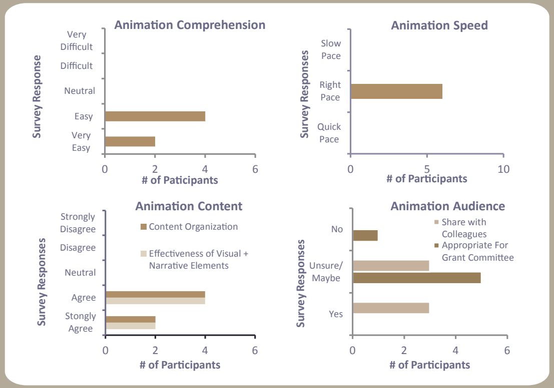
### Data

Participants submitted their responses anonymously via Qualtrics. All Likert scale responses and comments were recorded and used to evaluate effectiveness and accuracy of the animation.

### Methods of Analysis

Survey feedback was reviewed and answers to free response questions were evaluated to improve future iterations of the animation.

## Results




### Post Animation Survey Direct Comments

"Generally got the big picture along with the specifics which is I think the most important/useful aspect of these animations."
"The visuals and location of tumor was helpful to visualize."
"I think the video was great to explain things to someone who is new to the project or to someone who does not know a lot about science or medicine."

## Discussion & Conclusions

The animation was evaluated to be concise and at an appropriate level of detail based on qualitative feedback received. Participants found the animation to be well organized and effective in combining visual annd narrative elements. The audience may need to be reconsidered. While a grant committee was the original intended audience, the animation may be better suited for a medical audience of oncologists or neuro-oncologists not familiar with the research. Further testing with surgical residents and grant committees is necessary to determine the appropriate target auidence.

This project is significant to the field of medical illustration due to the use of visuals to enhance the learner's understanding of the subject matter. The animation, through the depiction of a new procedure and incorporation of the theory of dual processing and cognitive load, serves as a new resource for Neurosurgery field.

## Bibliography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