Dezawa A, et al., J Phys Med Rehabil Disabil 2020 6: 055
DOI: 10.24966/PMRD-8670/100055

HSOA Journal of
Physical Medicine, Rehabilitation & Disabilities

Review Article

Historical Review of Endoscopic Spinal Decompression

Akira Dezawa[1]* and Takashi Dezawa[2]

[1]*Department of Orthopedic Surgery, Head Dezawa Spine PED Center, Visiting Professor, Teikyo University, Tokyo, Japan*

[2]*Department of Orthopedic Surgery, Toho University, Tokyo, Japan*

Abstract

Improvements in imaging techniques, along with advancements in optomechanical devices such as 2-mm-thin endoscope, electronic scope, and CCD cameras, and development of new devices such as the high speed drill greatly affected the techniques of minimally invasive endoscopic surgery. In behind the birth of these groundbreaking medical techniques there were engineers who have supported from the beginning. Thus, it is also the history of medical-and-engineering ties between doctors and optical engineers, and past experience becomes a beam of light that shed upon the future.

Primum nil nocere (minimize the invasion) was a concept since the days of Hippocrates, and it has been an everlasting theme for surgeons. Then, a paradigm shift occurred, from the times of microscopes to the times of video endoscope where operators can share the live image with others. With these advancements, surgeons were able to understand the anatomical structures and relative positional relationship of each organs through the endoscope and developed their depth perception through two-dimensional video images. Endoscopic spinal decompression that uses high-definition endoscopic images and can treat a wide range of the spinal column enabled to decrease numbers of complications and faster rehabilitation.

Keywords: Endoscopic spinal decompression; Full endoscopic spine surgery; Minimally invasive spine surgery; Rigid endoscope; Stenosis

Introduction

Trying to see inside a human body with an instrument was a theme that went in tandem with the development of lenses and image capturing. By looking back at the history, we can foresight the future of minimally invasive endoscopic techniques. History of endoscopy goes way back to 100AD, in which medical instruments that can examine inside the body were discovered in the ruins of Pompei [1,2]. The first time a tube was used to examine the inside of an organism was done in 1805 by Philipp Bozzini. He inserted a tube inside the body, and by using a candle as the light source, he became the first person to examine inside the body. He also tried to examine the inside of the ear, urethra, rectum, and a woman's bladder by using a 13zoll (35cm) by 5.9 cm sized box-like device called a Lichtleiter (light guide) [3]. Antoine Jean Desormeaux was a French urologist who worked at the Necker Hospital, a hospital still presents in Paris and in 1853, he examined the urethra, bladder, and the rectum using an autoscope. He is the first person to create the phrase endoscope, a device to look inside the body. Known as the father of endoscopy, Desormeaux committed to popularize endoscopy. The light source was made by burning mixture of alcohol and turpentine and reflecting the light into a lens tube. Until the invention of incandescent light bulb by Edison, light source was made by using candles, gas, and turpentine. In 1879, with Edison inventing the incandescent light bulb, the development of endoscopy also found a new light. In 1970, George Smith (1930-) and Willard Boyle (1924-2011) invented the Charged Coupled Device (CCD), which converts light into electrical signals. With this device, images were converted into electrical signals, which then were displayed onto a monitor for everyone to see.

***Corresponding author:** Akira Dezawa, Department of Orthopedic Surgery, Head Dezawa Spine PED Center, Visiting Professor, Teikyo University, Tokyo, Japan, Tel: +81 448443333; E-mail: adezawajp@gmail.com

Citation: Dezawa A, Dezawa T (2020) Historical Review of Endoscopic Spinal Decompression. J Phys Med Rehabil Disabil 6: 055.

Received: October 09, 2020; **Accepted:** October 12, 2020; **Published:** October 19, 2020

History of Endoscopy

Rigid endoscope – semi-flexible endoscope period (1868-1957) (Table 1)

The first person to look inside the stomach of a live person using anesophago-gastroscope was a German doctor by the name of Adorf Kussmaul (1822-1902) in 1868. Using a metal tube with a length of 47cm and a width of 13mm, the process was extremely painful for the patient. The tip was shaped into an oval, but as it was a rigid endoscope, it was not able to bend at all during examination [1]. In 1887, Nitze and an Austrian technician by the name of Josef Leiter developed an urethro-cystoscope that used a molten platinum glow wire as a light source [4,5] (Figure 1).

In 1881, Josef Leiter collaborated with Mikulicz to develop the first widely-used rigid gastroscope [1,5,6]. Afterwards in 1911, Jacobaeus invented the laparo-thoracoscope, enabling the endoscope to reach most of the body's tube-shaped organs and cavity [7].

The new age of endoscopy arrived in 1932 when Rudolf Schindler invented a flexible gastroscope that had a flexible optic axis, with the help of an optical engineer by the name of Georg Wolf [8]. In 1959, after countless trials, Masaki Watanabe and Tsunekichi Fukuyo invented the the 21st Watanabe Arthroscope, which enabled not only examinations but also surgery and filming inside the joint [9] (Figure 2).

Basic principle of the arc lamp discovered, **1802**.
1805 Philipp Bozzini: Used a candle
Image fixation on asphalt by Niepce, **1822**
1826 Segalas: Autoscope and candle
silver-coated plates **1837,**
1853 Antoine Jean Desormeaux: Endoscope developed
1868 Kussmaul: Esophagogastroscope developed
Luminescent platinum wire **1870,**
Dry plates, Maddox, **1871**
1879 Nitze and Leiter: Cystoscope developed
1881 Mikulicz: Rigid gastroscope developed
Electric lighting entered general use in USA, **1883**
Discovery of X-rays, **1895**
Diode vacuum tube, **1904**
1911 H.C. Jacobaeus: Abdominothoracoscope developed
Tetrode vacuum tube, **1912**
1918 Kenji Takagi: Examination inside a cadaver knee joint using the cystoscope Charrier 22
1920 Zollikofer (in Switzerland): Meteorismusperitonealis achieved using carbon dioxide gas
1921 Eugen Bircher: Report of 18 cases of arthroscopy
1929 Kalk: Abdominoscope developed
Cool-ray lamp with transmission by glassibers, Heinrich Lamm, **1930**
1931 Burman: Arthroscope published in Journal of Bone and Joint Surgery
1932 Schindler (in Germany): Flexible gastroscope developed
UK television broadcast, **1936**
1937 Presentation of Takagi's endoscopes at the Paris Exposition, **1937**
Invention of silicon transistor, **1947**
Theoretical publication about fiber optics in Nature, Hopkins, **1954**

Table 1: Era of rigid endoscopes (1805 to 1957).

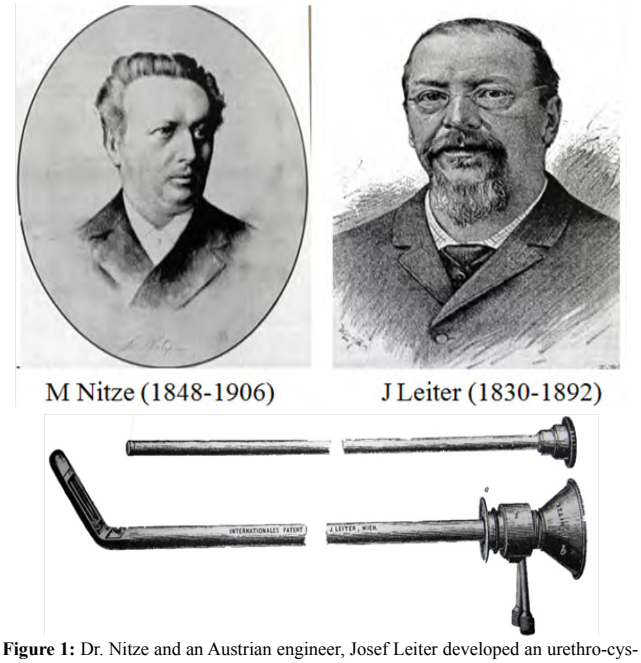


Figure 1: Dr. Nitze and an Austrian engineer, Josef Leiter developed an urethro-cystoscope, J. Leiter received the first international patent for an endoscope.

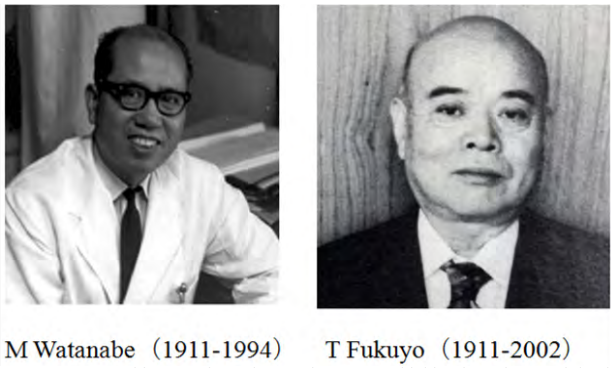


Figure 2: Dr. Masaki Watanabe and an engineer, Tsunekichi Fukuyo invented the the "21st Watanabe Arthroscope".

Cold light source video endoscopy period (1952-now) (Table 2)

Fourestier developed the cold light fiberglass in 1952 [10]. The technical advancement of the endoscopy accelerated with the development of the quartz rod lens by Hopkins [11], a lens still used today. This incorporates a new theoretical concept of light transmission called the total internal reflection, and this made it possible for the light to be transmitted inside the endoscopy lens without lowering the luminosity. Hopkins' "Rod Lens" and the flexible light fiber scope enabled the image to be brighter and clearer [12]. In 1970, by using CCD camera that converts light into electrical signals, operations were done by multiple surgeons using TV monitor displays, and the development of the CCD camera accelerated the development and the popularization of the endoscope. Even now, small-sized CCD camera and robots are continued to be in development to miniaturize video endoscopy with clearer resolution.

Fiberscope developed by Hirscowitz, **1957**
Optical fibers developed by Narinder Singh Kapany, **1958**
1962 Watanabe: Success in the world's first arthroscopic meniscectomy,using the Model-21 arthroscope
Integrated-circuit calculator developed, **1964**
1966 Kurt Semm: Automatic pneumoperitoneum device developed
Charged-coupled device developed, **1970**
Computed tomography developed, **1971**
1974 International Arthroscopy Association established.
1975 S.Hijikata: Percutaneous nuclectomy developed
Optical communication, **1977**
1983 Semm: Abdominoscopic appendectomy carried out
1985 Erich Muhe (in Germany): Abdominoscopic Cholecystectomy carried out
Miniature charged-coupled device developed **1986**
1987 Philippe Mouret: Abdominoscopic cholecystectomy
Carried out in Lyons, France.
1994 A robotic arm developed.
1996 Robotic telesurgery carried out using the Internet.

Table 2: Era of cool-ray lamps and videoendoscopy (1957 to present).

History of Endoscopic Spinal Decompression Techniques

Each type of endoscopeis categorized depending on the thinness (Table 3)

PELD (Percutaneous Endoscopic Lumbar Discectomy) is an

optical technique innovation expanded from the PN (Percutaneous Nucleotomy) method, and a rigid-type endoscopy called Full endoscopy is used for the spine. It is also used in uniportal bilateral decompression of the thoracic spine OYL resection, and biportal bilateral decompression is also in consideration.

Classification from endoscopy
Fullendoscopy
Tubular surgery with endoscopy
Laparoscopy
Retroperitoneoscopy
Thoracoscopy
Epiduroscopy
Classification of the method to maintain a space
constant saline irrigation
pneumoperitoneumwith CO_2 gas
natural cavity
Decompression classification from an approach
Inter laminal
Uniportal bilateral decompression
Biportal bilateral
Trans spinous process [13]
Translaminar [14-18]
Transpedicular [19]
Transforaminal [20,21]
Transiliac [22]
Transsacral [23]
Decompression classification from pathological condition
Central stenosis
Lateral recess stenosis
Foraminal stenosis
Extraforaminal stenosis

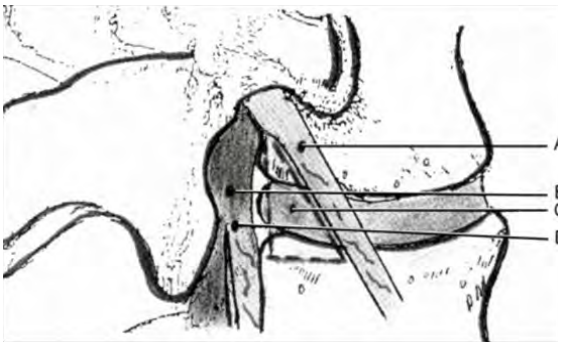
Table 3: Classification of endoscopes used in decompression techniques.

Although tubular surgery with assistant of endoscopy (an approach similar to when using the miscroscope) expanded into a technique suitable for the posterior region [24-26], as it is a natural cavity, a suction tube becomes necessary, and there is a limit to the size of the working channel. For the anterior region, both anterior lumbar discectomy and fusion during laparoscopy of aeroperitoneum and retroperitoneoscopy uses endoscope as a support for lateral approach. Also, this technique is used in VATS and applied during the decompression andcorrection of thoracic and thoracolumbar transitional vertebrae.

Methods to sustain the cavity are categorized into full endoscopy (sustains by flowing saline into the cavity [27]). Laparoscopy (uses CO2 gas to sustain the cavity [28]), VATS: Video-Assisted Thoracic Surgery (uses a small natural cavity instead of saline to sustain the cavity [29,30]), tubular surgery (METRx tube [31,32]), and abdominal wall lifting [33].

Full endoscopic spine surgery

In 1975, Hijikata used a contrast needle to enlarge the surrounding cavity and set up a standard cannula (inner diameter 3.0m, outer diameter 3.5mm, 2.6mm) under fluoroscopic guidance [34,35]. This led to the devisal of PN method (Percutaneous Nucleotomy), a method to extract the nucleus pulposus of the intervertebral disc post-laterally. Kambin used a 4mm Craig cannula. In 1988, Pravis Kambin suggested that a triangular area surrounded by the exiting root, traversing nerve root, and the end plate of the lower vertebral body is safe for endoscopic spine surgery [36-38]. Currently, technique that fully utilizes this triangle by conducting until the pedicle is popularized (Figure 3) [27]. Onik resected the intervertebral disc using a mechanical suction tube in which the outer diameter was 2.5mm [39]. Foraminoscope (Field Lens of 6 degrees) designed by Hans-Jorg Leu was utilized for 21 years until 2012 [40]. YESS system created by Tony Yeung consists of a 2.5mm surgical instrument, washing channel, multi channel used for rod lens, and an egg-shaped endoscopy. In particular, the inside-out concept suggested by him was safe and easy to perform even for beginners, as decompression and extraction of the spinal cord herniation is done gradually by going into the avascular area of the intervertebral disc [41,42]. Contrary to this, the outside-in method proposed by Hoogland is complicated and needs much practice to control hemorrhage, as this method directly decompresses the intervertebral disc herniation by resecting parts of the pedicle and the zygapophysial joint transforaminal [43]. The strong endoscopic technique performed by Rutten et al. enabled decompression to be done even to the lateral canal and the hidden zone of MacNab [44-47]. Now, decompression techniques using endoscopy for wide areas of the spine, from the cervical to the lumbar area and from the anterior to the posterior area, is being popularized. Furthermore, it is started to be applied in decompression techniques of the anterior/posterior areas of the cervical spine and yellow ligament resection of the thoracic spine [48].



P Kambin (1931-2020)

Figure 3: Illustration showing the boundaries of the Kambin triangular working zone: **A**: Exiting root, **B**: Dural sac **C**: Intervertebral disc, **D**: Traversing root.

Pravis Kambin suggested that a triangular area surrounded by the exiting root, traversing nerve root, and the end plate of the lower vertebral body is safe for endoscopic spine surgery. Currently, technique that fully utilizes this triangle by conducting until the pedicle is popularized.

Tubular surgery with assistant of endoscopy

In 1997, Forely and Smith performed a surgery where they extracted a herniation in the intervertebral disc by inserting an 18mm diameter microendoscopy (MED) [31,32]. Furthermore, vertebral arch resection was done by using a technique called the Destando syste [49] and Easy GO.

Laparoscopic (retroperitoneoscopic) lumbar decompression surgery technique

Decompression and fixation under pneumoperitoneum started in 1991 [28]. Furthermore, retroperitoneoscopy by lifting was performed. It became possible to decompress by dividing or moving the psoas major muscle anteriorly [33]. Also, at one point, operation performed anteriorly was done actively for thoracic spine herniation and degenerative diseases [29].

Summary

Future direction

Until now, popularization and advancements of the endoscopic spinal surgery was affected by the ability of the operator to understand the anatomical structure and the relative positional relationship of each organs under endoscopy, and the ability to see the depth perception from a 2-dimentional video monitor. Also, acquiring hand-eye coordination under magnified images and organ sensation such as bone, ligament, and nerves, and leading technology such as the AI Navigation robotics will become the gold standard for endoscopic spinal decompression. In particular, decompression techniques such as the full endoscopic technique will likely be developed through meta-analyses and randomized clinical trials more in the future for lesions where the diameter is small and microscope cannot be used [50].

Improvements of the endoscopy in recent times are mesmerizing, decreasing the chance of approach-induced disabilities by making and sustaining a cavity using a dilator and using a high-resolution VTR image endoscope. Evolving from the traditional intervertebral disc resection surgery using a microscope, the current method can reach the lesion precisely by substantially thinning the working channel and still have a similar performance as the traditional method.

The goal is utilizing the limited cavity as much as possible and obtain a clear visionary field to complete the surgery as fast and safe as possible. With the education system being standardized, minimally invasive techniques will provide a safe and nice treatment method for the people in the 21st century.

Conflicts of Interest

The authors declare that they have no competing interests.

Funding Statement

The authors declare that their article was not funded and financially supported by anybody or any corporation.

References

1. Reuter MA, Reuter HJ, Engel RM (1999) History of : an illustrated documentation : Vol. I – IV. Kohlhammer, Stuttgart, Germany.
2. McHenry LC (1969) Garison's History of neurology. Charles C Thomas, Springerfield, USA.
3. Bozzini P (1806) Light conductor, an invention for viewing internal parts and diseases, together with illustrations. J Pract Med Surg 24: 107-124.
4. Nitze M (1879) Uebereineneue Beleuchtungsmethode derHohlen des menschlichen Korpers. Weiner med 26: 851-858.
5. Leiter J (1880) Elektro-endoskopische Instrumente. Beschreibung und Instruction zur. W. Braumüller & Sohn, Wien, Paris.
6. Mickulcz J (1883) Uebereinengeheilten Fall von Magenresektionnebst Bemerkungen uber emn Gastroskopisches Symptomes des Magencarcinomas. Wienermed 33: 705-708.
7. Jacobaeus HC (1910) Possibility of the use of the cystoscope for investigations of serious cavities. Munich Med Wochenshrift 57: 2090-2092.
8. Schindler R (1966) Gastroscopy: The Endoscopic Study of Gastric Pathology (2nd edn.). Hafner, New York, USA.
9. Watanbe W, Takeda S, Ikeuch H (1957) Atlas of Arthroscopy, Igakushoin Ltd, Tokyo, Japan.
10. Fourestier M, Ennuyer A, Chamouard J (1964) Endoscopic Exploration of the Rhinopharynx by the so-called double light guide Pharyngo-laryngoscope"Sem Hop 8: 2296-2299.
11. Hopkins HH, Kapany NS (1954) A Flexible Fibrescope using Static Scanning. Nature 173: 39-41.
12. Hirschowitz BI (1958) Demonstration of a new gastroscope, the fiberscope. Gastroenterology 35: 50-53.
13. Mayer HM, Brock M (1993) Percutaneous endoscopic discectomy:surgical technique and preliminary results compared to microsurgical discectomy. J Neurosurg 78: 216-225.
14. Shibuya I, Dezawa A, Urayama S, Nakamura S (2018) Surgical treatment of a lumbar aneurysmal bone cyst using percutaneous endoscopic lumbar discectomy. Eur Spine J 27: 368-374.
15. Sairyo K, Sakai T, Higashino K, Inoue M, Yasui N, et al. (2010) Complications of endoscopic lumbar decompression surgery. Minim Invasive Neurosurg 53: 175-178.
16. Dezawa A, Mikami H, Sairyo K (2012) Percutaneous endoscopic translaminar approach for herniated nucleus pulposus in the hidden zone of the lumbar spine. Asian J Endosc Surg 5: 200-203.
17. De Antoni DJ, Claro ML, Poehling GG, Hughes SS (1996) Translaminar lumbar epidural endoscopy: anatomy, technique, and indications. Arthroscopy 12: 330-334.
18. Oertel JM, Burkhardt BW (2019) Endoscopic Translaminar Approach for Resection of Migrated Lumbar Disc Herniation. World Neurosurgery 128: 365-368.
19. Ringer AJ, Bhamidipaty SV (2013) Percutaneous access to the vertebral bodies: a video and fluoroscopic overview of access techniques for trans-, extra-, and infrapedicular approaches. World Neurosurg 80: 428-435.
20. Kim HS, Sharma SB, Raorane HD (2019) How I Do It? Transforaminal Endoscopic Decompression of Intraspinal Facet Cyst. Acta Neurochir 161: 1895-1900.
21. Mikami Y, Nagae M, Ikeda T, Tonomura H, Fujiwara H, et al. (2013) Tubular surgery with the assistance of endoscopic surgery via midline approach for lumbar spinal canal stenosis: a technical note. Eur Spine J 22: 2105-2112.
22. Choi G, Kim JS, Lokhande P, Lee SH (2009) Percutaneous endoscopic lumbar discectomy by transiliac approach: a case report. Spine 34: 443-446.

23. Gillespie G, MacKenzie P (2004) Epiduroscopy--a review. Scott Med J 49: 79-81.

24. Mixter WJ, Barr JS (1934) Rupture of the intervertebral disc with involvement of the spinal canal. The New England Journal of Medicine 211: 210-214.

25. Love JG (1939) Removal of the protruded interlaminar discs without laminectomy. Mayo Clinic Proceedings 14: 800.

26. Yasargil MG (1977) Microsurgical Operation of Herniated Lumbar Disc. Lumbar disc adult hydrocephalus. Springer, Heidelberg, Germany.

27. Kambin P, Nixon J, Chait A, Schaffer J (1988) Annular protrusion: pathophysiology and roentgenographic appearance. The Spine Journal 13: 671-675.

28. Obenchain TG (1991) Laparoscopic lumbar discectomy: case report. J Laparoendosc Surg 3: 145-149.

29. Mack MJ, Regan JJ, Bobechko WP, Acuff TE (1993) Application of thoracoscopy for disease of the spine. Ann Thorac Surg 56: 736-738.

30. Ebara S, Kamimura M, Itoh H, Kinoshita T, Takahashi J, et al. (2000) A new system for the anterior restoration and fixation of thoracic spinal deformities using an endoscopic approach. Spine 25: 876-883.

31. Foley KT, Smith MM. Microendoscopic discectomy. Techniques Neurosurg1997; 3: 301-307.

32. Perez-Cruet MJ, Foley KT, Isaacs RE, Rice-Wyllie L, Wellington R, et al. (2002) Microendoscopic lumbar discectomy: technical note. Neurosurgery 51: 129-136.

33. Dezawa A, Yamane T, Mikami H, Miki H (2000) Retroperitoneal laparoscopic lateral approach to the lumbar spine: a new approach, technique, and clinical trial. J Spinal Disord 13: 138-143.

34. Hijikata S (1975) A method of percutaneous nuclear extraction. Journal of Toden Hospital 5: 39-42.

35. Hijikata S (1989) Percutaneous nucleotomy. A new concept technique and 12 years' experience. Clin Orthop Relat Res 238: 9-23.

36. Kambin P, Sampson S (1986) Posterolateral percutaneous suction-excision of herniated lumbar intervertebral discs. Report of interim results. Clin Orthop Relat Res 207: 37-43.

37. Kambin P, Bracer MD (1987) Percutaneous posterolateral discectomy. Anatomy and mechanism. Clin Orthop Relat Res 223: 145-154.

38. Kambin P, Schaffer JL (1989) Percutaneous lumbar discectomy. Review of 100 patients and current practice. Clin Orthop Relat Res 238: 24-34.

39. Onik G, Shang YL, Maroon JC (1990) Automated percutaneous biopsy in postoperative diskitis: a new method. AJNR Am J Neuroradiol 11: 391-393.

40. Leu HJ, Hauser R (1996) Die perkutan posterolaterale Foraminoskopie : Prinzip, Technik und Erfahrungen seit 1991. Arthroskopie 9: 26-31.

41. Tsou PM, Yeung AT (2002) Transforaminal endoscopic decompression for radiculopathy secondary to intracanal noncontained lumbar disc herniations: outcome and technique. The Spine Journal 2: 41-48.

42. Yeung AT, Yeung CA (2003) Advances in endoscopic disc and spine surgery: foraminal approach. Surgical Technology International 11: 255-263.

43. Hoogland T, Schubert M, Miklitz B, Ramirez A (2006) Transforaminal posterolateral endoscopic discectomy with or without the combination of a low-dose chymopapain: a prospective randomized study in 280 consecutive cases. Spine 31: 890-897.

44. Ruetten S, Komp M, Merk H, Godolias G (2009) Surgical treatment for lumbar lateral recess stenosis with the full-endoscopic interlaminar approach versus conventional microsurgical technique: a prospective, randomized, controlled study. Journal of Neurosurg Spine 10: 476-485.

45. Komp M, Hahn P, Merk H, Godolias G, Ruetten S (2011) Bilateral operation of lumbar degenerative central spinal stenosis in full-endoscopic interlaminar technique with unilateral approach: Prospective 2-year results of 74 patients. J Spinal Disord Tech 24: 281-287.

46. Komp M, Hahn P, Ozdemir S, Merk H, Kasch R, et al. (2014) Operation of lumbar zygoapophyseal joint cysts using a full-endoscopic interlaminar and transforaminal approach: prospective 2-year results of 74 patients. Surg Innov 21: 605-614.

47. Ruetten S, Hahn P, Oezdemir S, Baraliakos X, Merk H, et al. (2018) Full-endoscopic uniportal decompression in disc herniations and stenosis of the thoracic spine using the interlaminar, extraforaminal, or transthoracic retropleural approach. J Neurosurg Spine 29: 157-168.

48. Ruetten S, Hahn P, Oezdemir S, Baraliakos X, Godolias G, et al. (2018) Operation of soft or calcified thoracic disc herniations in the full-endoscopic uniportal extraforaminal technique. Pain Physician 21: 331-340.

49. Destandau J (1999) A special device for endoscopic surgery of lumbar disc herniation. Neurol Res 21: 39-42.

50. Dowling Á, Lewandrowski KU, da Silva FHP, Parra JAA, Portillo DM, et al. (2020) Patient Selection Protocols for Endoscopic Transforaminal, Interlaminar, and Translaminar Decompression of Lumbar Spinal Stenosis. J Spine Surg 6: 120-132.

HERALD

Advances In Industrial Biotechnology | ISSN: 2639-5665

Advances In Microbiology Research | ISSN: 2689-694X

Archives Of Surgery And Surgical Education | ISSN: 2689-3126

Archives Of Urology

Archives Of Zoological Studies | ISSN: 2640-7779

Current Trends Medical And Biological Engineering

International Journal Of Case Reports And Therapeutic Studies | ISSN: 2689-310X

Journal Of Addiction & Addictive Disorders | ISSN: 2578-7276

Journal Of Agronomy & Agricultural Science | ISSN: 2689-8292

Journal Of AIDS Clinical Research & STDs | ISSN: 2572-7370

Journal Of Alcoholism Drug Abuse & Substance Dependence | ISSN: 2572-9594

Journal Of Allergy Disorders & Therapy | ISSN: 2470-749X

Journal Of Alternative Complementary & Integrative Medicine | ISSN: 2470-7562

Journal Of Alzheimers & Neurodegenerative Diseases | ISSN: 2572-9608

Journal Of Anesthesia & Clinical Care | ISSN: 2378-8879

Journal Of Angiology & Vascular Surgery | ISSN: 2572-7397

Journal Of Animal Research & Veterinary Science | ISSN: 2639-3751

Journal Of Aquaculture & Fisheries | ISSN: 2576-5523

Journal Of Atmospheric & Earth Sciences | ISSN: 2689-8780

Journal Of Biotech Research & Biochemistry

Journal Of Brain & Neuroscience Research

Journal Of Cancer Biology & Treatment | ISSN: 2470-7546

Journal Of Cardiology Study & Research | ISSN: 2640-768X

Journal Of Cell Biology & Cell Metabolism | ISSN: 2381-1943

Journal Of Clinical Dermatology & Therapy | ISSN: 2378-8771

Journal Of Clinical Immunology & Immunotherapy | ISSN: 2378-8844

Journal Of Clinical Studies & Medical Case Reports | ISSN: 2378-8801

Journal Of Community Medicine & Public Health Care | ISSN: 2381-1978

Journal Of Cytology & Tissue Biology | ISSN: 2378-9107

Journal Of Dairy Research & Technology | ISSN: 2688-9315

Journal of Dentistry Oral Health & Cosmesis | ISSN: 2473-6783

Journal Of Diabetes & Metabolic Disorders | ISSN: 2381-201X

Journal Of Emergency Medicine Trauma & Surgical Care | ISSN: 2378-8798

Journal Of Environmental Science Current Research | ISSN: 2643-5020

Journal Of Food Science & Nutrition | ISSN: 2470-1076

Journal Of Forensic Legal & Investigative Sciences | ISSN: 2473-733X

Journal Of Gastroenterology & Hepatology Research | ISSN: 2574-2566

Journal Of Genetics & Genomic Sciences | ISSN: 2574-2485

Journal Of Gerontology & Geriatric Medicine | ISSN: 2381-8662

Journal Of Hematology Blood Transfusion & Disorders | ISSN: 2572-2999

Journal Of Hospice & Palliative Medical Care

Journal Of Human Endocrinology | ISSN: 2572-9640

Journal Of Infectious & Non Infectious Diseases | ISSN: 2381-8654

Journal Of Internal Medicine & Primary Healthcare | ISSN: 2574-2493

Journal Of Light & Laser Current Trends

Journal Of Medicine Study & Research | ISSN: 2639-5657

Journal Of Modern Chemical Sciences

Journal of Nanotechnology Nanomedicine & Nanobiotechnology | ISSN: 2381-2044

Journal Of Neonatology & Clinical Pediatrics | ISSN: 2378-878X

Journal Of Nephrology & Renal Therapy | ISSN: 2473-7313

Journal Of Non Invasive Vascular Investigation | ISSN: 2572-7400

Journal Of Nuclear Medicine Radiology & Radiation Therapy | ISSN: 2572-7419

Journal Of Obesity & Weight Loss | ISSN: 2473-7372

Journal Of Ophthalmology & Clinical Research | ISSN: 2378-8887

Journal Of Orthopedic Research & Physiotherapy | ISSN: 2381-2052

Journal Of Otolaryngology Head & Neck Surgery | ISSN: 2573-010X

Journal Of Pathology Clinical & Medical Research

Journal of Pharmacology Pharmaceutics & Pharmacovigilance | ISSN: 2639-5649

Journal Of Physical Medicine Rehabilitation & Disabilities | ISSN: 2381-8670

Journal Of Plant Science Current Research | ISSN: 2639-3743

Journal Of Practical & Professional Nursing | ISSN: 2639-5681

Journal Of Protein Research & Bioinformatics

Journal Of Psychiatry Depression & Anxiety | ISSN: 2573-0150

Journal Of Pulmonary Medicine & Respiratory Research | ISSN: 2573-0177

Journal Of Reproductive Medicine Gynaecology & Obstetrics | ISSN: 2574-2574

Journal Of Stem Cells Research Development & Therapy | ISSN: 2381-2060

Journal Of Surgery Current Trends & Innovations | ISSN: 2578-7284

Journal Of Toxicology Current Research | ISSN: 2639-3735

Journal Of Translational Science And Research

Journal Of Vaccines Research & Vaccination | ISSN: 2573-0193

Journal Of Virology & Antivirals

Sports Medicine And Injury Care Journal | ISSN: 2689-8829

Trends In Anatomy & Physiology | ISSN: 2640-7752

Submit Your Manuscript: https://www.heraldopenaccess.us/submit-manuscript

Herald Scholarly Open Access, 2561 Cornelia Rd, #205, Herndon, VA 20171, USA.
Tel: +1 202-499-9679; E-mail: contact@heraldopenaccess.us
http://www.heraldopenaccess.us/