



Endoscopic spine surgery in China: its evolution, flourishing, and future opportunity for advances

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The beginnings

The predecessor of endoscopic surgery, arthroscopic microdiscectomy (AMD) was first introduced to China in the 1990s after its introduction in Japan, Germany and the United States in the 1980s (1-3). Endoscopic Spine surgery, however, did not flourish in China until Anthony Yeung introduced his YESS™ procedure in Beijing. Zou *et al.* published the preliminary report of spine endoscopy for lumbar disc herniation in 1998 (4). Subsequently, more Chinese physicians were trained by Dr. Yeung, and the YESS™ technique (inside-out) was recognized and practiced by more and more orthopedic spine surgeons (5). Later, the THESYS™ technique was introduced to China using the outside-in method to target the pathology (herniation) in the epidural space and disc through the foramen using serial dilation and reaming (6). Hoogland's technique initially favored a lateral uniportal approach that entered the disc through the foramen, but incidentally included foraminoplasty using trephines to enlarge the neuroforamen. This was used to access the disc for extruded disc herniations if the facet needed decompression.

At the same time, the endoscopic translaminal approach was also introduced to China at the L5–S1 segment (7). During this time, the indications of endoscopic lumbar discectomy were expanded from contained lumbar disc herniation to extruded and migrated disc herniation, calcified disc herniation, and foraminal stenosis using either Yeung's inside-out approach that included foraminoplasty and decompression of the foramen after entering the disc space, or Hoogland's technique requiring primary serial dilation. Since 2010, endoscopic spine surgery entered

into a booming stage in China after several symposiums on endoscopic spine surgery were held in China. Several pioneers of Chinese endoscopic surgeons and influential key supporters, such as Shuxun Hou, Yue Zhou, Guohua Lv, Xifeng Zhang contributed to the expansion and popularization of spinal endoscopic techniques in China (8-12). Chinese spinal endoscopic surgeons learned and modified different techniques, as well as expanded the techniques to treat other spinal conditions, such as tumor, spinal tuberculosis, pyogenic spondylitis, trauma and deformity (10-16). Xifeng Zhang modified the YESS™ technique and proposed an “Easy Technique” to improve access to various pathoanatomy by different angles and targeted trajectories (17). Endoscopic surgery was expanded from the lumbar-, to the cervical and thoracic spine by Chinese endoscopic physicians in recent years (18,19). Endoscopic surgery in China is performed by practitioners of different specialties, including orthopedic surgeons, pain physicians, neurosurgeons, traditional Chinese medicine doctors, and interventional doctors at almost all levels of hospitals. Notably, China has performed the most significant number of endoscopic surgeries around the world since 2018. The estimated number of endoscopic spinal surgeries is about 50,000–60,000 a year, and this number is still rising (19).

The Chinese way

Endoscopic spine surgery was introduced to China by Anthony Yeung in 1997 when he visited 306 Military Hospital in Beijing and demonstrated his intradiscal technique in a cadaver demonstration. Dewei Zhou,

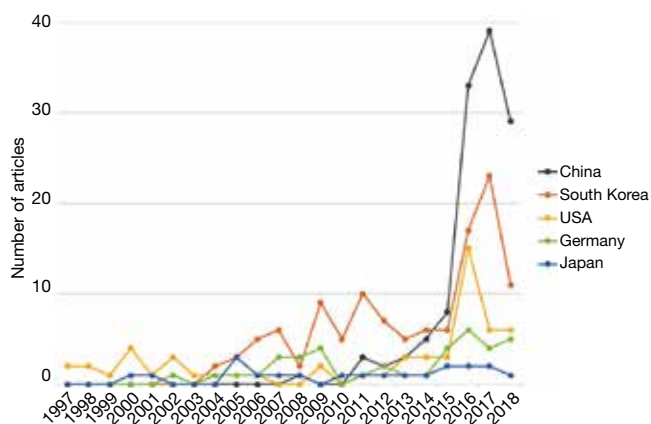


Figure 1 Time trend for the number of articles from top five countries from 1997 to 2018 (July 23). Unpublished data, courtesy of Dr. Jing Sung Kim, from Department of Neurosurgery, Seoul St. Mary's Hospital, Seoul, South Korea.

President of 306 Military Hospital, later published the first paper in Chinese literature on endoscopic disc surgery for disc herniation (4). While Endoscopic spine surgery has always stimulated interest by Chinese surgeons, it has escalated in the past 5–10 years to include neurosurgeons and other health practitioner in the Chinese system. Traditionally, brain surgeons had little training in the spine. In the past five years, however, their interest has substantially risen. Chinese endoscopic spine surgical volume of peer-reviewed PubMed listed publications has dramatically increased in recent years and taking the number one position from Korean authors in 2018.

Chinese key opinion leaders (KOLs) have distanced themselves from the KOLs in Korea with publications cited in PubMed due to the emphasis for publishing for advancement in Chinese academic institutions. The acceptance, development, and evolution of endoscopic techniques in Asia before 2018 was largely carried by Korean spine surgeons, whose publication volume is second in quantity, but has been generally recognized to have higher impact due to publication in high impact factor journals by following more strictly perceived Western guidelines of evidence-based medicine (*Figure 1*). The growth of endoscopic spine surgery in Asia is also influenced by the different cultural, political, and economic factors in Asian countries. Endoscopic spine surgery exhibits unique features in China due to China's acceptance of thousands of years of multiple systems in China's history. This factors as well as into its medical system, which

poses excellent opportunities as well as challenges to its development in China. There are numerous challenges to the implementation of endoscopic spine surgery in China coupled with countless opportunities to modernize the ways of delivering spine care in China.

A new era

The flourishing and rapid growth of endoscopic surgery in China is due to the high acceptance of multiple Chinese medical systems based on thousands of years of history. There are several particulars to the advancement of spine surgery in China. First, orthopedic surgeons performed most of the spine surgeries but without the use of the microscope, which is widely used in spine surgeries in Western countries. The introduction of endoscopic surgery in China filled this technological gap of minimally invasive spine surgery in China since it was more economical to introduce endoscopic surgery sets rather than relying on the reliance on more pricy operating microscopes. In other words, China skipped the era of microsurgical dissection in the spine and jumped straight to endoscopic surgery as the mainstay of minimally invasive spine surgery in China. Because of the learning curve inherent to endoscopic surgery, most traditional spine surgeons were not persuaded to rely on microscopes to practice spine surgery outside their traditional postgraduate surgical training. Therefore, endoscopic spinal surgery provided an opportunity for the next generation younger doctors from the traditional big hospitals as well as physicians from less-recognized hospital to become recognized as masters of endoscopic spine surgery.

Chinese philosophy and contemporary needs

The concept of minimally invasive surgery fits Chinese philosophy of avoiding open spine surgery, there is an urgent appeal for the hospitals to attract surgeons who practice minimally invasive surgery for marketing purposes, and endoscopic spinal surgery was one of the most viable choices. Due to the aging of the population, downward pressure of Chinese economy, and an incomplete commercial insurance system at present of China, the advantages of endoscopic spinal surgery, such as minimally invasiveness, and dramatically reduced hospital stays, meets the need of the Chinese government to reduce health care expenditures while delivering modern care. Private spine centers are also offering opportunities for well trained and recognized Chinese surgeons. The advancement of endoscopic spinal

techniques during the last 20 years has expanded the indications to a broader scale since many traditional spine surgeries can be replaced by endoscopic surgery.

The pioneers

Several pioneers have helped to train Chinese physicians and introduce the techniques to China. Particular regard should be given to Dr. Anthony Yeung, for his perseverance, teaching, and promotion of endoscopic spinal surgeons of China. After Dr. Yeung introduced his philosophy and technique to China, hundreds of surgeons and non-surgeons have gone to him for training at his Phoenix Arizona based Desert Institute for Spine Care. This caused Xifeng Zhang to establish the Yeung Endoscopic Spine Society, and prominent leading surgeons now follow his teaching. Two years after learning from Yeung, Xifeng Zhang applied the endoscopic technique for decompression of tuberculous abscess. Others have also contributed, including Yue Zhou, Zhenzhou Li, Fangyong Wang, Boling Liu, Hongwei Zhu, Peng Huang, Jianwei Du, Yu Ding, Xinyu Liu, Chuanli Zhou, Yong Gao, Qingbin Meng, Mingming Dou, Jun Zhang, and too many other endoscopic surgeons to mention. Therefore, these specific cultural, political, and economic factors of China are providing excellent opportunities for the development and popularization of the endoscopic spinal surgery in China.

The challenges

Challenges exist regarding the development of endoscopic spine surgery in China. The endoscopic spinal techniques were introduced from the West when the techniques are still in their process of evolution. Currently, China lacks systematic theoretical and technical basis for the development of endoscopes and endoscopic instrumentation for spine surgery. Debates about the superior philosophy behind the inside-out and outside-in techniques as well as misunderstanding and misinterpretation of the indications and best uses of the transforaminal versus the translaminar approach on the backdrop of Chinese medicine continue to impact the implementation and advancement of endoscopic spinal surgery in China. However, Chinese KOLs recognize and promote each technique as an evolving platform. The YESS™ technique has evolved and continually advanced and improved by Anthony Yeung over the last 28 years to address a broad spectrum of lumbar spinal diseases, starting with discogenic pain, almost all

types of lumbar disc herniation, spinal and foraminal stenosis, especially far lateral stenosis (20). His inside-out philosophy adopts intradiscal therapy as an integral part of comprehensive spine surgery because back pain begins in the disc, progressing to the need for decompression of the foramen to relieve stenosis and gain access the branches of the dorsal ramus that innervate the facets, and especially the extraforaminal lateral recess and the “hidden zone” of MacNab responsible for many causes of failed back surgery syndrome and anomalous anatomy. The outside-in technique has also been adopted by Chinese expert surgeons as an effective platform to treat common degenerative conditions of the lumbar spine as long as the patient’s pain generators and surgically treated.

The future

Artificial intelligence for ideal endoscopic positioning of cannulas instruments and robotics-assisted endoscopic surgery using image recognition software is under development by Yeung and his associates to advance the endoscopic spine surgery to a higher level. The quality of endoscopic physicians can be inconsistent, and many endoscopic surgeons start their practice without adequate training. Due to the lack of systematic training system, endoscopic spine surgeons mainly rely on observations of other surgeons and gain experience through their clinical practice. The learning curve is steep. Due to the lack of adequate knowledge and technical training, the beginners usually have a significantly higher rate of complications before the overcoming of the learning curve. Compared with a large number of endoscopic surgeries, there are few systematic and in-depth research on the technique and clinic outcomes of their practice. Some publications rely on sensational and empirical descriptions, and original and innovative creations are relatively scarce. These problems will significantly restrict the development of endoscopic spinal surgery to a higher level and should be addressed with multicenter well-structured clinical trials. The creation of the clinical and socioeconomic evidence needed to underpin the advanced protocols behind modern endoscopic spine surgery will aid in the communication with payers and government institutions to solidify its implementation in China.

Conclusions

In the future, efforts should focus on establishing training systems to help to improve the consistency of quality

of endoscopic surgery to aid in the expansion of the application of endoscopic spinal surgery to different indications in a transparent and standardized way. More original research and innovations should be done to make more contributions to the development of endoscopic spine surgery in the world. Artificial intelligence and other advanced technologies should be incorporated into the development of Chinese endoscopic spinal surgery. The authors believe that the future of endoscopic surgery in China will be even more promising and bright because of the enormous demand of the market in China, the size of its population as well as the further development of Chinese endoscopic spinal surgery technologies.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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