1. Introduction:

The anterior approach to the cervical spine was first described by Cloward in 1958\(^1\). Since this time, the results of the microscope applied to spine surgery have been very optimistic. Partial and/or complete discectomy and osteophyte resection can be performed to decompress the neural canal and foramen via standard operating room microscopic techniques. The operating microscope provides magnification, improves illumination and reduces the amount of bone resection required to expose the herniated disc (especially osteophytes of the vertebral body). There are three primary clinical pathologies where anterior cervical discectomy is applied: soft discs, cervical spondylosis and ossification of the posterior longitudinal ligament just under the disc level. The anterior approach is also used to decompress the anterior wall of foramen instead of posterior part. In this situation, it is not necessary to remove the entire disk, and the extreme lateral approach is performed directly onto the neural foramen.

A lesion at the C2-3 level may compress the C3 nerve root causing pain and sensory changes in the back of the neck, mastoid process and pinna of the ear. C4 nerve root compression may cause sensory changes and pain in the back of neck or over the scalp and anterior chest. The compression of the C5 nerve root often causes pain at the neck, tip of the shoulder and anterior arms. Sensory changes are localized to the lateral portion of the skin overlying deltoid muscle. The C5 nerve roots predominantly innervate the deltoid and biceps muscles. Deltoid is almost entirely innervated by C5, and the biceps has dual innervations from both C5 and C6. In situations of compression, the biceps reflex can be diminished because of either C5 or C6 nerve root compression.

C5-6 disc herniation will affect the C6 nerve root and may present with pain in the neck, shoulder, medial border of scapula, lateral arm and dorsal forearm. Sensory loss is often noted in the distribution of lateral forearm as well as thumb, index finger and occasionally the radial half of the middle finger. Muscle testing includes biceps muscle and wrist extensors. Biceps and brachia-radial reflex are lost or diminished. Pathology of C7 nerve root will cause pain at the neck, shoulder, medial border of the scapula, lateral arm and dorsal fore arm. The sensory changes are usually confirmed to the index and long fingers. Muscle testing of C7 level involves the triceps, wrist flexors and finger extensors. Triceps tendon reflex are involved at the pathology of C7 nerve root. Compression of the C8 nerve root will cause sensory changes in the ring and little finger. Manual motor testing includes the finger flexors (grip) and intrinsic muscles of the hand.

Foraminal herniations can be diagnosed easily with MRI. Annular defects, bulging and/or free fragments may be seen in the neural foramina. If the clinical exam correlates with the findings from MRI, it is not necessary to perform additional testing with EMG. Cervical myelopathy can be precipitated by either a large disc herniation or more commonly by severe pathological bone spur. Spondylotic changes may occur with or without a congenitally narrow spinal canal. Most patients are usually unaware of the precise onset time of the symptoms. Symptoms include the deterioration in gait and abnormal dexterity, generalized weakness and/or urinary urgency or frequency. A minor trauma may precipitate the onset of symptoms. However, symptoms often may begin without an inciting event.

2. Patient Selection and Indications:

There are two different indications for anterior cervical discectomy. The first is the intractable pain with and/or without neurological deficit. This pain
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is unresponsive to medical treatment. The second is the spinal cord compression. The cervical spine is mobile in young patients. If there is spinal stenosis, the mean diameter of the spinal cord becomes equal to the spinal canal diameter and compression of the spinal cord is unavoidable. Daily micro traumas cause progressive, stepwise cord damage and the mobility of the spinal cord decreases. However, with significantly decreased movement of the functional segment, there is less microtrauma when compared to younger patients (who are more mobile). In patients of advanced age, if there is a fusion of functional segment and significant degenerative disease near this area of fusion, the surgical intervention still may not be needed.

Two diagnostic tools are critical in surgical decision making. The first is dynamic MRI and the second is dynamic SEP and MEP. Dynamic MRI normally shows motion of spinal cord with harmony of spinal canal, and there is no change in the size and shape of spinal cord during the flexion and extension movements. However, dynamic stenosis in the hyper-extended position may cause squeezing of the spinal cord. The spinal cord appears to be much like an hourglass. In hyperflexion position, the diameters of spinal canal and cord are normal.

Most of these patients’ have normal SEP and MEP in neutral position of neck. However, in a position of hyperextension, because of the squeezing of spinal cord, the electrophysiological measurements is disturbed.

3. Contraindications:

It will be better not to choose anterior cervical approach for the cases with dorsal compression of neural structures and isolated traumatic disruption of the posterior elements. Thyromegaly or other pathologies of the surgical area can limit the surgical approach.

4. Surgical Procedures:

4.a. Surgical Equipment

Biplanar C-arm, operating microscope and cervical microdiscectomy equipment are the main parts of this surgical procedure (Figure 1). The sterilization equipment for cervical spinal surgery such as betadine, alcohol solution, drape and sterile towel are also prepared.

4.b. Operating Room Set up

The C-arm and operating microscope is located opposite to the surgeon (Figure 2). The spine surgeon is positioned according to the dominant hand. The right side of the patient is suggested for the right handed surgeons. The surgical assistant is positioned opposite to the surgeon and operation technician is located between the surgeon and assistant.

Figure 1a: Surgical equipment of the cervical microdiscectomy operation is shown.

Figure 1b: The latest design of Ozer’s retractor.
4.c. Patient positioning:
The supine position and a radiolucent spine operative table are suitable for anterior cervical microdiscectomy operations (Figure 3). A slight extension position of the neck with a rolled towel will facilitate the visualization and expand the discectomy level. The operation area is washed and draped in a usual sterile fashion after the correction of operation level with C-arm.

Before the operation, suitable antibiotics are given in operation room. The most important point is to avoid manipulating neck during endotracheal intubation in patients who has spinal canal stenosis. Anesthesiologist should check the maximum degree of cervical flexion and extension tolerated by the patient before operation.

4.d. Surgical Technique:
A transverse incision is made at the appropriate level (Figure 4a). Platysma layer is opened and dissected cranially and caudally. Sternocleidomastoid (SCM) muscle is found and through the medial border vessel-nerve packet is found and carotid pulsation is seen and felt by finger. It is reached to prevertebral fascia with finger dissection between the vessels-nerve packet and tracheoesophageal complex. Sometimes the superficial fascia has bands between the SCM muscles, vessels nerve packets.

During the finger dissection of thin layered bands, when they come together, they may act as strong rope and defense to the manipulation. So, this defense mechanism may prevent the exposure of the surgical area. Additionally, careful dissection of these bands are necessary, in order to avoid damage of superior laryngeal nerve. It is also difficult to set up the retractors because of the small surgical area. For these reasons, all of these bands must be determined and cut with a maximum care on neural structures.

Tracheoesophageal complex retracted medially and prevertebral fascia are opened and disc annulus, corpus vertebrae are seen in midline and longus colli muscles are straight lie down along the lateral border (Figure 4b,4c).

Correct level are marled with a little pin and confirmed by C-arm. And our designed retraction is placed just over the disc level and blades are screwed. Advantage of this retractor is preventing surrounding tissue come over surgical area at the same time to save the damage of tissues. And this retractor acts as a vertebrae sprider. We think that it is more practical as compared with Caspar retractor.
After these procedures, longus colli muscles are dissected laterally and front border of annulus are betrayed. Anterior osteophytes are cleaned and incision is made to the annulus.

Under the microscopic magnification and with the assistance of high speed drill cartilage endplates, osteophytes are removed. Moving the head of microscope posterior border of vertebrae and both foramen are opened. Free fragments of the herniated disc can be found among the layers of posterior longitudinal ligament (Figure 4d). It is found and removed. Sometimes free fragments can be localized behind the posterior longitudinal ligament. It is necessary to control this area, if it is not found, a fragment can be seen in the control MRI. Foramens are opened and fragments should be checked with nerve hooks.

If we stop the operation without doing anything it is called “simple discectomy”. Bone graft alone or bone graft with cage, bone graft with plate or disc prosthesis can be placed after the discectomy.

4.c.1. Bone graft:

The cartilage endplates are curetted or drilled after simple discectomy. The osteofites compressing the neural structures are excised with kerrison rongeurs, curettes and high speed drills. A cave for bone graft is prepared in the lower and upper vertebrae corporuses. The appropriate sized bone graft is chosen for disc level. The spongious part of the upper and lower surfaces of the bone graft must contact to the upper and lower surfaces of vertebrae corpus at the disc level. More surface area means the increase of fusion and decrease of pseudoarthrosis. After the bone graft is located to the prepared disc space, it is controlled with biplanar scopy.

The anterior surfaces of the upper and lower corporuses are smoothened with high speed drill or curettes for anterior plating. Anterior plates prevent the pull out of the bone graft and provide it stable in the disc space until the fusion process. There are many different sized and shaped anterior cervical plates in the marketing. The appropriate sized and shaped plate is located on the anterior surfaces of the prepared corporuses and screwed which are at the

Figure 4a:
The incision of cervical microdiscectomy operation is shown.

Figure 4b, 4c:
Tracheoesophageal complex, prevertebral facia, disc annulus, vertebra corpus and longus colli muscles are shown (the microscope photo and drawing).
upper and lower of the disc space under biplanar fluoroscopy (Figure 4e).

4.c.2. Cage:
The upper and lower cartilage endplates are curetted or drilled after simple discectomy and corpuses of upper and lower vertebrae are exposed. Posterior and Lushka joint based osteofites are excised with curettes and high speed drills. After these processes, the appropriate cave is prepared at the upper and lower surfaces of the disc space for the cage. The size of disc space is measured and appropriate cage is experienced for the disc space. The cavity inside the cage is filled with mixture of bone graft and bone marrow. The cage is located into the disc space and controlled with biplanar fluoroscopy.

Recently, we use knifed-PEEK cages which can provide the stability with its knives is sticked after 90° switching to the upper and lower vertebrae corpuses (Figure 4f).

4.c.3. Prosthesis:
The cartilage endplates and osteofites are curetted or drilled after simple discectomy. The upper and lower surfaces of the disc space are prepared for prosthesis. There are a few kind of disc prosthesis in the marketing and all of them have own hand tolls and different preparing instructions. Although, they are different marks, their base functions have similarity.

At first, the size of disc prosthesis is measured according to the size of disc space. And then, the cavity of disc prosthesis is prepared with appropriate tools of prosthesis set. During these processes, the simetry of the surgical area is controlled with biplanar fluoroscopy and microscope.

As a general rule for disc prosthesis, the two parts marked disc prosthesis are combined as one part marked disc prosthesis during performing the apparatus. And then, the disc prosthesis is inserted to the disc space under the control of biplanar fluoroscopy. We used PCM cervical disc prosthesis for our chapter (Figure 4g).

Conclusion:
The platysma layer, subcutaneous tissues and skin are stitched after the homeostasis of the surgical area. It is known that subsidence can occur even placed bone greft after cage and prosthesis. If it is placed vertebral margin subsidence can occur little on the other hand can protect the alignment.
5. Postoperative Care:
A soft collar can be applied to the patient during wake up time at the operating table and continued for 4 weeks, if a fusion material is implanted. A muscle relaxant and non-steroidal anti-inflammatory drugs are given systematically. The patients are allowed to mobilize in the same day and discharged the day after surgery. The patient may return his job in 2 weeks after surgery.

6. Complications and Avoidance:
It is known that familiar with surgical anatomy of the neck, careful patient selection, preoperative planning of the surgery will facilitate the surgery and prevent the complications. Using prophylactic antibiotics and care on sterility will decrease the infections.

Due to the anatomy of the neck, carotid artery, jugular vein, vertebral artery, superior and inferior thyroidal arteries has potential of injury. The identification of carotid sheath and feel under the fingers of surgeon will avoid the surgeon from a possible injury. Avoidance from the prolonged retraction of carotid artery will also prevent the possible embolic complications depends from the carotid artery. Careful dissections of muscles and respect to the anatomy of the neck will avoid the surgeon from the injury of superior and inferior thyroidal arteries. To care on the uncinate
processes and behave as a lateral borderline of microdiscectomy operation may prevent the vertebral artery injuries and sympathetic nerve injuries and also Horner’s syndrome.

The careful surgical technique and respect to the surgical anatomy will prevent the spinal cord and neural root injuries beside possible hypoglossal, spinal accessory, phrenic, auricular and cutaneous nerves. Gentle retraction of the thyroid gland, esophagus and trachea will prevent the injury and postoperative dysphasia and airway obstructions due to edema. Dural tears and cerebrospinal fluid leakage are also the possible complications of ACMF.

The failure of plate, bone graft, cages, and disc prosthesis can occur in the following processes after operation.

7. Case Illustrations:

Case 1:
A 35 year old man admitted to the physical therapy and rehabilitation clinic with complaints of severe neck and upper right extremity pain for 1 month. The neuroradiological images of the patient revealed C6-7 disc herniation (Figure 5a, 5b, 5c). Medical treatment and physical therapy was suggested to the patient. The patient admitted to the neurosurgery clinic because of the increasing of the complaints. The neurological examination revealed motor force regression at the right hand and numbness at the fifth finger. C6-7 microdiscectomy was performed to the patient and cervical disc prosthesis insertion was added to the operation (Figure 5e, 5f).
**Case 2:**
A 25 year old man had admitted to the neurosurgery clinic with complaints of neck and right upper extremity pain. His upper extremity pain had improved after operation. However, the neck pain worsened although additional physical therapy and medical managements.

He readmitted to the neurosurgery clinic three months after the first operation. The radiological images revealed pseudoarthrosis and segmental instability at the C4-5 level (Figure 6a, 6b, 6c). C4-5 microdiscectomy was performed to the patient and bone graft and anterior plating was added. The patient was uneventful after operation and fusion was detected at the post operative plain graphies (Figure 6d, 6e, 6f).

**Case 3:**
A 35 year old woman admitted to the neurosurgery clinic with complaints of neck, numbness and prickles in both hands. The radiological images revealed c5-6 disc herniation (Figure 7a, 7b). The operation was planned after medical and physical therapy managements. The cervical cage was inserted to the patient after anterior cervical microdiscectomy and discharged at the second day (Figure 7c, 7d).
8. References: