Development of Endoscopic Spine Surgery for Healthy Life: To Provide Spine Care for Better, for Worse, for Richer, for Poorer, in Sickness and in Health

Hyeun-Sung Kim¹,*, Pang Hung Wu¹,²,*, Il-Tae Jang¹

¹Nanoori Gangnam Hospital, Spine Surgery, Seoul, Korea
²National University Health System, JurongHealth Campus, Orthopaedic Surgery, Singapore

INTRODUCTION

In part of the wedding vow, when partners commit to support each other in various times of their lives, a common phrase is "to hold from this day forward, for better, for worse, for richer, for poorer, in sickness and health, to love and to cherish, until we are parted by death." Spine conditions affect most people with age, in both high-income and low-income countries, including both people who are healthy and athletic and people with complex medical problems and those who are home-bound. Robust treatment strategies are needed for this diverse variety of patients with different needs presenting with various degenerative and injury-related spine conditions. Recent advances in endoscopic spine surgery are a testimony to the integration of modernised spine surgical skills with technological advances. In this Neurospine Special Issue: Endoscopic Spine Surgery Part II: Visualized Surgical Process, we put together articles from a team of established endoscopic spine surgeons around the globe to provide a technical update and share their experiences on how they handle various spinal conditions in various clinical scenarios with the aim of adding quality years of healthy life and providing spinal care for better, for worse, for richer, poorer, in sickness, and in health (Fig. 1).

FOR BETTER SPINE CARE: MINIMISING TISSUE DAMAGE IN PROLAPSED INTERVERTEBRAL DISCS DURING ENDOSCOPIC DISCECTOMY

Prolapsed intervertebral disc is a common spinal problem affecting young and active individuals, as well as older patients with degenerative spinal conditions. It affects 1%–3% of the population in their lifetime. Conservative treatment fails in roughly 10% of patients with a prolapsed disc, who then require consideration for surgical intervention.¹ Conventional open discectomy requires ipsilateral laminotomy or complete laminectomy, resection of the ligamentum flavum, and subsequent discectomy. Although it is an effective treatment...
Development of Endoscopic Spine Surgery for Healthy Life

Kim HS, et al.

Neurospine 2020;17(Suppl 1):S3-8.

www.e-neurospine.org

with favourable patient-reported outcomes, it changes the paraspinal musculature, soft tissue, and the bony and ligamentous anatomy of the affected level, and causes epidural fibrosis following spinal surgery because fibrotic tissue replaces epidural fat.\(^2,3\) Endoscopic discectomy has practical advantages. By using a safe surgical corridor in the transforaminal route with various techniques to approach the disc, it is possible to minimise bony resection and ligamentous disruption while reaching the site of the prolapsed intervertebral disc.\(^4-7\) The benefits of these techniques also extend to the thoracic and cervical regions.\(^8-10\) The delivery of magnified endoscopic vision close to the pathological area, bypassing soft tissue and bony obstacles along the path to the pathology, enables the targeted delivery of thermal energy, mechanical debridement of soft tissue, bony resection, and removal of pathology with less collateral damage. These techniques epitomise the principles of minimally invasive surgery, providing solutions for many types of prolapsed discs with potentially difficult access issues.\(^11,12\) The long-term outcomes are comparable to those of open discectomy, but with a shorter hospital stay.\(^13\) As the techniques of endoscopic spine surgery evolved, surgeons’ focus shifted to providing better spinal surgical treatment with less damage to local anatomy, minimising recurrence, and easing the learning curve of endoscopic spine surgery.\(^12,14,15\)

**FOR WORSE CASE SCENARIOS (REVISION SURGERY, COMPLICATIONS, AND EXPANSION OF INDICATIONS): SOLUTIONS OFFERED BY ENDOSCOPIC DECOMPRESSION AND INTERBODY FUSION**

Population aging has been accompanied by an increase in the incidence and prevalence of lumbar degenerative spine conditions. With a high prevalence of these conditions, such as spinal stenosis, spondylolisthesis, degenerative disc disease, and their associated spinal conditions, there is a demand for surgical techniques to provide effective decompression and fusion.\(^16\) In head-to-head comparisons with open and minimally invasive microscopic decompression and fusion, full endoscopic uniportal and endoscope-assisted biportal decompression and interbody fusion achieved equivalent patient-reported outcomes, with better facet preservation, shorter hospital stays, improved perioperative pain management, and a lower infection rate.\(^17-19\) With the wide application of open and endoscopic spine decompression and fusion surgery in patients with degenerative spine disease, there has been a corresponding increase in patients who present with conditions requiring revision surgery. Similarly, recurrence of prolapsed disc is a common long-term complication of discectomy. Performing revision surgery using endoscopic discectomy, decompression, and fusion techniques has the following benefits: (1) As minimally invasive techniques result in a smaller wound and less soft tissue dissection, there is a lower chance of wound dehiscence and infection.\(^20\) Constant irrigation during endoscopic spine surgery is likely to reduce this risk even further. (2) A magnified endoscopic view with dissection done lateral to the dural scar tissue may decrease the risk of incidental durotomy.\(^21\) (3) The reduced extent of soft tissue and bony dissection under endoscopic vision can potentially preserve enough tissue to prevent instability and the need for fusion.\(^22-24\) (4) Alternative approaches to the same target site are...
possible with endoscopic spine surgery. For example, a contra-
lateral approach can reach the same foraminal region in a pre-
vious surgical site where a paraspinal approach or transforami-
nal approach was used.23 However, amid the optimism regard-
ing the expansion of indications for endoscopic spine surgery
to encompass increasingly challenging cases, one needs to be
cautious of the potential complications of endoscopic surgery,
such as incidental durotomy, neurological sequelae, and inade-
quate decompression, all of which are confounded by a steep
learning curve.24-26

FOR RICHER: COST OF ENDOSCOPIC
SPINE SURGERY-RELATED EQUIPMENT

Worldwide, 266 million individuals (3.63%) have degenera-
tive spinal conditions and suffer from lower back pain each year.
The highest and lowest estimated incidence rates were found in
Europe (5.7%) and Africa (2.4%), respectively. The distribution
of cases depends on demographics, as low- and middle-income
countries have 4 times as many cases as high-income countries.27
Endoscopic spine surgery is dependent on technological devel-
opments. Advances in the endoscopic camera optical system
and the development of endoscopic instruments and thermal
energy delivery techniques such as side-firing lasers and radio-
frequency coagulators present a double-edged sword. On one
hand, these technological advances provide a safer platform to
achieve the objectives of endoscopic spinal surgery, but on the
other hand, using novel equipment increases the cost of endo-
scopic spine surgery. The way to resolve this dilemma is the more
widespread usage of endoscopic spine surgery equipment, which
—together with mass production—will hopefully drive the cost of
surgery down. It is important for industry, health care policy-
makers, and endoscopic spine surgeons to be aware of the so-
cial responsibility of reasonable costs in the provision of endo-
scopic spine surgical care, in order to fulfil the objective of pro-
viding similarly effective minimally invasive spinal surgery re-
gardless of the social background of the presenting patient.28

FOR POORER: ADAPTATION OF
TECHNOLOGIES USED BY OTHER
DISCIPLINES IN SPINAL SURGERY

While various players attempt to reach an equilibrium to con-
tain the costs of endoscopic equipment, we can draw comfort
from the fact that endoscope-assisted surgery can adopt equip-
ment that is available for use by our orthopaedic and neurosur-
gical colleagues and apply it to endoscope-assisted procedures
such as unilateral biportal endoscopic (UBE) decompression
and fusion. The camera system used in orthopaedic arthroscopy
(e.g., for knee and shoulder surgery) can be used for UBE
with some minor modifications. In a similar vein, some open
spinal decompression and fusion equipment can be used in
UBE surgery.29 While there are debates on the approaches, ben-
efits, and outcomes of uniportal versus biportal endoscopic spine
surgery, evidence exists that both types of surgery yield favour-
able outcomes.17,30 The ability to use locally available equipment
would certainly encourage attempts to develop endoscopic prac-
tice despite variations in wealth and policies due to geographi-
differences.

IN SICKNESS: THE ROLE OF
ENDOSCOPIC SPINE SURGERY IN
PATIENTS WITH COMPLEX MEDICAL
PROBLEMS

As it is increasingly frequent for complex medical problems
to be well managed by other medical specialties, it is increas-
ingly common for patients with multiple complicated comor-
bidities to require spinal operations. Some of these patients have
a high risk of anaesthesia-related complications, which discour-
age both the patients and the treating physicians from pursuing
surgical treatment.31 General anaesthesia may cause issues in
elderly patients, with postoperative complications including
cognitive dysfunction and immobility-related complications
such as deep vein thrombosis and sacral sores. However, these
complications can be potentially avoided with various endoscop-
ic spinal procedures that can be done under local anaesthesia
and epidural anaesthesia, which allow for early postoperative
recovery and mobility without a significant effect on the central
nervous system.32-36

IN HEALTH: SUMMARY AND
CONCLUSIONS ON ADDING QUALITY
YEARS OF HEALTHY LIFE BY
ENDOSCOPIC SPINE SURGERY

The ultimate aim of all medical specialties is to add more qual-
ity years of healthy life for our patients. As patients have a lon-
ger life expectancy, it is important to treat their disabling spinal
conditions appropriately to enable patients to live a satisfying,
functional, and relatively pain-free life as long as possible. En-
doscopic spine surgery closely follows the ethical principles of
nonmaleficence, beneficence, justice, and respect for autonomy of the patients. One of the main principles of endoscopic spine surgery is minimising the collateral damage of surgery. With more experience, and hopefully with a magnified view of the structures in the endoscopic operating field, one can reduce the complications and tissue damage related to spine surgery. These efforts follow the principles of nonmaleficence. The positive outcomes of well-executed endoscopic spine surgery are well documented in the literature. With a further understanding of the indications and limitations of endoscopy, it will be possible to safely and effectively provide equivalent and possibly superior outcomes to patients in comparison to open surgery, thereby fulfilling the principle of beneficence. Justice of care is a complex issue in endoscopic spine surgery. There is a heavy dependence on advanced equipment to provide safe endoscopic care to patients, resulting in a risk that patients from places with limited resources may have problems accessing endoscopic care. The spine surgery community should work together with industry and healthcare facilities to tackle this issue. The ultimate aim is to provide the option of endoscopic spine surgery regardless of economic and social circumstances. With development of endoscopic training, the widespread availability of literature, and sharing of technical pearls, more surgeons will be trained to be proficient in endoscopic spine surgery. This development of skills, with an appropriate understanding of the limitations of endoscopic spine surgery, will provide an alternative option for both surgeons and patients to consider based on their personal values and beliefs. As such, endoscopic spine surgery allows more tailored treatment options for specific conditions, ultimately fulfilling the principle of respecting patient autonomy.

**CONFLICT OF INTEREST**

The authors have nothing to disclose.

**REFERENCES**

1. Jordan J, Konstantinou K, O'Dowd J. Herniated lumbar disc. BMJ Clin Evid 2009;2009:1118.
2. Dobran M, Brancorsini D, Costanza MD, et al. Epidural scarring after lumbar disc surgery: Equivalent scarring with without free autologous fat grafts. Surg Neurol Int 2017;8:169.
3. Bouche KG, Vanovermeire O, Stevens VK, et al. Computed tomographic analysis of the quality of trunk muscles in asymptomatic and symptomatic lumbar discectomy patients. BMC Musculoskelet Disorders 2011;12:65.
4. Kambin P, Sampson S. Posterolateral percutaneous suction-excision of herniated lumbar intervertebral discs. Report of interim results. Clin Orthop Relat Res 1986;(207):37-43.
5. Yeung A, Roberts A, Zhu L, et al. Treatment of soft tissue and bony spinal stenosis by a visualized endoscopic transforaminal technique under local anesthesia. Neurospine 2019;16:52-62.
6. Hoogland T, Schubert M, Miklitz B, et al. Transforaminal posterolateral endoscopic discectomy with or without the combination of a low-dose chymopapain: a prospective randomized study in 280 consecutive cases. Spine (Phila Pa 1976) 2006;31:E890-7.
7. Kim HS, Adsul N, Kapoor A, et al. A mobile outside-in technique of transforaminal lumbar endoscopy for lumbar disc herniations. J Vis Exp 2018;(138):57999.
8. Choi KY, Eun SS, Lee SH, et al. Percutaneous endoscopic thoracic discectomy; transforaminal approach. Minim Invasive Neurosurg 2010;53:25-8.
9. Sharma SB, Kim JS. A review of minimally invasive surgical techniques for the management of thoracic disc herniations. Neurospine 2019;16:24-33.
10. Ahn Y, Lee SH, Shin SW. Percutaneous endoscopic cervical discectomy: clinical outcome and radiographic changes. Photoned Laser Surg 2005;23:362-8.
11. Kim HS, Paudel B, Jang JS, et al. Percutaneous endoscopic lumbar discectomy for all types of lumbar disc herniations (LDH) including severely difficult and extremely difficult LDH cases. Pain Physician 2018;21:E401-8.
12. Kim HS, Raorane HD, Wu PH, et al. Evolution of endoscopic transforaminal lumbar approach for degenerative lumbar disease. J Spine Surg 2020;6:424-37.
13. Zhang B, Liu S, Liu J, et al. Transforaminal endoscopic discectomy versus conventional microdiscectomy for lumbar discherniation: a systematic review and meta-analysis. J Orthop Surg Res 2018;13:169.
14. Hsu HT, Chang SJ, Yang SS, et al. Learning curve of full-endoscopic lumbar discectomy. Eur Spine J 2013;22:727-33.
15. Kim M, Kim HS, Oh SW, et al. Evolution of spinal endoscopic surgery. Neurospine 2019;16:6-14.
16. Ahmed SI, Javed G, Bareeqa SB, et al. Comparison of decompression alone versus decompression with fusion for stenotic lumbar spine: a systematic review and meta-analysis. Cureus 2018;10:e3135.
17. Heo DH, Lee DC, Park CK. Comparative analysis of three types of minimally invasive decompressive surgery for lumbar central stenosis: biportal endoscopy, uniportal endosco-
Development of Endoscopic Spine Surgery for Healthy Life

Kim HS, et al.

18. Lee CW, Yoon KJ, Ha SS. Comparative analysis between three different lumbar decompression techniques (microscopic, tubular, and endoscopic) in lumbar canal and lateral recess stenosis: preliminary report. Biomed Res Int 2019;2019:6078469.

19. Kang T, Park SY, Kang CH, et al. Is biportal technique/endoscopic spinal surgery satisfactory for lumbar spinal stenosis patients? A prospective randomized comparative study. Medicine (Baltimore) 2019;98:e15451.

20. Chahoud J, Kanafani Z, Kanj SS. Surgical site infections following spine surgery: eliminating the controversies in the diagnosis. Front Med (Lausanne) 2014;1:7.

21. Kim CH, Chung CK, Jahng TA, et al. Surgical outcome of percutaneous endoscopic interlaminar lumbar discectomy for recurrent disk herniation after open discectomy. J Spinal Disord Tech 2012;25:E125-33.

22. Choi DJ, Kim JE. Efficacy of Biportal endoscopic spine surgery for lumbar spinal stenosis. Clin Orthop Surg 2019;11:82-8.

23. Wu PH, Kim HS, Jang IT. How I do it? Uniportal full endoscopic contralateral approach for lumbar foraminal stenosis with double crush syndrome. Acta Neurochir (Wien) 2020;162:305-10.

24. Lee CW, Yoon KJ, Kim SW. Percutaneous endoscopic decompression in lumbar canal and lateral recess stenosis - the surgical learning curve. Neurospine 2019;16:63-71.

25. Kim HS, Raorane HD, Wu PH, et al. Incidental durotomy during endoscopic stenosis lumbar decompression: incidence, classification, and proposed management strategies. World Neurosurg 2020 Feb 12:S1878-8750(20):30260-6. https://doi.org/10.1016/j.wneu.2020.01.242. [Epub].

26. Kim H-S, Sharma S, Wu P, et al. Complications and limitations of endoscopic spine surgery and percutaneous instrumentation. Indian Spine J 2020;3:78-85.

27. Ravindra VM, Senglaub SS, Rattani A, et al. Degenerative lumbar spine disease: estimating global incidence and worldwide volume. Global Spine J 2018;8:784-94.

28. Choi KC, Shim HK, Kim JS, et al. Cost-effectiveness of microdiscectomy versus endoscopic discectomy for lumbar disc herniation. Spine J 2019;19:1162-9.

29. Hwa Eum J, Hwa Heo D, Son SK, et al. Percutaneous biportal endoscopic decompression for lumbar spinal stenosis: a technical note and preliminary clinical results. J Neurosurg Spine 2016;24:602-7.

30. Lee CH, Choi M, Ryu DS, et al. Efficacy and safety of full-endoscopic decompression via interlaminar approach for central or lateral recess spinal stenosis of the lumbar spine: a meta-analysis. Spine (Phila Pa 1976) 2018;43:1756-64.

31. Zambouri A. Preoperative evaluation and preparation for anesthesia and surgery. Hippokratia 2007;11:13-21.

32. Kim JH, Kim HS, Kapoor A, et al. Feasibility of full endoscopic spine surgery in patients over the age of 70 years with degenerative lumbar spine disease. Neurospine 2018;15:131-7.

33. Guan Y, Huang T, An G, et al. Percutaneous endoscopic interlaminar lumbar discectomy with local anesthesia for L5-S1 disc herniation: a feasibility study. Pain Physician 2019;22:E649-54.

34. Oksar M. Sedation for percutaneous endoscopic lumbar discectomy. ScientificWorldJournal 2016;2016:8767410.

35. Wang MY, Grossman J. Endoscopic minimally invasive transforaminal interbody fusion without general anesthesia: initial clinical experience with 1-year follow-up. Neurosurg Focus 2016;40:E13.

36. Ito F, Ito Z, Shibayama M, et al. Step-by-step sublaminar approach with a newly-designed spinal endoscope for unilateral-approach bilateral decompression in spinal stenosis. Neurospine 2019;16:41-51.
Development of Endoscopic Spine Surgery for Healthy Life

Kim HS, et al.

Neurospine 2020;17(Suppl 1):S3-8.

Title: Girl Before A Mirror
Artist: Pablo Picasso
Year: 1932
© 2020 - Succession Pablo Picasso - SACK (Korea)