Chapter 1
The Unilateral Biportal Endoscopic Spine Surgery Concept: An Overview

Javier Quillo-Olvera, Diego Quillo-Olvera, Javier Quillo-Reséndiz, and Michelle Barrera-Arreola

Abbreviations

EQ-5D	European Quality of Life—5 dimensions
ODI	Oswestry Disability Index
PROs	Patient-reported outcomes
RF	Radiofrequency
SAP	Superior articular process
UBE	Unilateral biportal endoscopy
UBE-TLIF	Unilateral biportal endoscopic transforaminal lumbar interbody fusion
ULBD	Unilateral laminotomy bilateral decompression
VAS	Visual analogue scale

Introduction

"Primum non nocere," or "first, not harm," is a principle that has prevailed over time in medicine, and in spinal surgery, it has directed its evolution and development. In other words, the surgeon tries to do when he or she faces a disease to find the way that least impacts the patient life.

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J. Quillo-Olvera (✉) · D. Quillo-Olvera · J. Quillo-Reséndiz · M. Barrera-Arreola
The Brain and Spine Care, Minimally Invasive Spine Surgery Group, Hospital H+ Querétaro, Spine Clinic, Querétaro, México
e-mail: neuroqomd@gmail.com; drquilloolvera86@gmail.com; kitnoz@hotmail.com; michelle.barrera@anahuac.mx

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For example, when a surgeon performs a lumbar decompression, the first thing to do is think about the minor procedure-related collateral damage. Or, when it is necessary to correct a sagittal or coronal imbalance because of degenerative processes, the chosen technique is based not only on fixing the X-rays that made our decision but also on relieving the symptoms of the disease.

For this reason, the “Primum non nocere or non-maleficence principle” is a bioethical concept and a medical one that implies the knowledge and surgical skills of the surgeon applied through proper judgments based on variables that make up a patient an individual entity.

Given this situation, surgical techniques have evolved, and one of the reasons why spinal surgery has transcended is to visualize the anatomical structure that generates the disease to be more specific and decrease the collateral damage in patients.

Spinal surgery has had to adopt different modalities to visualize the pathology. A historical milestone was the microscopic assistance procedures [1, 2]. This event made it possible to significantly reduce the collateral damage of procedures such as total laminectomy for disc herniation, established as a standard. Over time, its traumatic and iatrogenic potentials were observed [3].

Knowledge and technology from other medical specialties redefined spinal surgery, incorporating cameras to visualize and magnify anatomical structures [4].

Hijikata and Parviz Kambin conducted spinal surgery to another step: percutaneous procedures addressed to the intervertebral disc anatomically, observing bony and connective structures to allow safer and less aggressive access to the disc, using lenses or endoscopes [5–9].

However, the simple use of lenses and cameras in the spine would not define the least invasiveness procedure nature assisted by these technologies. The continuous irrigation of saline solution allowed the boom that we know at this time of water-based spinal endoscopy [10].

Then, the rationale of water-based spinal endoscopy we currently know is the direct visualization of structures, the magnification of the anatomy, and the proper illumination of the surgical field, which leads to complying with the principle that we mentioned at the beginning, “Primum non nocere,” or trying to mitigate the collateral effect related to the procedure. Spinal endoscopy is transforming the way of treating spinal diseases surgically since more and more indications for its use are accepted as effective treatments.

The main advantage of current spinal endoscopy over other surgical options is simple, more minor damage to vertebral and paravertebral tissues [11]. In addition, the high effectiveness in decompressing the neural elements after overcoming the learning curve has made it possible to relate current endoscopic techniques with good results in the short and medium terms, mainly used in degenerative diseases [10].

Water-based spinal endoscopy can be divided into two major variants, uniportal techniques, of which multiple texts have been published, and unilateral biportal endoscopy (UBE), which is the focus of this book.

The UBE technique was reported for the first time in 1994 by Dr. Daniel Julio De Antoni, and several texts after that were published demonstrating the effectiveness [12]. The earliest indications consisted of epidural pathology related to the intervertebral disc. Contraindications that exceeded the technique at that time were:

- Multilevel degenerative spinal disease
- Posterior vertebral osteophytes
- Degenerative foraminal stenosis
- Bilateral lumbar segment disease
- Far-lateral disc herniations
- Infections
- Patients with spinal tumors
- Revision surgery

Twenty-eight years later, this technique can be used in most diseases for which it was not indicated at that time, except in spinal tumors yet [13–18].

The procedure described by De Antoni evolved thanks to updates that the technique underwent, especially in South Korea. Expert surgeons such as Jin Hwa Eum, who in 2016 for the first time reported encouraging results similar to those obtained through microsurgical technique in 75 patients with herniated discs and lumbar stenosis, treated with UBE and bilateral decompressions through a unilateral laminotomy (UBE-ULBD) [19]. And Professor Cheol Woong Park, the current President of the World UBE Society.

San Kyu Son developed cervical and thoracic decompression procedures through biportal endoscopy, and Dong Hwa Heo has been a key promoter of biportal endoscopic surgery describing various techniques, including biportal endoscopic lumbar interbody fusion and lumbar segmental, multifocal decompressions [20, 21].

An Overview of the UBE Technique

The UBE technique consists of a correct triangulation of two vectors addressed to a site under the guidance of intraoperative fluoroscopy. The vectors are used as ports, one for the endoscope and the other to introduce the surgical tools (Fig. 1.1). This is a true water-based endoscopic technique. The endoscopic system irrigates 0.9%

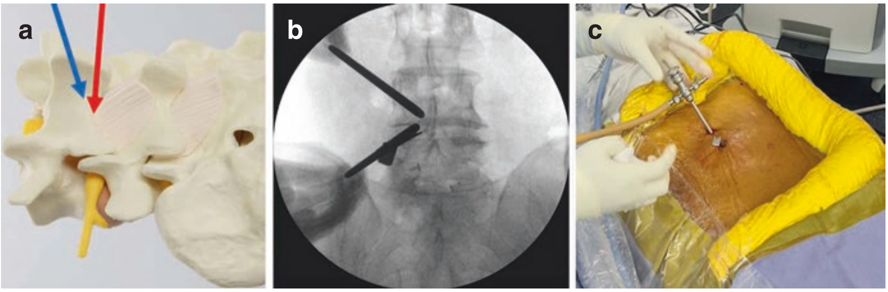

Fig. 1.1 (**a**) Lumbar spine with two trajectories (blue and red arrows). The blue arrow represents the endoscopic port and the red one the working channel. (**b**) Intraoperative AP view of C-arm showing proper triangulation during a paramedian biportal lumbar approach. (**c**) Right paramedian UBE lumbar approach

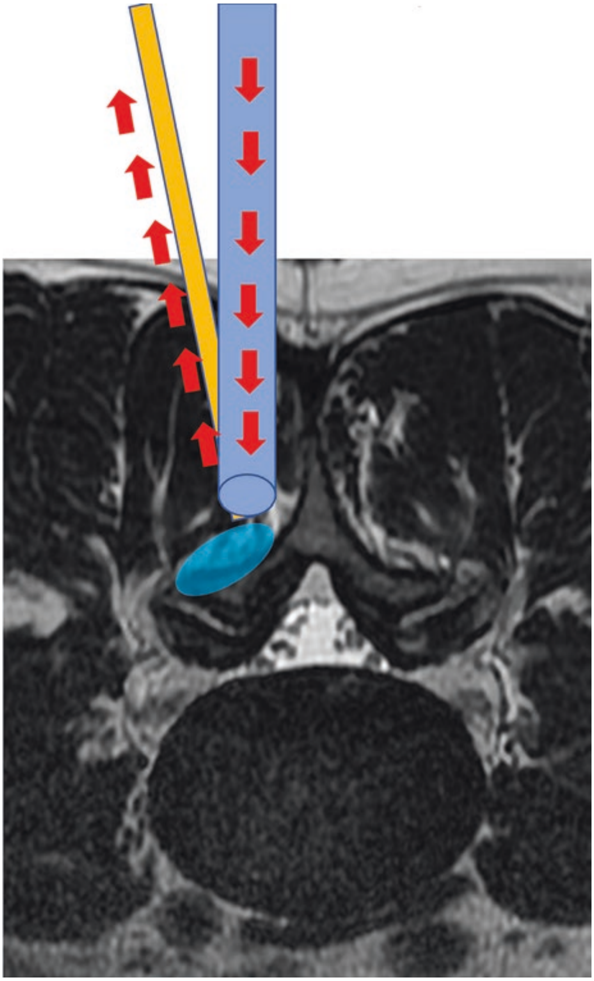

Fig. 1.2 Inflow-outflow system. The red arrows represent the continuous flow of saline irrigated by the endoscopic system and exit through the working channel (orange bar)

saline throughout the procedure, and the outflow exits directly through a semi-tubular working cannula placed independently as the second channel (Fig. 1.2).

Then, the spine surgeon must be patient in learning first how to co-locate the instruments with the endoscope through a correct unilateral biportal approach. Subsequently, the surgeon must locate specific anatomical landmarks that will serve as a guide to orient himself or herself and adequately conclude the planned procedure (Video 1.1).

The author's suggestion is to respect this learning process. Therefore, the UBE technique can be systematically divided into the following steps:

- Correct triangulation of the ports.
- Co-locate the surgical instruments with the endoscope.
- Confirm a proper inflow-outflow system of saline.

- Observe and recognize the bone landmarks.
- Complete the procedure previously planned.
- Develop skills based on the repetition of cases.
- Expand the indications of the technique.

Unilateral biportal endoscopic surgery (UBE), as it is currently known, works through a water-based medium, which means that the endoscopic system continuously irrigates saline solution at a recommended pressure of between 4.41 and 31.00 cmH_2O [22].

The saline irrigated by the endoscope aims to:

- Create a positive hydrostatic pressure to maintain a permeable space below the back muscles.
- Keep the surgical field clean, without particles from the procedure. The cleaning field is obtained through a continuous inflow-outflow of the saline from the endoscope to the working channel.
- Act as a less aggressive hemostatic medium, allowing the bleeding site to be accurately located.
- Allow a clear, magnified, and illuminated visualization of an anatomical structure.

The visualization system used in the UBE consists of rigid rod lens of 4.0 mm shaft diameter and 175 mm of length. The optical features of the arthroscope depend on the diameter, angle of inclination, and field of view. The angle of inclination is the angle between the arthroscope axis and a perpendicular line to the surface of the lens. The angle of inclination used in UBE oscillates between 0° and 30° (Fig. 1.3).

The field of view refers to the viewing angle encompassed by the lens and varies according to the type of arthroscope. For example, the 4.0 mm scope has a 115° field of view. On the other hand, rotation of a 30° arthroscope produces a larger field of view compared with 0°, which is of help in ipsilateral subarticular decompression or craniocaudal viewing of the contralateral foramen (Fig. 1.4). The 0° scope is helpful in central stenosis decompression.

The scope is attached to a light source and a camera to display the spine's image on a video monitor so that the surgeon can observe the procedure.

The arthroscope should always be inserted into a sheath. In UBE, different brands have developed special ones for the spine, completely different from others used in peripheral joints. The sheath is used to maintain the scope into the portal ensuring visual clarity and providing continuous flow into the surgical site. Besides, the arthroscope sheath protects the lens against the drill or shaver.

Arthroscopic sheath is composed of different elements (Fig. 1.5).

- A coupler lets to fix the obturator and lens with the sheath.
- The sheath barrel protects the lens. Different beveled-ended tip barrels have been developed for only use in the spine.
- The spigot plane is equipped with valves to manage the fluid inflow. Commonly, it can rotate to avoid tubing twisting during the procedure.

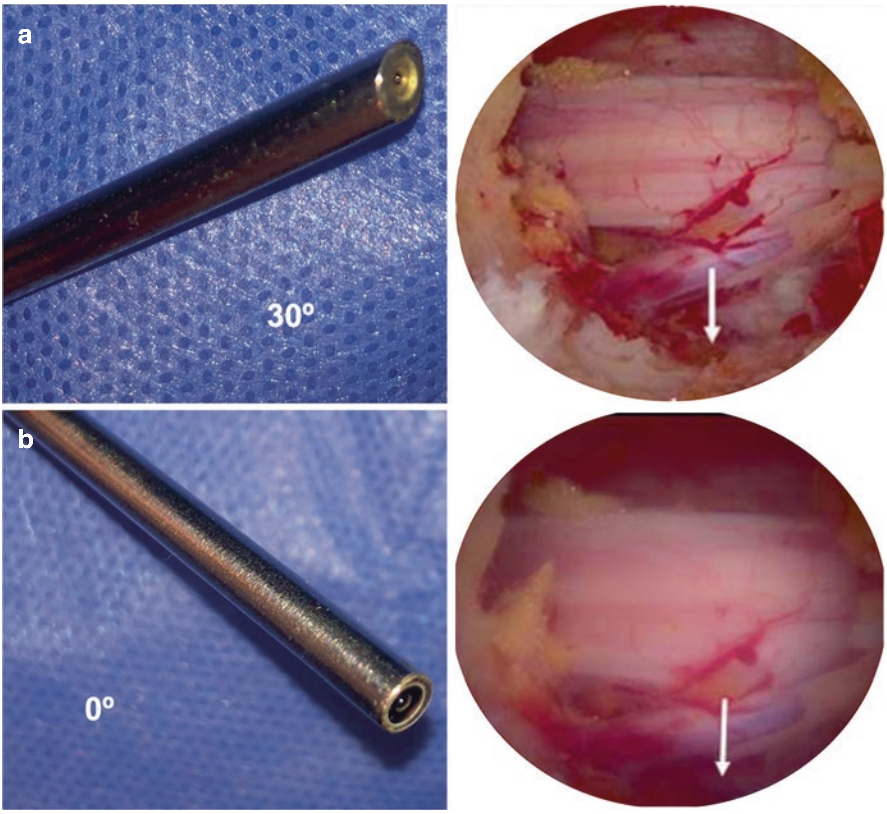

Fig. 1.3 The angle of inclination. (**a**) 0° and (**b**) 30°

The sheath should always be inserted in the spine coupled with a blunt obturator. Then, the obturator is removed, and the scope is inserted.

As we mentioned before, irrigation is essential to clean the surgical field. In UBE, the inflow passes directly through the arthroscopic sheath and the outflow through the other portal employing a semi-tubular cannula. The second portal is for the surgical instruments with independence (Video 1.2). When a pump for irrigation is unavailable, the hydrostatic pressure increases by elevating the 3 L 0.9% saline bag. For each foot of elevation of the solution bag above the joint level, approximately 30 cmH_2O of pressure is produced.

In UBE, the surgeon freely handles the surgical tools with the dominant hand, and the nondominant hand holds the endoscope, which follows the instruments throughout the procedure (Video 1.2).

An essential tool used in UBE is the radiofrequency (RF) probe. The RF plasma can ablate, coagulate, and allow hemostasis of the target tissue at a relatively low temperature (Video 1.1). Thus, the surgeon should avoid a nerve heat injury in

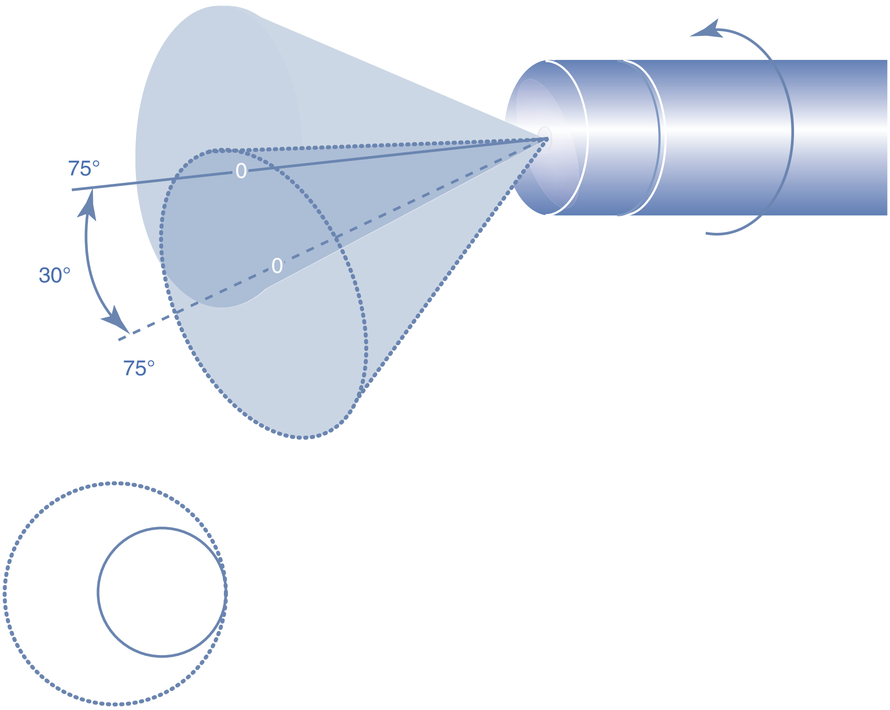

Fig. 1.4 Field of view of a 30° arthroscope

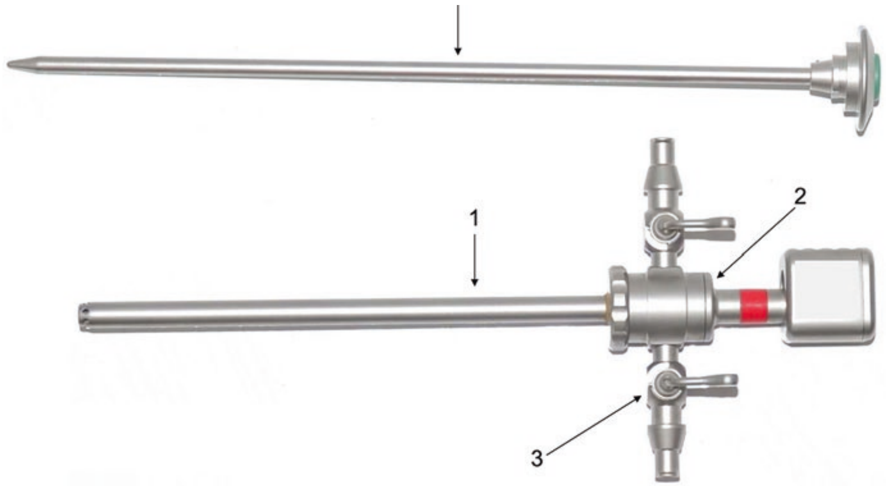

Fig. 1.5 Arthroscopic sheath and obturator. 0. Blunt-tip obturator, 1. sheath barrel, 2. coupler, 3. spigot plane

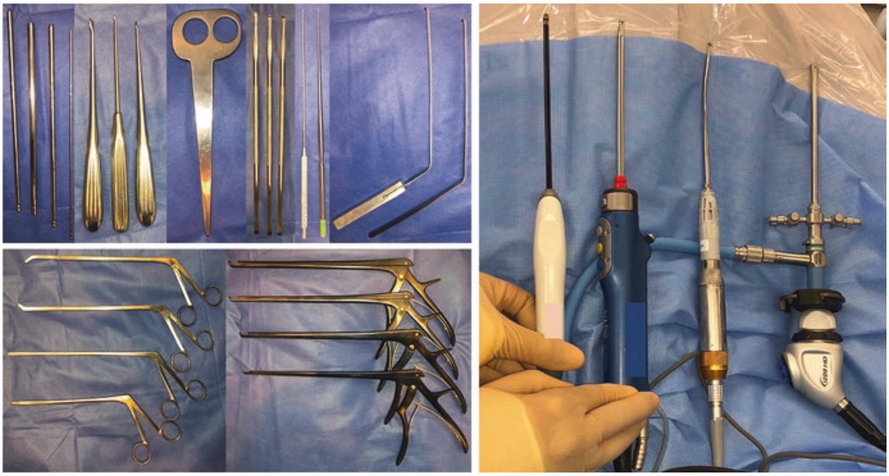

Fig. 1.6 Different surgical tools are commonly employed in UBE

spinal procedures at maximum. Currently, low-energy RF probes for UBE use are specially designed by different brands.

Other surgical tools like special-designed water-based high-speed drill systems with different ball tips to undercutting the bone are commonly used in UBE. Different tip measures and angulations of Kerrison rotary punches, pituitary grasps, dissectors, and nerve hooks are also used to perform the procedure. In general, this technique introduces working tools commonly used in spinal microsurgery, which is quite familiar to the surgeon (Fig. 1.6).

Generalities of UBE

The UBE technique has been gaining popularity. In Western countries, it is increasingly common to observe the interest of young surgeons in different endoscopic procedures that derive from the oriental experience (South Korea, China, and Japan).

In social networks, a medium that has been exploited from the COVID-19 pandemic, there is more information concerning UBE; for example, on FACEBOOK (https://www.facebook.com/), we can find the following groups where expert surgeons share clinical cases and multimedia about their experiences with the biportal endoscopy.

Here are the following groups with their electronic address:

1. UBE, Society of Unilateral Biportal Endoscopy—https://www.facebook.com/groups/586843421514791
2. Korea UBE—https://www.facebook.com/groups/166265787324002

3. UBE Spine Foundation India—https://www.facebook.com/groups/3428968007128468
4. World UBE Society—http://ubeworld.com/default/

In addition, different authors have reported encouraging results in various pathologies treated by biportal endoscopy, mainly in degenerative spinal diseases [23, 24]. A systematic review reported a reduction in the overall VAS and ODI scores at the final follow-up compared with preoperative scores in 11 studies included. Therefore, it meant an improvement in function and disability with satisfying results. The study also measured the satisfaction of patients who underwent UBE technique only for lumbar degenerative pathology finding 84.3% (range, 75.35–95%) from 7 of 11 studies analyzed. However, this study threw 6.7% (range 0–13.8%) of complications reported in 10 of 11 studies analyzed, with the dural tear as the most common complication [24].

There are three particular advantages of UBE:

1. UBE is a minimally invasive technique associated with minimal collateral damage, allowing reduced surgical trauma, less intraoperative bleeding than other conventional methods, rapid discharge from the hospital, and early return to activities.
2. UBE allows some freedom in using the endoscope and surgical instruments, unlike the restrictions observed through the tubular retractor or the uniportal endoscopy.
3. The familiarity of the posterior approaches for any spine surgeon reduces the learning curve compared to uniportal endoscopy.

Several authors have reported their results regarding UBE for lumbar disc herniation (LDH). For example, Soliman in 2013 carried out a prospective study including 43 patients with a diagnosis of noncontained LDH treated with the biportal endoscopic technique, reporting an average hospitalization time of 8 h, a range of complications of 11.6% that included 2 cases of dural tears, 1 case of transient urinary retention, 1 case of recurrence, and 1 case of persistent severe lower back pain. In addition, the clinical results showed improved postoperative VAS and ODI scores compared to the preoperative ones and 95% satisfaction after surgery [25]. Other studies have reported the association of reduced surgical time and the number of cases completed; the more cases, the shorter the surgical time [19, 25, 26].

On the other hand, Park et al. found no clinical inferiority between the UBE technique and microsurgery in treating patients with lumbar spinal stenosis through patient-reported outcomes (PROs) using ODI, VAS, and EQ-5D at 3-, 6-, and 12-month follow-up, in 30 patients allocated in the microscopy group and 29 in the biportal endoscopic group. Therefore, the authors suggested that UBE is a suitable alternative for patients with symptomatic lumbar spinal stenosis through the results of this randomized control trial [17]. In another study published by Kim et al., the outcomes of 105 patients who underwent lumbar decompression surgery by UBE were reported. The mean age of the patients was 71.2 years (range, 52–86 years), and they were followed up for an average of 14 months. The authors reported an average surgical time of 53 min per decompressed level. The postoperative satisfaction results based on the Macnab criteria were also encouraging since 88 patients rated their postoperative results as excellent and 12 as good. In addition, the VAS and ODI scores improved significantly after surgery compared to the preoperative scores. However, there were complications reported in this study; however, these were only 2.9% (3/105); two patients presented a dural tear treated with conservative measures, and 1 patient presented a postoperative epidural hematoma evacuated utilizing UBE [27].

Another degenerative pathology treated by UBE is lumbar foraminal stenosis. This technique aims to remove the tip of SAP through a paraspinal approach or through a contralateral inter- or translaminar approach to decompress the foraminal area of stenosis [28]. These techniques are not usually associated with a high risk of instability since decompression is limited to the most cranial part of the SAP, respecting the joint capsule and other stabilizing ligaments and structures of the spine. In addition to preserving the movement and stability of different segments through minimal collateral damage to other spinal and paraspinal structures, the need for lumbar fusion in many of these degenerative cases is reduced [29].

Ahn et al. reported results obtained in 21 patients with foraminal stenosis treated with UBE. The authors included 11 cases of foraminal stenosis, 9 cases with a herniated disc, and 1 case associated with the disease of the adjacent segment. The mean surgical time reported was 96.7 min per level, and the mean follow-up was 14.8 months. The complication rate was 4.8% (1/21), of which 1 was a dural tear. However, postoperative satisfaction was excellent and good in 80.9% (17/21) [30].

Recently, the indications for unilateral biportal endoscopy have expanded. Currently, it is possible to perform biportal endoscopic fusions through transforaminal approaches (UBE-TLIF), which has been discussed in various articles concluding that the early radiological and clinical results of these procedures are favorable [16]. Heo et al. reported results of 69 patients who underwent single-level UBE-TLIF. One of the advantages observed through the UBE-TLIF technique is the adequate preparation of the endplates under direct endoscopic vision. The authors reported an average of 85.5 mL of bleeding and an approximate surgical time of 165.8 min. The incidence of complications was 7.2% (5/69), 2 cases of dural tear, and 3 cases of postoperative epidural hematoma; all the patients overcame their complications with conservative measures [31].

Lastly, an attempt has been made to measure the collateral effect related to a UBE procedure. Choi et al. compared the inflammatory response from various decompression procedures (MD, transforaminal PELD, interlaminar PELD, and UBE) by measuring biological markers such as creatine phosphokinase and C-reactive protein. Both endoscopic techniques (uniportal and biportal) were characterized by lower increasing values of these inflammatory markers after surgery than MD. The muscular area involved in the approach was also delimited and recognized as a zone of hyperintensity in the cross-sectional area of paraspinal muscles. The largest hyperintense muscle zone was observed in the MD group, the smallest in the PELD group, and in the middle, the UBE group [32].

The above has only been a glimpse of the unilateral biportal endoscopic (UBE) technique. However, throughout this book, essential aspects will be highlighted to be taken into account for the surgeon interested in UBE.

Conclusion

Unilateral biportal endoscopy (UBE) is a set of techniques based on two ports independent of each other, used to introduce the endoscope and surgical tools. Despite using an arthroscopic type lens and having adopted specific visualization technology used in other peripheral joint surgeries, the UBE technique is specific for spinal surgery, with significant differences such as the type of solution to irrigate throughout the procedure, the irrigation pressure suggested in spinal procedures, the use and intensity of energies to coagulate or for hemostasis, and the surgical instruments, among others. Thus, the biportal endoscopic technique has been adapted to the needs of the spine surgeon. In this book, different techniques derived from UBE will be described.

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