Lumbar degenerative disc disease is a condition which causes anatomical and morphological changes leading to clinical complaints.\textsuperscript{11} It is commonly seen clinically as a disorder involving disc extrusion with or without free fragment, disc protrusion (central, paracentral, intraforaminal or distant lateral) and internal disc rupture. In cases that do not respond to conservative therapies, surgery is the appropriate treatment. The first discectomy surgery was performed in 1906 by Oppenheim and Fedre Krause, however the first article published in the literature dated 1934 belongs to Mixter and Bar.\textsuperscript{16} Later on in following years, discectomy procedures involving open laminectomy, hemilaminectomy and fenestration started to be used very commonly in the whole world.\textsuperscript{10} Although these methods, which can also be defined as classical lumbar discectomy procedures, have advantages such as providing a big exploration site, easiness in practice and enabling the surgeon to recognize other present pathologies; they also entail some disadvantages such as prolonged hospital stay, abundant tissue damage, delayed mobilization and high risk of epidural fibrosis and instability.\textsuperscript{20} All the abovementioned disadvantages led the researchers to develop less invasive discectomy interventions such as chemonucleolysis, percutaneous nucleotomy, microdiscectomy, endoscopy guided discectomy and transforaminal or interlaminar full-endoscopic discectomy.\textsuperscript{4,9,17} (Figures 1 and 2)
In 1975 Hijikata developed the percutaneous discectomy technique by using fluoroscopy, which is the basis for minimal invasive surgery technique. This technique was later on improved by Onik by means of adding a new aspiration probe. By the end of 1970s, together with the contributions of researchers such as Yaşargil, Caspar and Williams, microscopic discectomy period involving the use of a microscope in discectomy operations had started. Thanks to this technique, it was possible to have smaller incisions, less muscle dissection, less epidural fibrosis, less postoperative pain, early mobilization and early return to work. Today, this technique is still used as a gold standard in the surgical treatment of lumbar degenerative disc disease. Microscopic discectomy was less invasive than conventional discectomy procedures; nevertheless, they it was an open procedure and had important drawbacks like limited site for operation and epidural fibrosis rates reaching up to 20% in the literature.

In the forthcoming years, thanks to the technological developments in endoscopic devices, endoscopic techniques started to be used in many fields of medicine (abdomen, thorax, large joints). In 1983 Hausmann and Forst defined the method of using a nucleoscope to control the residual fragment after discectomy. In the same year, Kambin et al. defined posterolateral arthoscopic lumbar microdiscectomy. All these studies accelerated the development of endoscopic techniques. Schreiber and Suizawa suggested using double port in percutaneous endoscopic discectomy. By the end of 1990s the microendoscopic discectomy method of Foley and Smith was defined as a facilitating method for the surgeon since it enabled the use of the devices that were employed in microlumbar discectomy. (Figure 3) In 2002, Young and Tsou improved the percutaneous transfarimal endoscopic technique by means of using high resolution endoscope and flexible bipolar radiofrequency probe under local anesthesia.

All these studies had facilitated the involvement of endoscopic transfarimal discectomy technique in neurosurgery practice by the end of 1990s. The most minimally invasive method that is known
Figure 3a: Optic

Figure 3b: Discectomy tools

Figure 3c: Dilatators

Figure 3d: Source of light

Figure 3: a,b,c,d Devices for endoscopic discectomy
today among various surgical interventions aiming at sufficient decompression of neural structures and causing minimum tissue damage, which is the basic purpose of lumbar degenerative disc disease surgery, is reported as full-endoscopic transforaminal discectomy in the literature.\textsuperscript{12,13,19}

Full-endoscopic discectomy technically can be performed with either transforaminal or interlaminar approach. Transforaminal endoscopic discectomy is a method that was defined before and employed frequently with success.\textsuperscript{10} However, particularly in the L5-S1 space, transforaminal approach cannot be used because of some anatomical challenges like large transverse process, large facet joints, narrowed disc space and high iliac crest. Retten et al. defined the interlaminar endoscopic approach at the beginning of 2000s in order to overcome these anatomical challenges.\textsuperscript{19}

L5 transverse process is wider than upper lumbar spaces. According to a cadaver study carried out by Ebraheim \textit{et al.}, intertransverse space is the narrowest at the L5-S1 space (13.4 mm. +/- 4.1 mm in average); this space is, on the other hand, 24 mm. +/- 3 mm in average at other lumbar spaces.\textsuperscript{7} Again, Ebraheim \textit{et al.} reported that the interlaminar space at L5-S1 level was the widest space with 31 mm (21-40 mm.). Moreover, in the coronal plane, L5 lamina is positioned not directly vertically to the upper lamina, but with an angulation in the upper and lower parts. This anatomical feature facilitates insertion in the interlaminar space with a 5-10 degree endoscopy angle at L5-S1 level on the craniocaudal trajectory.\textsuperscript{3} In addition; the fact that the S1 root exits at the L5-S1 space with an average 22 degrees (18-26 degrees) enables access to the disc herniations at the S1 axilla.\textsuperscript{3}

Ligamentum flavum is not only an active ligament for the biomechanics of the spine, but also a natural barrier hindering postoperational epidural fibrosis.\textsuperscript{4} L5-S1 space is the spot where the said ligament is the thinnest with a thickness of 2-6 mm. During the full-endoscopic interlaminar discectomy, the ligamentum flavum is accessed through a window of about 4-6 mm and therefore the epidural fibrosis risk is taken down to minimum by means of preserving this natural barrier.\textsuperscript{4}

Full-endoscopic interlaminar discectomy can be performed under general or local anesthesia. Kambin \textit{et al.} reported that they were able to perform transforaminal endoscopic discectomy on extruded, migrated, and even sequestered discs successfully under local anesthesia.\textsuperscript{5} In their study published in 2011, Chen \textit{et al.} received similar successful results under the two anesthesia methods.\textsuperscript{3} According to Chen, the opportunity to receive continuous information about the neurological condition of the patient in operations carried out under local anesthesia is useful in terms of preventing neural injuries. However, the maneuvers performed while searching for the disc can be uncomfortable for the patient under local anesthesia. In full-endoscopic interlaminar procedures carried out under general anesthesia, on the other hand, the maneuvers performed in the endoscope in medial-lateral directions can be as easy as those performed in craniocaudal direction.\textsuperscript{3}

Choi \textit{et al.} reported in their study, which was published in 2006, that the percutaneous endoscopic interlaminar technique could be performed in prone or lateral decubitus position.\textsuperscript{4} They listed the advantages of lateral decubitus position as follows; enabling the surgeon to use the endoscope more comfortably, providing a wider vision as the dural sac changes its position downwards, not causing intraabdominal pressure elevation and therefore decreasing the risk of epidural bleeding. Nevertheless, prone position is reported to be a more familiar position for spinal surgeons and therefore a better position for orientation; just as, in almost all the series, the intervention is performed in prone position.\textsuperscript{15,19,22}

In the same study, it is recommended to have discography during the procedure.\textsuperscript{4} Indigo carmine was used for discography, which enabled the visualization of the disc material in blue under the endoscope during the procedure, and therefore it was possible to bring the risk of injury to neural structures to minimum.\textsuperscript{4,15} However, this is not a routine procedure according to the literature.\textsuperscript{4,15,19}

Today full-endoscopic discectomy is not used for soft discs, but also for extruded, migrated and even sequestrated discs. Choi \textit{et al.} reported 4 patients, who had L4-L5 high grade disc herniation
with inferior migration, successfully operated with interlaminar approach.\textsuperscript{5}

Recurrence rates after discectomy vary between 5 to 20% being independent from the technique employed.\textsuperscript{1,2,19} Success rate for revision operations, on the other hand, is worse than primary operations due to epidural fibrosis scar tissue, stenoses, arachnoiditis, segmental instability and additional traumas to develop during the revision procedure.\textsuperscript{13} Epidural fibrosis is the most important risk factor in terms of causing injuries to the dura and neural structures.\textsuperscript{19} Because of all these reasons, it is most appropriate to use minimally invasive endoscopic methods also in revision surgeries.\textsuperscript{1,19} In a prospective, randomized study published in 2009, Ruetten et al. successfully used full-endoscopic transforaminal or interlaminar technique on 100 patients, who had been operated with open technique before, and reported a recurrence of only 5.7%.\textsuperscript{19} Moreover, they reported that common complications of open surgery such as dural or neural injury, urinary retention, delayed wound healing and infection (21\%) were observed less frequently in endoscopic revision surgery (6\%).\textsuperscript{19} Similarly, Kim et al. published a series of 10 patients operated with interlaminar full-endoscopic technique and reported positive results.\textsuperscript{15}

Complications can also be observed in the endoscopic lumbar discectomy technique just like in other discectomy surgical procedures. Complications such as injury to dura, neural injury, injury to vascular structures and conversion to open discectomy are reported in the studies although with low rates.\textsuperscript{4,6,12,14} In the study of Kang published in 2011, composed of 1503 operations, symptomatic post-discectomy pseudocysts are reported more in the interlaminar approach when compared to the transforaminal approach.\textsuperscript{14}

The most important drawback of the full-endoscopic interlaminar discectomy technique is the long and challenging learning process. The technique requires absolute attention, as it is an endoscopic and complicated procedure. Wang et al. report two critical issues in their study, in which they investigate the learning process of this technique. The first one is learning the anatomical orientation and the second is the manipulation of neural structures in the spinal canal.\textsuperscript{22} In the same study they also state that in order to shorten the learning period and to minimize the complications that may arise during this process, firstly the surgeon should have done many microdiscectomy operations, should have microsurgery experience, should be capable of anatomic orientation by means of cadaver practices, should start with the assistance of an experienced surgeon and that it is important to have a proper patient selection during this period.\textsuperscript{22}

In conclusion, in open microdiscectomies as well as in full-endoscopic transforaminal or interlaminar techniques a success rate of around 90\% and recurrence rate of about 6\% are reported. That is, the problem does not stem from the technique itself, it is rather related to the type of the disc herniation and annular defect.\textsuperscript{2,18,24} Nevertheless, advantages such as; low rate of complication in endoscopic techniques, short operation time, perfect vision with 25-degree optics, the chance to observe from monitors for residents’ training, easiness of revision surgeries, price advantage thanks to the short hospital stay, early mobilization and early return to work; feature endoscopic methods in the surgical treatment of lumbar disc disease.\textsuperscript{18} Due to the anatomical challenges mentioned before, interlaminar approach is a technique that can be successfully employed in necessary spaces, particularly at L5-S1.
References

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