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MINIMAL INVASIVE
SPINE SURGERY AND
THE HISTORICAL
DEVELOPMENT

Zuhtu Ozbek MD, Hasan Emre Aydın MD, Didem Arslantas MD

Definition

Micro-surgery is defined as the surgical procedure which is made with a small incision using other tools such as microscope or endoscope.⁸ “Also referred as “key hole” surgery, this procedure requires a serious preoperative planning although it appears simple.⁸ Selection of the patient, identification of the target level and efficiency of the superficial procedure required for surgical procedure are of importance. The aim of improving treatment methods is to reach the anatomic tissue and perform the procedure with minimal trauma.⁶

Being regarded as the pioneer of minimal invasive spinal surgery and defined as administration of chemopapain into the disc space, chemonucleolysis was first applied on 1969. The aim is to lyse the nucleus pulposus using chemical substance and to remove the compressive effects of the herniated disc fragment on the nerve root by activating the enzyme. The procedure is only a central nucleotomy and it does not target the pathological region.² Use of this method is forbidden due to the high risk of anaphylaxis, arachnoiditis and associated complications.^{5,10}

History of the Microscopic and Endoscopic Methods

Recently, spinal surgical methods were improved and such changes enabled less invasive procedures. Starting to be used first in 1953, the microscope was also used for the intracranial vascular surgery and increased success in this field led use of the microscope for spinal procedures.⁸ The pioneering surgeons such as Yaşargil, Caspar and Williams used the microscope in the spinal region in order to minimize surgery-emergent morbidity and they referred it “lumbar micro-discectomy”.^{8,11} Endoscopy was added to the use of microscope for lumbar disc surgery in ‘70s and percutaneous discectomy was first performed by Williams and it was referred as percutaneous endoscopic discectomy.¹⁰ Endoscopy derives from terms “endo” and “scopien” and they refer direct visualization of interior structures in the ancient Greek.³ Spinal surgeons improved endoscopic and tubular entry methods in ‘90s and they could enlarge the procedure area without injuring surrounding muscle fibers thanks to the retractors.¹⁰ Endoscopic microdiscectomy was first performed by Foley and Smith in 1997.¹⁰ Such successes in the field of lumbar procedures were extended to cervical and thoracic regions within a short time.¹¹ This rapid advance of spinal surgical methods are chronologically demonstrated in the [Table 1](#).

Table 1:
Development of methods of spinal surgery in chronological order

Date	Surgeon	Surgery
1892	Smith	Lumbar laminectomy for discectomy
1893	Lane	Lumbar laminectomy for spinal stenosis
1911	Albee Hibbs	Lumbar fusion
1925	Elsberg	Cervical laminectomy for discectomy
1967	Yasargil, Caspar	Lumbar microdiscectomy
1969	Smith	Chemopapaine injection (chemonucleosis)
1970	Williams	Percutan microdiscectomy
1975	Hijikata	Endoscopic microdiscectomy
1983	Benjamin	Toracal endoscopic microdiscectomy
1997	Foley Smith	Microendoscopic discectomy (MED)

Easily applicable laser coagulation methods recently emerged due to the advancements and advertisements on media; however, there is no retrospective controlled studies on those techniques on the contrary to the minimal invasive spinal surgery.¹⁰ Being developed in the light of chemonucleosis, this procedure aims to ensure coagulation of central nucleus pulposus. The procedure does not target the pathological region. Most spinal surgeons do not use laser methods since controlled studies are lacking.

On the contrary to the other procedures, visualized area is narrow for spinal endoscopic methods. Use of endoscopy has a history of almost 200 years in the gynecological and abdominal interventions and thus, it can be easily used within a large potential space.¹¹ Narrow visualized field is the principal challenge against the minimal invasive spinal surgery since the spinal cord does not have a large cavity.¹⁰ Despite working within a narrow and dark field, use of auxiliary devices such as microscope, fluoroscopy, intraoperative computerized tomography and neuro-monitoring made the minimal invasive spinal surgery safer.¹⁰

Advantages and Complications of Minimal Invasive Methods

Minimal invasive surgical methods offers several advantages such as shorter hospitalization period, less blood loss and less tissue damage as well as ability to spare normal anatomy and rapid healing resulting with earlier return to daily activities.¹¹ (Table 2) Studies indicated that complications such as recurrent disc herniations, incision and prolonged surgery are less with minimal invasive methods.¹⁰ This method is associated with a small incision and accordingly, it became easily applicable by most surgeons based on training seminars.¹⁰ In the light of this fact, associated complications may be more frequent if the procedure is not performed by experienced spinal surgeons.⁸ The most remarkable disadvantage is major vessel injury which may intra-operatively occur. Adequate visual field cannot be ensured due to bleeding and controlling the massive bleeding may be challenging.⁶ Therefore, being accustomed to the image on the two-dimensional monitor and learning endoscopic instrumentation will require time and experience.³

Table 2:

Advantages of minimal invasive surgery for the patient

Advantages of minimal invasive surgery for the patient
Minimal muscle and tissue injury
Risk of infection in postoperative period reduced
Minimal need of blood transfusion
Short hospitalization time
Minimal pain in postoperative period
Minimal drug usage for the pain
The patient discharged in the same day
Minimal cosmetic problems
Early return to daily activities
Short surgery time
Same results as classic surgery

Use of minimal invasive surgical methods versus the classical surgical modalities for spine disease is still debated despite all advances made in this field.⁵ The logic underlying the minimal invasive procedures is not different than that of classical methods. Aim of both approaches is to decompress the nerve root. The most significant advantage arising from the minimal invasive surgery for candidates of lumbar microdiscectomy involve reduced exposure time to anesthesia, ability to prefer local anesthesia, day surgery and early discharge.¹² Patient can be discharged within 24 hours and may return to work in a period of 2 to 6 weeks.² Another important consideration is about decreased anatomic damage due to the small tissue incision enabled by use of microscope and small sized surgical tools. The surgeon is enabled to reach vertebra using a small incision should surrounding soft tissues are spared and thus, patient experiences less pain in the postoperative period.⁷ Classical methods may lead to late complications such as spondylolisthesis depending on the impaired anatomy since lamina, ligamentum flavum and

medial facet are removed.³ Based on those characteristics, it is clear that minimal invasive surgical methods reduce perioperative morbidity.^{9,5} Available clinical studies found that time for improvement of long-term leg pain is similar for classical discectomy and minimal invasive surgical methods. It is known that dural damage is more frequent with micro-invasive methods, and however, no significant difference was found between two approaches when all complications are evaluated.⁴ Complication rate of minimal invasive surgical procedure is 6 percent (Table 3).

Table 3:

Complications of minimal invasive surgery

Complication	Rate
CSF Fistula	2.2
Radiculopathy	0.4
Bleeding (500mL)	3.4

Conclusion

Minimal invasive surgery experienced a rapid improvement throughout last 4 decades. Considering technological revolution and low treatment costs, success rate of the minimal invasive spinal surgery had recently reached 80 percent. In 11 retrospective studies which were conducted within last 3 decades, 3543 underwent microendoscopic surgery and it was found that the success rate was 74-100 % taking into consideration the study outcomes involving postoperative period of 6 months.⁸ Therefore, it is superior to the classical discectomy, which is the gold standard for lumbar disc herniations associated with radiculopathy. The increased success rate enabled that intended use of those methods could be expanded and they could be even the routine procedure of spinal surgery.⁸ The advances in the field of minimal invasive methods enabled use of this approach for lumbar fusion, transforaminal lumbar interbody fusion, spinal tumor biopsies, vertebroplasty and kyphoplasty in addition to the lumbar microdiscectomy (Table 4).⁹

Table 4:
Classification of Minimal Invasive Surgery
Procedures

Open procedures	Microdiscectomy
Fine needle procedures	Chemonucleolysis Nucleotomy Epidural and facet Vertebroplasty and Kyphoplasty
Endoscopic Procedures	Microendoscopic discectomy, laminectomy TLIF, XLIF, DLIF Percutan endoscopic transforaminal discectomy Lumbar percutan fusion
Other	Laser induced percutan discectomy

Considering social advantages, a part of people prefers minimal invasive surgical methods due to cosmetic reasons which are principally based on small skin incision.⁹ Moreover, in a study where obese subjects were evaluated, small incision and early mobilization secondary to short healing period made this procedure preferable by obese subjects.¹ Lack of general anesthesia requirement enables this treatment method to be easily preferred for subjects with systemic disease(s).

Considering economical dimensions, it was observed that minimal invasive procedures reduced significantly the treatment costs of hospitals.⁹ Use of easily applicable methods for treatment of spinal diseases, which cause significant labor loss will compensate it secondary to the shorter healing period.

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