Initial Experience With a Robotics Guided Optics Platform in Lumbar Spine Surgery.

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Introduction

Illumination and magnification during lumbar spine surgery to improve visualization is achieved in multiple ways. This can include the use of the operative microscope, loupe magnification with a headlight or endoscopic camera systems. The use of an advanced optical system with an integrated light source, coupled with robotic technology for positioning, represents an evolutionary advance in the performance of lumbar spinal surgery.

Optical Chain of CS-m and ROVOT-m

Optical Chain consists of: 1) Optical Payload, 2) Light Source, 3) Camera, 4) Holder, 5) Display A) CS-m with both binocular lenses in use for viewing of operative field. B) ROVOT-m with video of operative field on a high definition display for both operators.

Methods

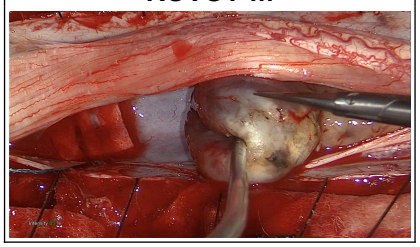
Patients from a single surgeon's practice who had undergone surgery between January 1, 2014 and April 30, 2016 were included. Operative times and durotomy were measured to assess the learning curve and complications, respectively. High-definition intraoperative video was recorded to evaluate optical technology and surgical workflow. We also measured the depth of field (DoF), field of view (FoV) and the volume of view (VoV) for the CS-m and ROVOT-m.

Metrics of Optical Power

Parameters	CS-m	ROVOT-m
Field of View (FoV)	Restricted Focal Point (x, y coordinate)	Focal Plane = Area
Depth of Field (DoF)	Restricted compared to ROVOT, inversely varied with Mag	3-4X greater than CS-m, inversely varied with Mag
Functional - Viewable and Usable	Useable<<<Viewable	Viewable = Usable
Lens (Direction of Light)-Numerical Aperture	High Convergence	Low Convergence High Parallelity
Volume of View	Restricted	Full

Comparison of optical metrics and surgical image quality between CS-m and ROVOT-m

Intradural Extramedullary Spinal Tumor Resection using ROVOT-m



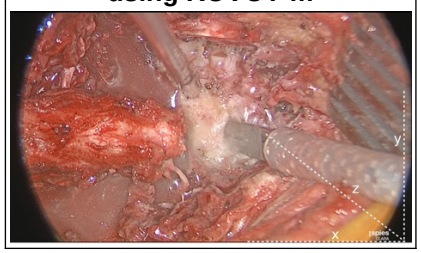
Results

Upon implementation of the optical system, the authors were able to approach mean operative times within 5 cases. In fact, operative times became faster than the surgeon's historical mean operative time, after 20 cases. 107 lumbar spine cases were performed using the CS-m and METRx system with a 12.1 % incidence of intraoperative dural tears. The incidence of durotomy in the 51 cases performed with ROVOT-m was 3.9 %. This represented a 68% decrease in intraoperative durotomies. The Volume of View was calculated to be 5 X 5 X 5 cm.

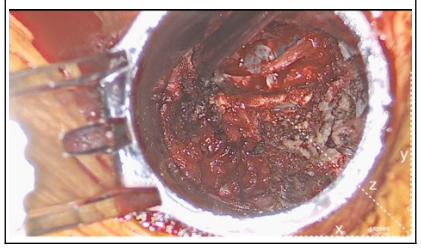
MIS Microdiscectomy

Using METRx with ROVOT-m

Open Lumbar Laminectomy using ROVOT-m



Microdiscectomy using ROVOT -m and METRx MIS



Conclusions

This review represents the largest and most extensive review to date of this evolutionary surgical visualization system and its use in lumbar spine surgery. Advantages of the robotic optics positioning system include:

- Enhanced surgical focus volume which eliminates point focusing issues seen with the use of CS-m and loupe magnification.
- Equal visualization and access to the surgical field for 2 surgeons.
- Improved ergonomics of surgeon and assistant by eliminating extreme and prolonged positions experienced with traditional methods.
- Improved visual trajectories with uniform illumination allowing for equal access to the extreme margins of the surgical field.
- Obviates the need to "switch" sides during the procedure.
- Enhanced visualization will advance tissue preservation during surgery.
- Minimal learning curve with potential to decrease operative times.
- Significantly reduced intraoperative complications (dural tears).

Movie

Movie

Movie

Movie