Tools and Adaptations to Enable Endoscopic Spinal Surgery
Technology #17646

Applications

- Spinal decompression by ablation of ligamentum flavum
- Spinal endoscopic surgeries
- Tumor ablation in the spinal canal
- Improved treatment of spinal decompression due to herniated discs, bone growth, and cartilage

Problem Addressed

Lumbar spinal stenosis (LSS) is a condition where narrowing of the spinal canal causes the compression of important neural structures, which leads to painful shock-like sensations, pain in the extremities, and the potential loss of motor and sensory function, affecting approximately 1.2 million people in the United States. The fundamental offending pathology of a majority of LSS patients is thickening of the ligamentum flavum (LF), the collagenous connective tissue bridging the interlaminar spaces of the dorsal spinal canal. Currently available surgical treatment to remove thickened ligamentum flavum requires general anesthesia and extensive dissection of surrounding tissues and spinal bone merely to access the surgical site. This leads to increased surgical risks and prolonged postoperative recovery periods, requiring extensive physical therapy and medicinal pain management.

Technology

This invention presents a variety of novel endoscopic tools and techniques designed to enable complex minimally invasive endoscopic procedures in the spinal canal, as accessed via a natural hole at the base of the sacrum, called the sacral hiatus. The endoscopic devices presented in this invention enable access, direct visualization, and precise and unobstructed targeting of tissue by a fiber optic probe and/or other tools during surgical procedures. In one application, this will allow the surgeon to selectively ablate compressive pathology such as hypertrophied ligamentum flavum (LF) with minimal disruption to adjacent tissue, resulting in effective treatment of LLS in a short outpatient procedure as opposed to the current standard which requires extensive tissue and bone removal. This result is achieved by one or more of the presented inventions working in concert:

- An endoscope with a digital imager, light source, fluid flushing port, and:
  1. A compound curvature set such that the endoscope hugs the dorsal wall of the spinal canal.
  2. One or more working channels equipped with concentric, pre-curved tubes which allow secondary, precise control of tools such as laser-fibers, graspers, hooks, laser-shields, etc. Steering of each tube-set is accomplished via a geared mechanical handle at the proximal end of the endoscope. Additionally, the tubes may be equipped with locking mechanisms at their distal tip to mechanically fix their respective tools.
  3. Two or more flaps which, in a compressed surgical field such as the spinal canal, can extend laterally from the tip of the endoscope to clear the endoscope field of view and surgical area.
  4. An optical fiber coupled to a Ho:YAG or similar laser operable to provide coherent light at a
specific infrared wavelength, which can ablate ligamentum flavum through fracturing of its extracellular matrix due to rapid thermal heating of water. An optical fiber can also be coupled to a frequency quadrupled Nd:YAG laser to provide coherent light at an ultraviolet wavelength, which can ablate ligamentum flavum through direct photodecomposition of the tissues extracellular matrix with minimal thermal injury to adjacent tissue. A Q-switch can be coupled to the controller and the laser to deliver a sequence of Q-switched laser pulses sufficient enough to ablate ligamentum flavum with minimal undesirable thermal effects, preventing non-ablative heating damage to surrounding regions of the target tissue.

- A cannula with a curvature such that the endoscope will hug the dorsal wall of the spinal column after navigating the lumbar-sacral curve.

**Advantages**

- Easy endoscopic manipulation and independent control of surgical tools and optical fiber probes
- Allows for a wider variety of and increased complexity of surgeries, in addition to ablation of ligamentum flavum, with minimally invasive approach; enables spinal endoscopic surgeries to be performed as outpatient procedures in less than one hour
- Eliminates the need for general anesthesia and extensive bone and tissue dissection to access the surgical site, significantly shortening the post-operative recovery time

**Categories For This Invention:**

- Lincoln Laboratory
- Medical Devices
- Other (Medical Devices)
- Surgical
- Life Sciences
- Biotechnology
- Health
- Clinical Applications
- General & Plastic Surgery
- Neurology
- Other (Clinical Applications)
- Instrumentation
- Other (Instrumentation)
- Therapeutics
- Other (Therapeutics)

**Intellectual Property:**

- Instruments for minimally invasive surgical procedures
- US Patent Pending 2016-0095505
- Steering techniques for surgical instruments
- US Patent Pending
2015-0148602

**Inventors:**
Matthew Johnson  
Westin Hill  
Tara Boettcher

**Publications:**
Ablation of Porcine Ligamentum Flavum with Ho:YAG, q-switched Ho:YAG, and Quadrupled Nd:YAG Lasers  
Lasers in Surgery and Medicine  
2015

**External Links:**
Lincoln Laboratory  
https://www.ll.mit.edu/