1. Introduction:

Microendoscopic discectomy system (MED) was first introduced in 1997 by Foley and Smith (1). Metrx system is the next generation of MED system. It allows surgeon to perform discectomy in a minimally invasive fashion (1,2). It also offers some advantages over other minimally invasive techniques (3). Thanks to this system, nerve roots are exposed directly, even far sequestred disc fragments may be decompressed effectively, while minimally affecting the surrounding tissues. Interlaminer space is approached by splitting paravertebral muscles with a small incision, approximately 1.5-2 cm long. By using tubular retractor system, contained lumbar disc herniations even sequestered disc fragments can be removed unlike other percutaneous approaches. The root that is compressed by lateral recess stenosis can also be decompressed by this system. A lateral approach may also be used so far lateral disc herniations can be removed effectively. A prospective clinical study has shown that treatment of lumbar disc herniation is effective by using microendoscopic technique (4).

2. Indications:

Lumbar disc herniation with or without sequestration is the most common indication of endoscopic discectomy. If the pain from one nerve root compression by disc herniation is not relieved by conservative treatment, endoscopic discectomy can be considered. Absolute indication for lumbar disc herniation is progressive muscle weakness. The common indication of discectomy is to obtain quick relief of pain and disability (4). Endoscopic discectomy provides both rapid recovery and returning routine life as soon as possible. One level lumbar stenosis and lateral recess stenosis can be decompressed by the surgeon who is experienced in microendoscopic discectomy (4). High speed drill must be available to challenge for hypertrophied facet joints. MED system can also be used for foraminal or extraforaminal sequestration (7). We preferred to set the tubular retraction system lateral to the spinal channel between transvers processes. Isthmic part of lamina must be shaved to expose the foraminal sequestrations. The lateral and upper part of facet joint which is caudal from sequestration must be removed for exposing the extraforaminal disc herniations. MED system can be used for central, mediolateral, foraminal and extraforaminal disc herniations from L2-3 level to the L5-S1 level. MED system has also been used for posterior cervical foraminotomy, discectomy and thoracic discectomy and also for recurrent lumbar disc herniations (8,9).

3. Contraindications:

Contraindications are similar to standard discectomy. Coagulation disorders, using antiaggregant and anticoagulant drugs are main contraindications. Lumbar spinal stenosis is relatively contraindicated. Transverse and anterior-posterior length of the spinal canal must be measured preoperatively. Diameter of spinal canal lower than 15 mm is considered a contraindication for using tubular retraction system.
4. Surgical Procedures:

4.a. Surgical Equipments:
Surgical equipment can be classified according to their function.
I. Visualization and illumination equipments
II. Tissue retraction equipments
III. Laminotomy and discectomy equipments

Visualization is obtained by endoscopic assembly of METRx system. Camera head and light cable is connected to endoscope via clockwise rotation. Camera head is connected to the video recorder and monitor. Light cable is connected to the cold light source. After connection is completed, white balance must be performed. For white-balancing, a white object is placed 1 cm apart from the lens of endoscope while pressing white balance button on video recorder. Now endoscopic system is ready to visualization.

Tissue retraction equipments include Kirshner wire, 5 muscle splitting tubes, one working tube and one flexible arm which can be fixed to the operating table. Diameters of the splitting tubes increases to the diameter of the working tube. Working tube has two accessory processes. One process is for connection to the flexible arm, the other one is for attachment of endoscopic system. If operating microscope is preferred for visualization, second process is not necessary. Flexible arm can be fixed by turning the circle clockwise for tube to be positioned. Circle is turned counter clockwise to release the arm and then positioning of the working tube. Endoscopic system is placed into the tube via a plastic ring tightened by an arm. This plastic ring has an aspiration part to remove the blood from operation field. Aspiration port can be used as an irrigation port to clean endoscopic eye.

Surgical instruments are similar to standard discectomy. Instruments used in MED are longer, thinner, bayouenet-design and non-reflecting dark. However, surgeon has lost the skill of 3-D visualization while performing discectomy by MED system. That's why the disc remover has numbers which show the depth of disc remover tip. This is very important nuance to avoid injuring paravertebral tissues. Kerrison punch must have a 3 mm footplate. Both Kerrison punches oblique and straight must be available on the operation table. High speed drill is helpful for medial facetectomy. Drill handle must be angled and must be the longest choice (Figure 1a).

4.b. Operating room setup:
Operating room is arranged for surgeon to view both video monitor and fluoroscopy monitor. Surgeon stands on the same side of disc herniation. C-arm of fluoroscopy is placed under operation table. This allows fluoroscopic visualization in whole operation. C-arm is placed not to discomfort the surgeon (Figure 1b). Anesthesia is placed at the head side of the patient.

4.c. Patient positioning:
Operation can be performed under general or spinal anesthesia. Patient is positioned in prone with lumbar flexion. Silicon rolls or frames are advised to put on the anterior crista iliaca. Rolls must not compress both left and right femoral arteries. Silicon-made rolls help to prevent meralgia paresthetica. Care must be taken not to compress the abdomen by rolls to prevent epidural bleeding which can make the operation uncomfortable (Figure 1b).

4.d. Surgical Technique:
After surgical field is prepared by antisepsis rules, it is dried and draped. A 20-gauge needle is inserted into aimed level, just 1.5 cm lateral to the midline. The level is confirmed by flouroscopic imaging (Figure 1c). If the level is correct, a K-wire is inserted after the needle is removed. K-wire must be aimed to the intervertebral disc space. Care must be taken not to enter the K-wire into the interlaminer space and then penetrate the spinal canal (Figure 1d-f). Skin is incised 1.6 cm for 1.6 m working tube (Figure 1g). Fasia can then be incised. Fasial incision makes it easy for dilator tubes to insert into the paravertebral muscles. Initial tube is inserted over the K-wire (Figure 1h). Surgeon feels the bone tissue through the muscles. Sequential insertion of dilator tubes splits muscles. Tip of dilator tubes dissect muscle which cover the lamina by medial to lateral, rostral to caudal movements. Finally, working tube is inserted over the dilator tubes (Figure 1i-m). After confirming the level by fluoroscopy, working tube is connected to flexible arm which is fixed to operating table. When appropriate position is obtained, flexible arm is tightened (Figure 1n-p).

Endoscope which was connected to the light source and camera cable before, is secured to the working
Figure 1:
Stages of the endoscopic discectomy using METRx system. METRx instruments set (a); Set-up of the surgical room must be prepared so that the surgeon can look the C-arm and monitor at the same time (b); A needle will help to learn the proper level (c); After sterile covers, retractor arm is fixed to the table (d); The flexible arm is placed on the tip of the arm and fixed (e,f); A 1.5 cm incision is done (g); The first dilator is inserted onto the K-wire (h); Other dilators are inserted and muscles are seperated fromthe lamina by feeling of the surgeon (i,j,k,l,m); Working tube with 1.6 cm diameter is inserted around the last dilator (n,o).
tube with a plastic ring. Arm of plastic ring is tightened for endoscope not to turn. Now it is ready to watch the operation from the monitor (Figure 1r-t).

Endoscopic view is focused by turning black ring on the MED endoscope. Yellow ring on the endoscope turns the image on video monitor. It is advised to arrange the view as in the standard discectomy. Lateral side is positioned in 6 o’clock, medial side is positioned in 12 o’clock on the monitor. A ‘V’ shaped recess is observed in the monitor. This recess shows the position of the endoscopic eye within the working channel. Orientation is confirmed with a curette. The curette must be observed in 12 o’clock position when it is directed to the midline. If it is correct, discectomy can be performed like as standard discectomy.

Muscles overlaying lamina, facet and interlaminar space must be removed. Bipolar cautery and scissors are used for this purpose. First, muscles are cauterized by bipolar, then dissected by scissors in Kerrison shape which is available in METRx endoscopic set. Using this method reduces bleeding. Lamina, facet and ligamentum flavum are exposed to maximize the visualization.

Laminectomy and medial facetectomy are performed. Laminectomy must not be enlarged up to the ligamentum flavum ending. If it is performed to the end of the ligamentum flavum, removing free ligamentum flavum will be difficult. Ligamentum flavum is removed in layers. A curette or No.15 scalpel may used for this purpose. Each layer is removed by Kerrison punch. Dura and root are exposed. If

Figure 1:
The proper position is observed on the C-arm image (p); Endoscope is placed and the surgeon works with instruments (r,s,t).
it is needed to angle the working tube, flexible arm can be released. At that time, working tube must be kept underpressure not to miss the muscles that were retracted before. Root is retracted by a hook to search the disc herniation. When the herniation or fragment is visualized, suction is performed by a specially designed retractor-suction tip. If posterior longitudinal ligament is intact, it is incised with a no 15 scalpel. Then discectomy is performed, up to root is well decompressed (Figure 2a-c). If there is a free fragment, other free fragments must be searched. The root is moved by hook for searching other fragments. Disc space may be irrigated by saline solution. Sometimes disc tissue is found by this maneuver. We prefer using local antibiotics to the disc space at the end of discectomy and never faced a discitis after irrigating the disc space with rifampiscin. Bleeding is controlled by bipolar cautery or application of spongostan.

Flexible arm is released, working tube is withdrawn. Fascia is closed by interrupted one or two absorbable sutures. Skin is reapproximated with subcutaneous sutures or sterile skin adhesives.

**Tubular Retraction System with Microscope**

The METRx tubular retraction system can also be combined with an operation microscope, so a three dimensional imagination can be obtained (Figure 3a). Microscopic visualization in tubular retraction system gives a 90 degree working angle. On the other hand

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**Figure 2:**
MR images of a patient with extruded fragment on L5-S1 level (a, b, c)
endoscopic discectomy is performed by a 30 degree angle. Some surgeons believe that 30 degree angle has advantages (10). It is useful for decompressing to contralateral lateral recess stenosis from an ipsilateral approach. However, it is possible to decompress contralateral recess stenosis by using microscopic discectomy with giving angle to the tubular retraction. Main disadvantage of using a microscope is reflection from tubular system. Arrangement of light source of microscope to the diameter lower than 1.5 cm can solve this problem (Figure 3b). Another disadvantage of using the microscope is touching the surgical instruments to the microscope’s lens apparatus. The lens focussed more than 350 mm must be preferred when performing microscopic discectomy. Optic lens of endoscopic system sometimes becomes dirty with blood and with smoke from bipolar coagulation. In that instance, removing and cleaning the optic system is necessary. This increases the duration of the surgery and causes a disorientation in operation field.

5. Postoperative care:
After operation, patient is followed at postoperative care unit. If the vital functions are stable, patient is sent to his or her room. Family members are allowed to stay with patient at the room. Patient is
informed about the operative findings and what he or she must do. We advise the patient to lay in the bed for six hours in supine position. After the patient has wakened spontaneously and effect of spinal anesthesia has resolved, he or she is ambulated at postoperative eight hours. If there is no problem, patient is discharged with a family member or a friend or with a vehicle.

6. Complications and Avoidance:

Complications of endoscopic microdiscectomy are similar to those of standart discectomy. Dura laceration, root injury, epidural venous bleeding, injury to the paravertebral vessels and abdominal tissue, infections and neurological deterioration are the complications that may be seen.

Although it is not easy to repair dural tear via 16 mm tube, it may be performed using a microneedle holder. Atraumatic suture with maximum 12 mm round needle is advised for repairing. Dural graft matrices like Dura Gen can also be used for covering dural tears. Fibrin glue can be placed on dural graft matrix. In that instance, fascia must also be approximated in a watertight fashion. In spite of all these measures, if CSF leakage occurs, lumbar external drainage must be considered for 3 to 4 days.

Microendoscopic discectomy is an instrument dependent operation. These instruments are fragile and must be handled with care. Angle of the working tube must not be changed unless flexible arm is fully released. Flexible arms and cables of light and endoscope must be placed away from surgeon’s working corridor. Tip of the endoscope is cleaned with a soft and wet sponge. Handling of the tip of the endoscope must be very careful and crashing the endoscope tip to the metal faces should be avoided. While illumination, temperatures may exceed 41°C at the tip of the endoscope and 8 mm beyond. To avoid tissue burning, irrigation of the operation field must be done in intervals.

7. Conclusions:

Endoscopic microdiscectomy is an effective and safe choice for surgical treatment of lumbar disc herniation. It’s not superior to the microdiscectomy in terms of clinical results. But it is not lower, either. Endoscope provides the surgeon working with a 30 degree angle. But it doesn’t have three dimensional imaging. Learning curve is longer for the surgeon who used to use operating microscope in the other spinal operations. Experienced surgeons can also overstep recurrent disc herniations, lumbar stenosis, cervical foraminotomy, discectomy for lateral lumbar disc herniation, thoracic discectomy by using METRx endoscopic system. Surgeon has a chance to unite tubular retractor system with operating microscope. It will be three dimensional visualization with minimally invasive fashion as we performed nowadays.

8. References: