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Transforaminal Approach in Lumbar Disc Herniations: TransForaminal MicroDiscectomy (TFMD) Technique

Lomber Disk Patolojilerine Transforaminal Yaklaşım: TransForaminal MikroDiskektomi (TFMD) Tekniği

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ABSTRACT

AIM: The endoscopic foraminal approach in foraminal, lateral and far-lateral disc hernias, is a contemporary minimal invasive approach. This study was performed to show that the approach is possible with using the microscope without an endoscope, and even intervention on the discs within the spinal canal is possible by having access through the foramen.

MATERIAL and METHODS: Forty-two cases with disc hernias in the medial of the pedicle were included in this study. Surgeries were performed with the transforaminal approach and microsurgically. Extraforaminal disc hernias were not included in the study. Access was made through the Kambin's triangle. The foramen was enlarged and the spinal canal was entered.

RESULTS: The procedure took 65 minutes on average, and the mean bleeding amount was about 100 ml. Patients were mobilized within the same day postoperatively. No permenant complications were seen. Follow-up periods ranged between 5 and 84 months and the mean follow-up period was 30.2 months.

CONCLUSION: Transforaminal microdiscectomy is a method that can be performed in any clinic with standard neurosurgical instruments. It does not require additional equipment or a high amount of investment. Application of transforaminal inter-body fusion is possible when required.

KEYWORDS: Transforaminal microdiscectomy, Lumbar disc herniation, Minimal invasive surgery, Kambin's triangle

ÖZ

AMAÇ: Foraminal, lateral ve far-lateral disk hernilerine endoskopik foraminal yaklaşım, minimal invazif güncel bir yaklaşımdır. Mikroskopla da bu yaklaşımın rahatlıkla yapılabileceğini, hatta nöral foramenden girerek spinal kanal içindeki disklere de müdahale edilebileceğini gösteren teknik tanımlanmaktadır.

YÖNTEM ve GEREÇLER: Pedikül mediyalinde olan ve transforaminal yolla mikroşirürjikal yaklaşım uygulanan 42 disk hernisi olgusu çalışmaya alındı. Pedikül lateralinde olan disk hernileri çalışmaya dahil edilmedi. Kambin üçgeninden yaklaşıldı, foramen genişletilerek spinal kanal içine girildi. Standart aletlerle transforaminal mikrodiskektomi (TFMD) uygulandı.

BULGULAR: İşlem ortalama 65 dakika sürdü ve ortalama kanama miktarı 100 ml idi. Hastalar postoperatif aynı gün mobilize edildiler, ertesi gün taburcu oldular. Kalıcı komplikasyon görülmedi. Takip süresi 5-84 ay arasında olup, ortalama takip süresi 30,2 ay idi.

SONUÇ: Transforaminal mikrodiskektomi standart nöroşirürji donanımı olan her klinikte uygulanabilecek bir yöntemdir. Ek bir donanım ve yüksek maliyetler gerektirmez. Gereğinde transforaminal cisimler arası (interbody) füzyon veya nukleus protezi uygulanabilmesi mümkündür.

ANAHTAR SÖZCÜKLER: Transforaminal mikrodiskektomi, Lomber disk hernisi, Minimal invaziv cerrahi, Kambin üçgeni

INTRODUCTION

A basic tenet of surgery is to effectively treat pathology with minimal disturbance of normal anatomy, leaving "the smallest footprint." This is being accomplished more effectively by designing procedures that require smaller incisions, result in less soft-tissue disruption, and involve limited surgical corridors. The development of these procedures has been implemented through technological advances in illumination, magnification and instrumentation (23). Currently, microdiscectomy is the golden standard in lumbar disc surgery. The endoscopic foraminal approach in foraminal, lateral and far-lateral disc hernias is a contemporary minimal invasive approach. This study was performed to show that the approach is possible using the microscope without an endoscope, and even inter-

vention on the discs within the spinal canal is possible by having access through the foramen.

MATERIAL and METHODS

Disc hernias were divided into three groups according to locations as medial to the pedicle, inter-pedicular (foraminal), and lateral to the pedicle (Figure 1). Forty-two cases with disc hernias medial to the pedicle (within the spinal canal and in the central, paramedian and lateral positions) and foraminal disc hernias were included in this study and surgeries were performed with the transforaminal approach and microsurgically. Extraforaminal disc hernias were not included in the study.

Surgical Technique

We performed the procedure with patient in prone position under spinal or general anesthesia. The table can be tilted to the lateral. The level is determined using C-arm scopy and AP and lateral scopy. Later, depending on the anatomy of the area, type of the pathology and depth of the pathology, a skin incision 2-2.5 cm in length is made 6 to 10 cm (mean 8 cm) lateral of the midline (having access from as far as possible laterally will be more suitable if proper separators and instruments are available) (Figure 2, 3, 4). After cutting the fascia, access will be with digital dissection between the paraspinal muscles (we use the space between the m. iliocostalis and m. quadratum lumborum) and the lateral side of the facet and transverse processes and the intertransverse ligament.

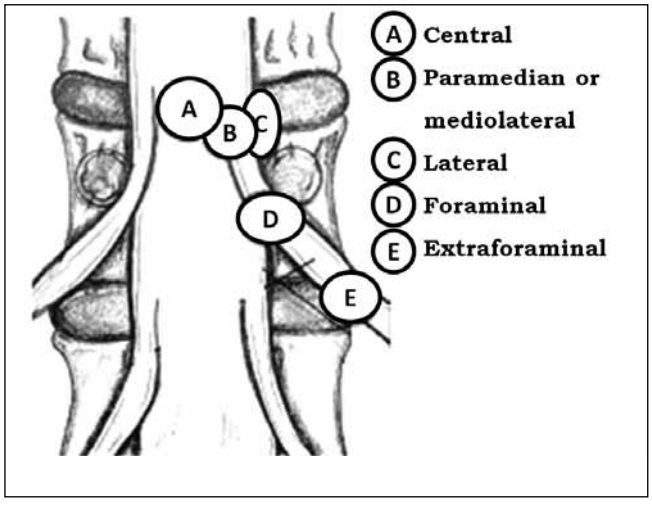

Figure 1: Types of disc herniation.

Following the repeat scopy control, the separator is placed and the required distance is reached. The disc is reached directly from the inferior of the foramen if the disc has no cranial or caudal extensions. Depending on the paramedian/median extension of the disc, the foramen is enlarged from the lateral of the facet by removing it with a thin Kerrison punch or suitable drill. Compression on the root leaving the foramen can be possible in discs with cranial extension. Dissection is started on the transverse process-pedicle junction in the superior of the foramen. The root is exposed first, and then discectomy is performed. The pedicle of the lower vertebra prevents exploration in discs with caudal extension.

Interventions on the inter-canal disc hernias are possible if the anatomy is suitable. It is possible not only to remove the extruded fragment, but also to perform disc curettage. Interbody fusion can be made if required with graft or cage after discectomy and curettage.

The materials we use in this procedure are those available in any center that micro-neurosurgery is performed:

1. Surgical microscope
2. Radiolucent operation table
3. C-arm scopy

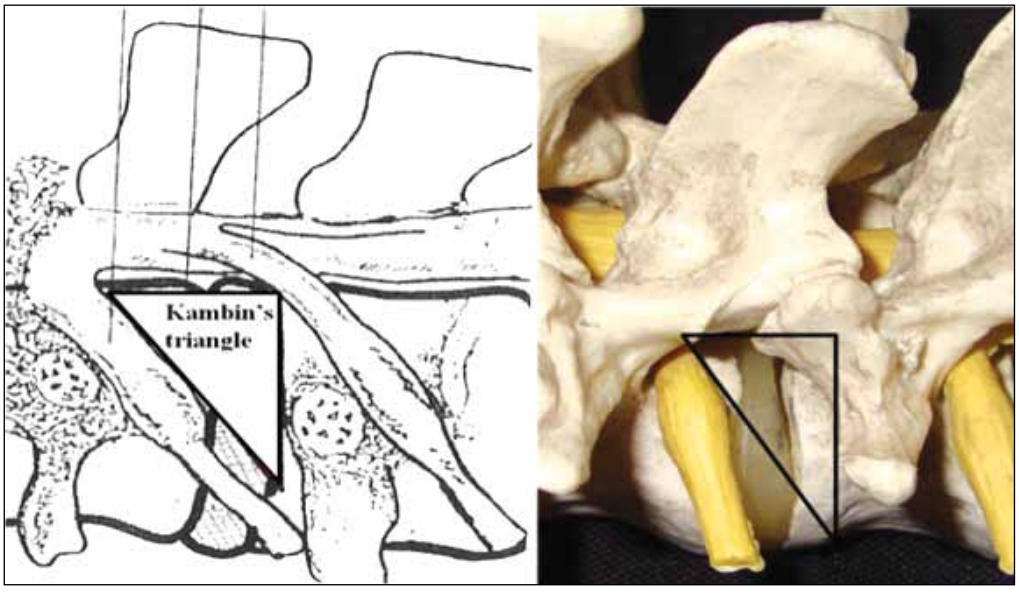

Figure 2: Kambin's triangle.

4. Microsurgical instruments
5. Landolt separators used in pituitary surgery, Meyerding separators used in lumbar microdiscectomy, separators used in the anterior cervical approach (Caspar, Clovard etc.) or nasal speculum, whichever is present or convenient

RESULTS

Twenty-nine of the cases were male, while 13 were female. Ages ranged between 23 and 72. There was a disc hernia at L4/5 in 11 cases, L3/4 in 15 cases, L2/3 in 8 cases and L1/2 in 8 cases. The procedure took 65 minutes in the average, and the mean bleeding amount was about 100 cc. Patients were mobilized within the same day postoperatively and were discharged the next day.

No complications were seen except for mild radicular paresthesia in 2 cases that lasted for about 2 weeks. Follow-up periods range between 5 and 84 months, and the mean follow-up period was 30.2 months.

The preoperative pain score was between 7 and 10 (mean 9.5) according to Visual Analogue Scale (VAS). The postoperative pain score was marked 0 to 4 (mean 1.4) by the patients, according to VAS.

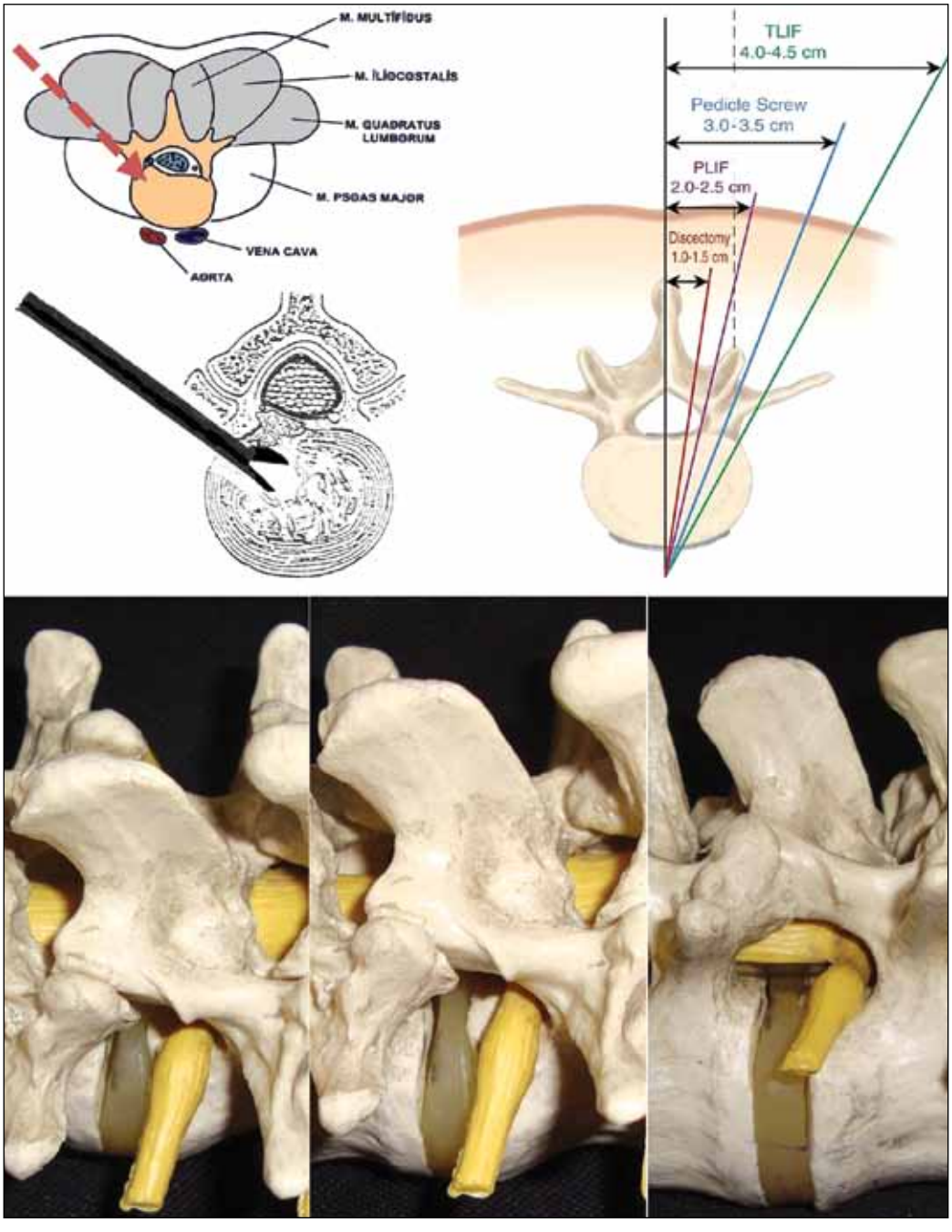

Figure 3: The relationship between the access location and discharge of the disc.

The Oswestry Disability Index (ODI) questionnaire form that was filled preoperatively provided a score between 28% and 96% (mean 64.88%= daily life completely restricted because of pain) while postoperatively it was 0% to 26% (mean 9.76%= pain not a serious problem in daily life).

Compared with preoperative results, postoperative VAS and ODI results showed a significant improvement ($p<0.001$).

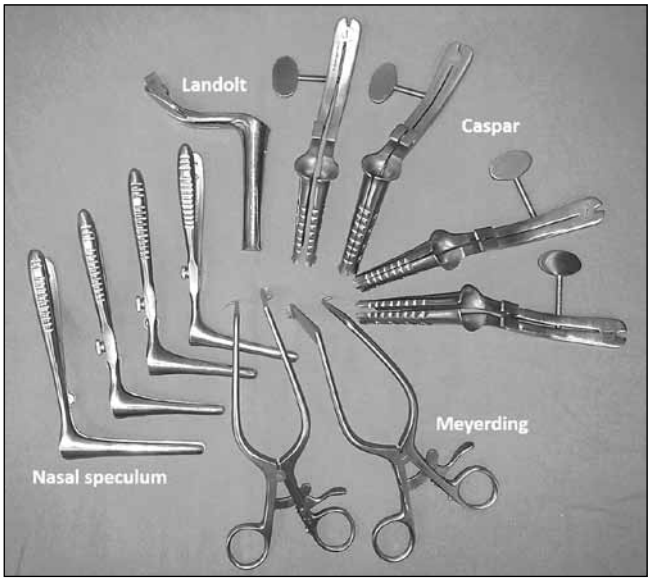

Figure 4: Separators that were used during the surgery.

The demographical and surgical characteristics of forty-two patients have been presented in Table I.

When asked "If you had known the result before, would you have accepted this treatment anyway?" in the postoperative patient satisfaction form, 41 patients answered "Yes" and 1 patient answered "Undecided, maybe".

A sample case has been presented in Figure 5.

DISCUSSION

A search for a treatment method for intervertebral disc hernia started following description of the disorder by Mixter and Barr in 1934 (21). Macroscopic interventions were performed for disc hernias till the 70s. Microdiscectomy was developed after the use of the microscope by Yasargil in 1977 (29) and became the gold standard in treatment.

Percutaneous Microendoscopic Discectomy (PMED) is a technique that was developed as an alternative to microdiscectomy. Foley and Smith suggested the interlaminar approach to disc hernias first in 1997 using tubes with different diameters and an endoscope mounted on these tubes (1). This system that they named the micro-endoscopic discectomy (MED) system was used widely. Later, this system was used in far lateral disc hernias (2), in lumbar narrow canal (18), in posterior cervical microforaminotomy (19), and even in interbody fusion and instrumentation (5).

This system has some advantages. Tissue trauma and particularly muscle trauma is less. It is possible to see the nerve

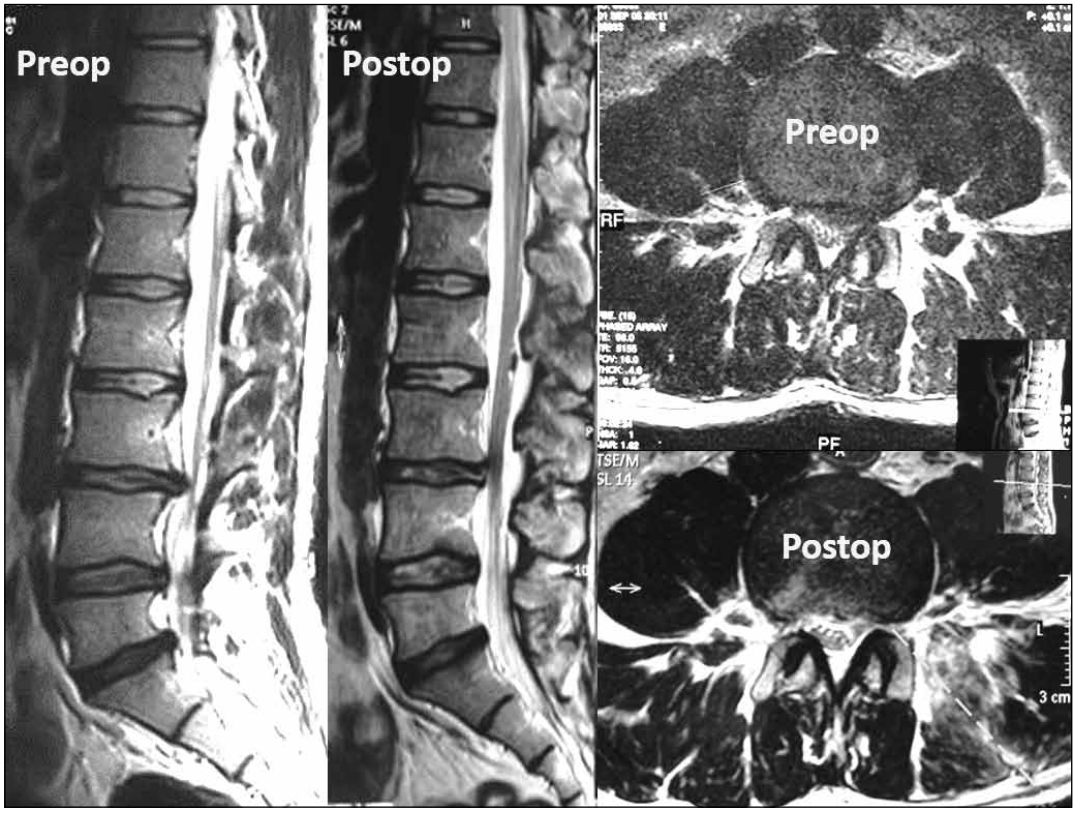

Figure 5: Sample case 1: Paramedian disc herniation: Pre-operative and post-operative axial MR and the access route. Microdiscectomy was performed with transmuscular transforaminal approach after making a skin incision 2 cm in length, 7 cm lateral to the midline. Radicular pain disappeared in the post-operative period. The patient was mobilized 4 hours after the operation and was discharged on the same day.

Table I: Patients' and Surgical Characteristics

Case	Gender/ Age	Level	Surg. Time (min)	Bleeding (ml)	Preop VAS	Postop VAS	Preop ODI	Postop ODI	Complication
Case 1	M/27	L3-4	65	100	10	1	82	12	-
Case 2	F/32	L4-5	70	120	9	1	69	6	-
Case 3	M/35	L2-3	70	120	10	3	75	21	-
Case 4	F/40	L4-5	65	100	9	1	70	0	radicular paresthesia
Case 5	M/46	L3-4	60	100	8	0	37	0	-
Case 6	F/23	L4-5	55	80	10	1	96	0	-
Case 7	M/49	L2-3	70	120	9	1	68	9	-
Case 8	F/36	L3-4	65	100	7	1	28	5	-
Case 9	F/62	L3-4	75	120	8	0	35	0	-
Case 10	M/37	L4-5	70	120	10	2	66	17	-
Case 11	M/64	L3-4	50	80	10	2	71	15	-
Case 12	M/25	L1-2	55	80	9	2	59	16	-
Case 13	M/59	L1-2	70	100	10	1	72	0	-
Case 14	M/41	L2-3	75	100	10	2	69	15	-
Case 15	M/27	L3-4	80	100	10	3	71	21	-
Case 16	F/45	L1-2	60	80	9	1	63	10	-
Case 17	F/39	L3-4	50	80	10	2	70	15	radicular paresthesia
Case 18	M/72	L1-2	65	100	9	4	68	20	-
Case 19	M/38	L2-3	60	80	10	3	76	16	-
Case 20	F/44	L2-3	55	80	10	0	70	0	-
Case 21	M/42	L4-5	60	100	9	1	59	10	-
Case 22	M/39	L1-2	65	100	9	1	60	8	-
Case 23	M/40	L3-4	70	120	10	1	73	9	-
Case 24	M/29	L2-3	60	100	9	0	62	0	-
Case 25	F/55	L4-5	60	140	10	1	65	0	-
Case 26	M/43	L3-4	65	80	10	1	68	8	-
Case 27	M/51	L2-3	60	100	10	0	62	0	-
Case 28	M/35	L1-2	75	100	10	1	64	10	-
Case 29	M/39	L3-4	70	120	9	0	56	0	-
Case 30	F/69	L2-3	75	80	10	1	69	9	-
Case 31	M/40	L4-5	75	100	10	0	71	0	-
Case 32	F/25	L4-5	60	140	10	4	68	26	-
Case 33	M/38	L3-4	75	100	9	1	62	9	-
Case 34	M/61	L1-2	65	120	10	2	74	17	-
Case 35	M/70	L4-5	65	100	10	0	68	0	-
Case 36	M/32	L3-4	55	80	10	4	65	21	-
Case 37	F/50	L3-4	70	120	10	1	60	15	-
Case 38	M/48	L4-5	60	100	9	2	64	18	-
Case 39	M/30	L1-2	55	80	9	1	60	10	-
Case 40	M/47	L3-4	70	80	9	0	52	0	-
Case 41	F/38	L4-5	65	100	10	4	66	24	-
Case 42	M/34	L3-4	65	80	10	2	62	18	-

min: *minutes,* ***ml:*** *mililiter,* ***ODI:*** *oswestry disability index,* ***VAS:*** *visual analogue scale.*

root and the disc directly. In addition, bone decompression is also possible. This procedure can be performed on an outpatient-ambulatory basis. In addition, it is performed in the interlaminar area, which the spinal surgeons are very familiar with, and using a technique very similar to the classical technique. The disadvantage of this system is the difficulty of performing the surgery in the 2-dimensional screen, the requirement of familiarity with the technique, and lack of superiority to the microsurgery. In addition, the ligamentum flavum must be removed to perform the procedure while protection of the ligamentum flavum is possible in microlumbar discectomy (30).

Shift to the Microscope from the Endoscope: The MED system has limitations. The endoscope is not reusable. The working area within the tubular retractor is limited, and the tip placed with an angle of 25 degrees is frequently soiled requiring removal and cleaning (30). The MED system was therefore replaced with METRx and a 3-dimensional image was obtained through the tube and decompression of the lateral recess stenosis was also ensured (25). Familiarity of spinal surgeons with the microscope increased the popularity of the system, and the separator system mounted on the table and adjusted easily allowed performing bilateral decompression comfortably with a unilateral approach.

The non-optimal long-term results of the translaminar intra-canalicular surgery forced many surgeons to look for alternative methods for lumbar disc surgery. Hult suggested the anterior transperitoneal approach in 1950 (4). Smith et al. introduced the nuclear reduction and chemonucleosis view in 1963 (28). Onik et al. (22) presented nucletomy and lead the way in laser disc surgery.

Increased understanding of the arthroscopic anatomy of the foraminal and extraforaminal region (14,15,17) and the description of radiographic landmarks of the working zone on the dorsolateral annulus, (16,17,20,24) combined with the availability of small-caliber glass rod fiber optics, have permitted further lateralization of the skin entry point and posterior positioning of the open end of the cannula adjacent to the neural structures (12,13). This has opened a window of opportunity that permits retrieval of herniated disc fragments under arthroscopic illumination and magnification (11).

Transforaminal Endoscopic Discectomy: This is an intervention with priority in extraforaminal and far lateral lumbar disc hernias lumbar disc that is preferred to the classical lumbar discectomy approach. Although it is more commonly used in far lateral, foraminal disc hernias, it is also used in midline disc hernias by experienced surgeons. Transforaminal endoscopic foraminal decompression has been described in lateral recess syndromes and in foraminal stenosis (6-9).

This intervention, which was first described by Hijikata (3) in 1975, was later performed by Kambin (10) in 1983. Kambin named this procedure "percutaneous arthroscopic discectomy". In recent years, this procedure had been called the "transforaminal endoscopic discectomy" (TED). The success rate of TED is directly proportional to the selection of suitable cases. Percutaneous arthroscopic discectomy with rigid endoscopic optic is a method that should be considered particularly for extraforaminal or far lateral lumbar disc herniations (26, 27). Lumbar tomography will be very useful for the surgical strategy if advanced bone deformity and degeneration are seen on lumbar MRI in radiology studies.

Shift to Microscope from Endoscope

The TFMD (transforaminal microdiscectomy) technique we use is considered as an alternative method that uses Kambin's triangle and minimizes the instability and muscle denervation risk seen in classical surgery, eliminates the necessity of working in 2 dimensions in the other arthroscopic methods, increases safety thanks to the magnification and 3-D environment, and requires no high-cost equipment.

Advantages

1. The technique does not require any additional equipment other than standard neurological surgical equipment. Unlike other microinvasive methods, there is no need for an extra apparatus (low cost),
2. Working in three dimensions and magnification compared to the arthroscopic approaches (reduces complications),
3. Minimizing the instability risk by protecting bony structures such as the facet and lamina,
4. There is almost no muscle denervation since separation of muscles will be minimal,
5. Early mobilization, short hospital stay and early return to active life,
6. Interbody fusion can be performed easily if required.

Disadvantages

1. Requires good anatomic knowledge and experience
2. The L4-5 level and the L5/S1 level can present difficulties in patients with a high iliac crest.
3. Significant foraminal stenosis as the foramen must be enlarged

Indications

- Lateral and far lateral discs
- Discs with paramedian and even median extensions
- Discs migrated to the cranial from the lateral
- Cases with spinal stenosis and facet hypertrophy with convenient foramen.

Limited Use

- The discs of the lower levels (L5/S1 and sometimes L4/5) where the iliac wing closes the foramen
- Disc hernias migrated caudally (extending to the pedicular level)
- Cauda Equina Syndrome.

CONCLUSION

Transforaminal microdiscectomy is a method that can be performed in any clinic with standard neurosurgical instruments. It does not require additional equipment or a large amount of investment. Cases without obesity and with large foramina were preferred initially. The advantage of this method is to deal with inter vertebral disc without touching any structures that play a role in the stability of spine. Application of transforaminal inter-body fusion or nucleus prosthesis is possible when required. Because of possible obstruction by the iliac wings, the lumbar discs at higher levels are more suitable for this approach. TFMD can be performed without causing neurological deficits and wide decompressions leading to instability, particularly in high-level median disc hernias.

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