Cervical Myelopathy

- Pathology -

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Description :

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L'encyclopédie neurochirurgicale

DEFINITION

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HISTORY

- 1823 : Charles Prosper Ollivier d'Angers in "From the spinal cord and its diseases" suggests a link between a protruding intervertebral disc and the myelopathy.
- 1888 : Strumpell and Pierre-Marie (1898) studying the "spinal cord lesions from chronic cervical osteoarthritis" reported the the relationship between spondylosis and paraplegia.
- 1892 : Victor Horsely did a cervical laminectomy for a patient with cervical spondylotic myelopathy in TaylorJ, CollierJ. The occurrence of lesions in optic neuritis of the spinal cord-Injury, tumor, myelitis. (An account of twelve cases and one autopsy). Brain1901; 24:532.
- 1928 : JA Barré YC Liu and specified the role of cervical spondylosis in the genesis of certain myelopathies.
- 1952 : W. R. Brain, D. Northfield and Mr Wilkinsonin The neurological manifestation of cervical spondylosis. Brain (1952) 75 (2): 187-225 published the first work on the neurological manifestations of cervical spondylosis.
- 1955 : Robinson RA, Smith GW. Anterolateral cervical disc removal and interbody fusion for cervical disk syndrom. Bull Johns Hopkins Hosp 1955; 96: 223 (Abstract)
- 1956 : Wolf B, Khilnani M, Malis L. Emphasized on the importance of narrowing of the cervical canal in the genesis of cord complications in The sagittal diameter of the bony cervical spinal canal and its significance in cervical spondylosis. J. Mount Sinai Hosp 1956; 23:283 -292.

EPIDEMIOLOGY

Cervical spondylotic myelopathy represents 55% of cervical myelopathies in adults (7). The condition is observed mostly after the age of 50 years, with men more affected than women. Its incidence increases with age and it is a leading cause of functional disability in the elderly (25).
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NATURAL HISTORY

The natural history of cervical myelopathies is not well understood.
The natural history of cervical spondylotic myelopathy. Matz PG, Anderson PA, Holly LT, Groff MW, Heary RF, Kaiser MG, Mummaneni PV, Ryken TC, Choudhri TF, Vresilovic EJ, Resnick DK. J Neurosurg Spine. 2009; 11 (2) :104-11.

ETIOLOGIES

1. Constitutional Stenoses

Pure constitutional stenosis rarely is a cause of cervical myelopathy except in extreme cases of severe stenosis as in achondroplasia.It is more often a predisposing factor.

2. Cervical Spondylosis

Spinal degenerative diseases start as early as the age of 20 years and constitute the main etiology of cervical myelopathy(25).They seem to be favored by the load on the spine in certain professions, previous trauma (rugby players) and occur earlier and more frequently in patients with abnormal movements (spasmodic torticollis disease, Tourette's, choreoathetosis ...). Decompensation of congenital cervical blocks leads to early onset of degeneration from adjacent segment "overload".
The initial lesions start in the disc and correspond to a reduction of the water content of the nucleus pulposus (nuclear desiccation), an increase of collagen, and a decrease in the mucopolysaccharides and chondroitin sulfate content. Anatomically, there are annular fissures which engage in displaced fragments of the nucleus. There is a loss of disc height (narrowing of the disc space). These anatomical changes alter the mechanical properties of the disc and are responsible for its degeneration (26, 76).

The degenerative cascade successively involves the disc ("soft" herniated disc, degenerative disc disease, herniated calcified "hard disc"), unco-vertebral joints (uncarthrosis), the facet joints (zygapophysial or facet joint osteoarthritis). The ligaments (posterior longitudinal ligament, ligamentum flavum) hypertrophy, lose their mechanical properties, thicken and calcify. All these lesions aggravated by osteophytic reaction reduce the size of the cervical spinal canal and are much more pathogenic than the constitutional narrow canal.

The lesions may sometimes be limited to one or two adjacent segments, at the most mobile segments of the lower cervical spine (C5/C6 and C6/C7), but sometimes extend through the whole sub-axial cervical spine (C3-C7).
Degenerative lesions can also be the source of static spinal disorders (loss of physiological lordosis, sometimes kyphosis or rarely degenerative scoliosis), being initiated by the loss of disc height, chronic instability or degenerative spondylolisthesis secondary to a change in the orientation of the joint surfaces. During flexion-extension movements, the ligaments that have lost their elasticity can jut into the lumen of the spinal canal, contributing to the compromise of the spinal cord (76).

3. Ossification of the posterior longitudinal ligament(OPLL)

OPLL is a disease found mainly in the Far East and could correspond to a specific anatomic type of degenerative cervical spine lesion in Asian populations, suggesting a hypothetical genetic predisposition, corroborated by the increased prevalence in certain families and in identical twins (3).

Significant lesions of the posterior longitudinal ligament are observed in 11% of patients in the sixth decade in the Far East. The disease has an incidence of 1.4%. Few cases have been observed in Caucasian populations in Europe and the United States. The frequency of this disease seems to be underestimated.

Ossification usually starts behind the body of C5 and progressively spreads through the entire cervical spine in contrast to segmental (or localized) forms, discontinuous or continuous forms.

In the Japanese population, obesity and glucose intolerance significantly favors the ossification of the anterior and posterior longitudinal ligament (78).
The clinical course is unpredictable: 80% of patients followed-up over a period of greater than 10 years remain asymptomatic despite the presence of significant anatomical lesions, 20% will develop neurologic deficit and are candidates for surgical treatment (52).

The pathogenesis of OPLL remains uncertain: osteogenesis ensues from hypertrophied and hypervascular ligament when it "detaches" from the posterior surface of the vertebra by disc protrusions.

4. Late posttraumatic forms

They should be differentiated from forms revealed during trauma, and related to unrecognized or poorly treated lesions: non-union causing chronic instability, mal-union reducing the diameter of the cervical spinal canal, post-traumatic discopathies usually localized to one injured segment.

5. Other etiologies

Cervical rheumatoid arthritis affecting especially the upper cervical spine (atlanto-axial dislocation) and to a lesser extent the lower cervical spine may present with the clinical picture of cervical myelopathy (59). We can regroup rare neurologic complications which can cause narrowing of the cervical canal such ankylosing spondylitis, gouty tophi from the posterior joints and vertebral ankylosing hyperostosis (Forestier's disease) or Paget's disease. Myelopathies have been observed in patients on long-term dialysis due to epidural calcification (85).
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PATHOPHYSIOLOGICAL PRINCIPLES OF THE PATHOLOGICAL PROCESS

1 Mechanical compression.

A reduction in the dimensions of the cervical canal, especially in the sagittal plane, is found in all cases. It is the main cause of cervical myelopathy. It is mainly related to the development of the anterior osteophytes and/or hypertrophy of the ligamentum flavum, on which the degenerative hypertrophy of the articular processes (facets), the posterior longitudinal ligament and the laminae can be superimposed (76).

Delayed myelopathy due chronic cord compression has been demonstrated in the dog (32) and in rats (42). A decreased neuronal density of 20% is observed as from the 9th week and more than 35% beyond the 25th week, whereas no significant lesion is observed before the 3rd week. Below the site of the compression there is axonal loss. The phenomena of cavitations of the gray matter appear as soon as there is a significant neuronal loss whereas the white matter is left unaffected for long.

2 Micro-traumas

Each hour the cephalic end (head) makes hundreds of movements involving rotation and flexion- extension in varying proportions. It has been shown that with maximum flexion of the neck, the posterior wall of the spinal canal lengthens by 5cm and the anterior wall by 1.5 cm therefore stretching the dura and the cord. During movements of flexion-extension there is a decrease in the dimensions of the spinal canal aggravated during extension by the bulging of the yellow ligament. During each movement micro-traumas occur when compressive elements come in contact. The evolution of the myelopathy correlates with the number of these movements: these movements can be limited cervical immobilization.

Degenerative lesions of the disco-ligamentous apparatus leads to chronic instability responsible for a sub-luxation seen on dynamic images, additionally imposing more shearing movements on the cord (24).

3. Vascular phenomena

Venous stasis stemming from canal stenosis appears to have an important pathophysiologic role in cervical myelopathy by causing chronic ischemia and cord edema.

A couple of years ago, through the initiative of Aboulker (1), it was proposed to systematically investigate for a superior azygos system pathology in which drains the cervical epidural veins. It is by this mechanism that neurological signs of dural arteriovenous fistulas are explained.

The role of arteries seems more modest due to the richness of the anastomotic system at the cervical level, but it is not an impossibility to consider a compression of radiculomedullary arteries of the cord, the anterior spinal arteries or even the vertebral arteries, by keeping in mind that the age for osteoarthritis is corresponds to that of atherosclerotic plaque (92). The anatomical lesions discerned during the autopsies of patients with cervical myelopathy suggest an ischemic mechanism (62).
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DIAGNOSIS

I- CLINICAL FEATURES

The clinical features result from the direct compression of the nerve roots and/or the spinal cord, alteration in the arterial flow, venous congestion and inflammation. Certain genetic elements can influence the resistance of the neural structures (33).

1. Mode of onset

The affection is two times more common in males than in females and begins between the ages of 50 and 60 years (25). Before 50 years, it is more often a discogenic canal stenosis from a "soft" central disc. Neurological impairment

is often preceded for several months or years by mechanical cervical pain (50 to 80% of cases) which is poorly systematized, episodes of torticollis or even true cervico-brachial neuralgia .
This often occurs in a context of repetitive microtraumas, occupational or sports related spinal "overload" and more rarely cervical spine injury without obvious radiological lesion, labelled "cervical sprain", which can only be discerned through dynamic images. However, it is possible that such a trauma causes discs and/or ligamentous injuries leading to degenerative lesions (14). The more common scenario is that of mundane mechanical pain from cervical spondylosis.

Gait disturbances are usually early in the form fatigability, tendency to the fall, reduction in the walking distance that can correspond to a true intermittent neurological claudication and sometimes episodes of flinching movements of the lower limbs. Gait disturbances may also be related with difficulties of coordination (ataxia sensory), disorders of balance, a poor perception of the ground, or even pain or paresthesia that occur for increasingly shorter distances.

In practice these disorders are fairly easy to differentiate from gait apraxia (astasia abasia) observed in adults chronic hydrocephalus, and from intermittent claudication due to lumbar canal stenosis while bearing in mind that these pathologies frequent in this age group may be associated.

Upper limbs affection can be another mode of presentation of the disease. Most frequently presents with pain or paresthesia more or less systematized in a radicular territory accompanied by a subjective sensation of clumsiness or functional disability making it increasingly difficult to achieve the delicate(fine) movements. Amyotrophy may be the presenting symptom.

Acute decompensation of a latent form during a relatively minor cervical trauma is a common mode of revelation: the clinical picture is that of a central cord contussion (Schneider's syndrome) with incomplete tetraplegia where the motor impairment is disproportionately greater in upper compared to lower extremities and maximally brachial diplegia (72).

2. Neurological examination findings

Neurological signs vary from one patient to another and occur in different proportions in the upper limbs, lower limbs and to a lesser degree the sphincters (63).

2a- Upper limbs affection

Because of their pathophysiologic mechanism there is still no good correlation between the topography of segmental neurological signs and the site of the anatomical lesions.
Subjective sensory manifestations (Symptoms) are almost always present as paresthesia or mechanical pain triggered by straining or neck movements, or as nocturnal neuropathic pain. The symptoms are unilateral or bilateral and often asymmetrical without an accurate radicular pattern. More rarely, it presents by a typical picture of cervico-brachial neuralgia that can be revealed during history taking a few years earlier.

Radicular pain of mechanical origin, secondary to degenerative changes, can be provoked during the clinical examination by eliciting Spurling's sign (radicular pain reproduced when the examiner exerts down-ward pressure on vertex with the neck in extension while tilting head towards symptomatic side) and the abduction relief sign (reduction or disappearance of the radicular pain when the patient abducts the arm by putting his hand on his head) (21).

Objective sensory manifestations (Signs) can be demonstrated by the examination of the painful region. They lack an accurate radicular topography and are often in the form of hypoesthesia of all sensory modalities. The disturbances may be prominent on the lemniscal pathway explaining the clumsiness to achieve fine movements: holding pencil, sewing, manipulating small objects .

A segmental motor affection may be due to a lesion of the nerve root or of the anterior horn cell; the latter sometimes simulate starting amyotrophic lateral sclerosis. The affection is usually distal in the hand muscles accompanied by muscle atrophy and rarely fibrillations localized in the upper limbs.

The abolition of one or more reflexes is frequently observed but their exaggeration can be found in the high cord affection. Clinical examination may reveal a Hoffmann's sign in upper limbs in cases of involvement the pyramid tract.

The functional impairment felt by the patient stems from both an affection of the sensation and diminished motor power.

2b-Lower limbs Affection

It is responsible for abnormal gait, impaired balance, functional impotence and tendencies to the fall.

Pyramidal involvement is rarely responsible for a significant motor deficit. There is often spastic paraparesis with hypertonia of the extensors, an exaggeration of deep tendon reflexes and a bilateral positive Babinski sign. The affection can be discrete at the beginning and objectified only after fatigue and after classical facilitation maneuver. It can be masked when associated with lumbar canal stenosis or peripheral neuropathy.
Involvement of the posterior column is responsible for subjective manifestations such as paresthesia, numbness and pain sometimes spontaneous or provoked by neck flexion (Lhermitte's sign). Posterior column lesion is objectivated by the decrease in vibration sensation, impairment of arthrokinesthesia and sometimes presence of Romberg's sign.

Involvement of the spinothalamic tact is rarer and late and results in a thermal hypoesthesia and hypalgesia.

The gait disturbance presented by the patient are more related to hypertonia and sensory ataxia than to the motor deficit.

2c-Sphincter dysfunction

Present in 30-40% of the cases and are often underestimated. They are in the form of dysuria, urinary frequency and sometimes stress incontinence. They are not always related to their cause (suggestive of prostatism or age-related incontinence in women) and should be systematically investigated by measuring the post-void residual via an ultrasound of the bladder.

3. Clinical forms

The condition is in fact very polymorphic; depending on the topography of symptoms, their severity and evolution. It is therefore possible to individualize several clinical forms:

3a-Ataxic-Spastic Form : It is the most frequent form predominantly manifesting by gait disturbances and dysequilibrium with sub-clinically affection of the upper limbs. All lesions causing cord affection can be evoked faced with this form notably "slow" cord compression in which there is no sensory level and the sensory manifestations are discrete, and multiple sclerosis (in which the signs are not diffused).

3b-Amyotrophic form predominantly affecting the upper limbs can at the beginning simulate amyotrophic lateral sclerosis but the course is much more rapid and disabling.

3c-Spastic paraparetic forms-with minimal sensory lesion,

3d-Brown Sequard-like forms-occur when there is predominantly unilateral cord lesion.

3e- Forms evolving by successive spurts are suggestive of late onset multiple sclerosis.

Nurick's classification established in 1972 (61) evaluates in a simple and reproducible manner the functional disability of patients, monitoring of their progress and evaluates the results of treatment, but is relatively imprecise (Table 1).

The classification of the Japanese Orthopaedic Association (JOA) (38) which is imposed on most English speaking authors after modification (6) is the sum of functional scores. The maximum score is 17 for patients without any neurological disease (Table 2).

4-Evolution

There is no spontaneous improvement. The course is unpredictable with progressive neurological deterioration occurring most often (33). However, long periods of dormancy can be observed (53). In about 75% of the cases, the evolution occurs in a discontinuous mode by successive bouts over several years. In 20% of the cases the evolution is more or less rapidly progressive and in 5% of the cases, there is a sudden decompensation often caused by cervical trauma of varying severity. This decompensation is rare in patients below 75 years with moderate cervical myelopathy (JOA score> 12) (53).

In the case of degenerative cervical stenosis without myelopathy, the presence of electromyographic abnormalities or clinical radiculopathy predicts progression to symptomatic cervical myelopathy (53).

The end stage is represented by a complete inability to ambulate and / or severe functional impairment of the upper limb producing severe disability.
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II-Imaging

1 - Plain Radiography

Plain radiographs are still relevant despite the development of modern imaging techniques (Figures 1, 2, 3).
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These should include the following views: Antero-posterior (AP), lateral, ¾ obliques and especially lateral dynamic films that cannot be easily obtained with CT and / or MRI.

Plain radiographs enable an overall assessment of the dimensions of the spinal canal and detect the existence of a constitutional canal stenosis-a predisposing factor for cervical myelopathy (49):

- The antero-posterior diameter of the spinal canal measured from the middle of the posterior vertebral body to the nearest point of the spinous process is equal to or less than the antero-posterior diameter of the vertebral body: Pavlov index (64).
- The presence of platyspondyly with widening of antero-posterior diameter of the vertebral body
- The articular processes are projected on the posterior part of the vertebral body.

They show the characteristic lesions of cervical spondylosis predominantly at the C5/C6, C6/C7 and C4/C5 disc levels, and specify the number of levels involved. The following are shown:

- Hypertrophy of the articular processes (facets)
- Osteophytes (bone spurs) of the posterior joints, endplates and unco-vertebral joints
- Pinching of the intervertebral disc
- Ligamentous ossification.

Disorders of shape of the spine (static deformities) are objectified: loss of physiological lordosis, inversion of curvature, degenerative spondylolisthesis and instability on dynamic films most often in flexion. Pathologies such a sequelae of cervical spine injury or predisposing factors such as congenital cervical fusion may be associated.
Of old, it was classical to measure the dimensions of the spinal canal on these images correcting for radiological magnifications but this has lost its relevance today as these measurements are performed on the CT scan.

2-CT Scan

The CT scan is the reference examination to study the spinal canal; its accuracy in this disease is evaluated in some studies to be between 70 and 90% (23). Acquisition is done in contiguous fine cuts or continuous spiral cuts after intravenous injection of contrast medium. We consider horizontal cuts, sagittal and coronal reconstructed bone window images as well as "soft tissue" images. The dimensions of the spinal canal whose mean values have been established for years (14) are measured. (Table 3)
Canal stenosis or narrowing is considered when the antero-posterior diameter at the site of maximum lesions (C5/C6 or C6/C7) is less than 12 mm.

All radiological signs observed on standard radiographs are objectivated with more details on the CT Scan (Fig. 4, 5, 6):
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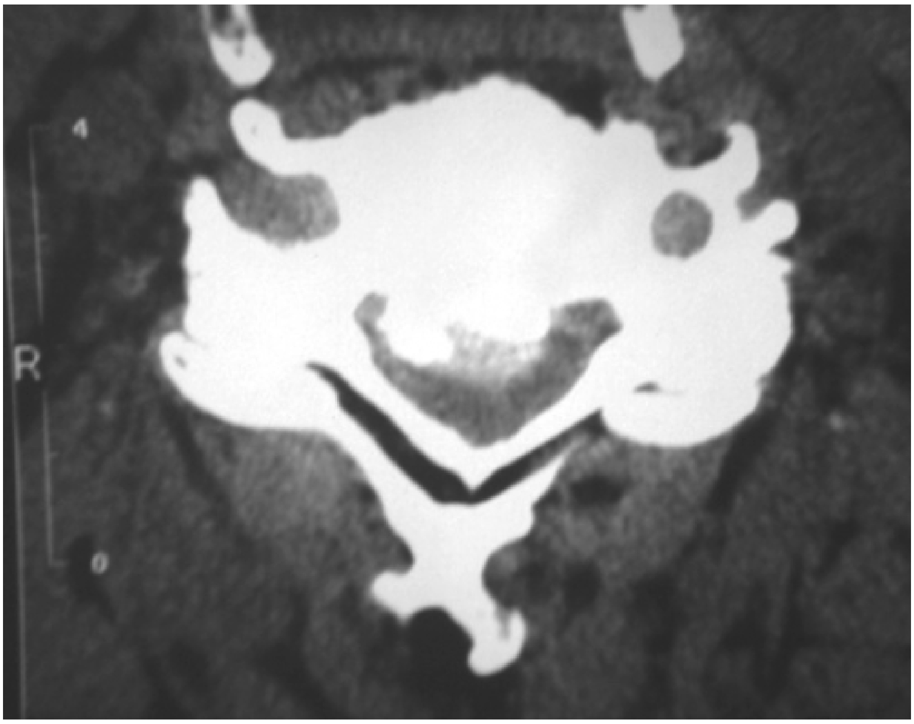
<a href="IMG/png/myelo-fig5.png" type="image/png" title="">



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- On horizontal cuts: discopathies ("soft" or calcified), joint hypertrophy, facet joint osteoarthritis and ligamentous calcifications,
- On reconstructed images: the static spinal disorders (deformities) and degenerative spondylolisthesis. CT enables a better appreciation of the components of the canal stenosis than conventional radiology:
- Constitutional canal stenosis
- Lesions related to the cervical spondylosis
- "Soft" herniated disc
- Synovial cysts and associated pathology. The ossification of the posterior longitudinal ligament is easily demonstrated at the posterior vertebral body from which it is most often separate. Dynamic films are difficult to do, but cuts can be achieved in extension or flexion by inserting pillows below the shoulders or under the head. The CT Scan amongst others allows us to contrast between central cervical canal stenosis associated with a predominant central cord symptomatology ("sub lesional") and lateral stenosis associated with a predominance of radicular semiology ("lesional") in the upper limbs.

3 - MRI

MRI is the paraclinical test of choice (2, 5). It enables the assessment of soft tissues and the repercussion of canal stenosis on the cord. Compared to intraoperative findings, the accuracy of MRI in the evaluation of lesions has been estimated at approximately 90% (10).
The MRI should include T1 and T2, sagittal, coronal and axial sequences. The injection of a paramagnetic substance (gadolinium) is usually not necessary (Figures 7, 8, 9, 10).
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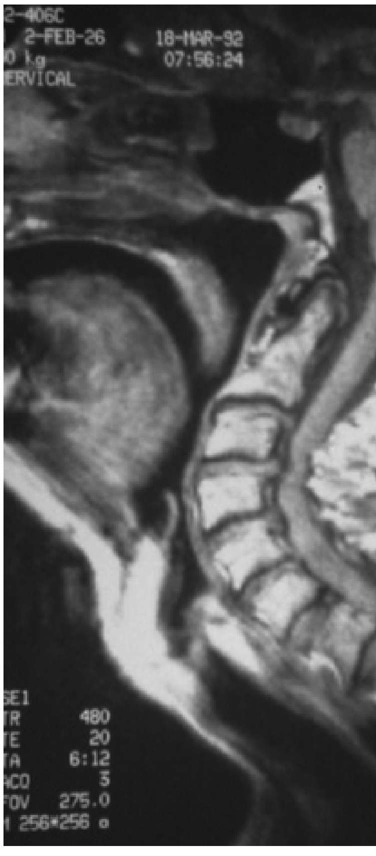

Like the CT scan, it is possible to carry out measurements of the spinal canal. MRI precises on the extent of stenosis contrasting segmental stenosis limited to one or two levels from extensive stenosis as well as the site of maximum anterior or posterior mechanical stress. It influences the decision as regards the choice of surgical technique. It may underestimate the ossified lesions.

Instability observed on plain films, can possibly be reproduced by performing sequences in positions where instability was observed.

The frequency of degenerative changes according to level varies thus: C2/C3: 25%, C3/C4: 14%, C4/C5: 25%, C5/C6: 56%, C6/C7: 44% (14).

T1 sequences give a better appreciation of the cord morphology that most often appears distorted and atrophic opposite disco-osteophytic projections or hypertrophied ligamentum flavum. The subarachnoid spaces appearing hypointense are difficult to analyze because can be confused for ligamentous structures which are also the same hypointensity. Disc and ligamentous calcification and osteophytes can cause an exaggeration of hypointense artefacts. The ossification of the posterior longitudinal ligament appears as hypointensity of varying thickness and widespread on the posterior surface of the vertebral body in front of the spinal cord.

T2 weighted images are the most useful sequences to study CSF which appears hyperintense. It is common to observe a thinning or effacement of the anterior or posterior subarachnoid spaces and a central cord hyperintensity at the site of maximum compression within adjacent segments. The significance of this hyperintensity is poorly understood. It is probably a cord edema related to repeated microtraumas. For some, it is not correlated with the severity of neurological lesion. With no prognostic significance, the cord signal may disappear after surgery (66).This is in contrast to what is observed in severe acute spinal cord injury where the hyperintense evolves either to a gliosis hypointense on T1 or syringomyelia. However, other studies are in favor of a relationship between the T2 signal abnormality and postoperative functional outcome (47). The hypointense on T1 in the spinal cord, which can also be observed in cervical myelopathy is usually not reversible after surgery and is associated with a poorer functional outcome (50).

In some cases, the central cord hyperintensity demonstrated by MRI has a characteristic "Snake-eye" appearance (two small areas of hyperintensity in the gray matter). This corresponds to a cystic necrosis secondary to mechanical compression and venous engorgement. The destruction of the gray matter in the anterior horn accounts for the resultant slower recovery of motor function in the upper limbs (56).

In the preoperative evaluation, information provided by the T2 sequences are sufficient to make the diagnosis and allows for non-consequential omission of T1 sequences (69).

4 - Myelography and CT myelography

Myelography and CT myelography are indicated only when MRI is impossible to do or is contra-indicated. These studies can be complementary to the latter (75). They objectify the diameter of the spinal canal, anterior and posterior compressive elements whose topography can be median or paramedian (Figures 12, 13).
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Compression may be severe to cause an interruption of the opaque column at the site of maximum stenosis. Horizontal (axial) cuts enable the assessment of the dimensions of the cord which may appear atrophic and deformed: concave anterior surface, an anterior open "V-shape" deformation, and posterior displacement by bony spurs that may appear to be embedded in the spinal cord. Late films may opacify an intramedullary pseudosyringomyelic cavitation.

Myelography can realize dynamic images. The projections from discopathies are increased during flexion and those of the ligamentum flavum in extension. In case of instability it helps to objectify the aggravation of spondylolisthesis during flexion and its repercussion on the diameter of the spinal canal.
In some studies, the rate of accuracy of myelography in the diagnosis of cervical cord and root compression is greater than 80% (83).

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III-FUNCTIONAL STUDIES

1 - Electromyogram (EMG)

EMG studies show signs of peripheral neuropathic lesions in the upper limbs, but do not specify the etiology. They are more likely to reveal radiculopathy than "anterior horn" lesion of relatively diffused topography.
Electro-physiological disturbances involve several roots and / or segments and are often more extensive than suggested by clinical examination. It can sometimes reveal sub-clinical fibrillation. EMG is useful for differential diagnosis with amyotrophic lateral sclerosis. It may be normal in cases of moderate or purely sensory radiculopathy. The probability of observing an EMG anomaly in the absence of clinical motor impairment is extremely low (58).

This study is not justified in cases of well defined radiculopathy with good clinical and radiological correlation.

2 - Evoked Potentials

Somatosensory evoked potentials (SEPs) of the lower limbs are disturbed in all patients with cervical myelopathy and inconsistent in the upper limbs. This perturbation is not specific and does not usually allow for the specification of the site of the lesion in the spinal cord. They are very useful for differential diagnosis with early ALS.
Pyramidal tract study by the recording of motor evoked potentials (MEP) may reveal subclinical impairment and allows for the specification of the level of lesion depending on the site at which the response is registered: C2/C3 for trapezius, C5 for the deltoid, C6 for biceps, C7 for the radial and C8/T1 for adductor fifth finger.
Evoked potentials are of both diagnostic and prognostic values (48) and should be done more routinely.

Upper limbs MEP are more sensitive in making the diagnosis. Disturbances in the SEP of the median nerve and the posterior tibial nerve are proportional to the severity of the lesion. Normalization of the median nerve SEP is associated with good post-operative prognosis.

In the event of degenerative cervical lesion responsible for structural spinal cord compression but without precise clinical signs, the existence of electromyographic signs of a lesion to the anterior horn, abnormalities of SEP, PEM and symptomatic cervical radiculopathy is correlated with the onset of myelopathy (4, 16).

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TREATMENT

I MEDICAL TREATMENT

Medical treatment in cervical spondylotic myelopathy can only be symptomatic. It can however yield transient improvement in early or slightly advanced forms or when there is a contra-indication for surgery (14). An epidemiological study on cervical radiculopathy showed that 75% of patients improved on conservative treatment and only 25% of the patients were operated upon (65). After a follow up of 6 years , 90% of patients remained relieved. Suggestive factors of poor response to conservative treatment may include advanced age, duration of symptoms, severity of myelopathy and canal stenosis (25).
However, data from the literature regarding the effectiveness of these various measures in the medical therapy of cervical spondylotic myelopathy, and their position relative to surgery in influencing the evolution of the disease is still insufficient (55). Medical treatment may include:

- Class I or II analgesics
- Muscle relaxants to alleviate cervical pain (reactive muscle spasm of paravertebral muscles and trapezius) and radiculalgias.
- Non-steriodal anti-inflammatory drugs which can diminish edema from joint lesions and eventually that of the nerve root sheath.
- Steroids have not proven their efficacy in this indication (55). They can nevertheless be prescribed during exacerbations.
- Tricyclic antidepressants and anticonvulsants, depending on the symptomatology of the patient's pain (neuropathic pain).
- Kinesitherapy therapy focused on the para-vertebral muscles, upper limbs motor deficits and gait abnormalities, combined with physiotherapy.
- Heat therapy do not seem useful in the "global" management of the patient during medical visits.
- Cervical immobilization may be proposed when there is clinical or radiological instability bearing in mind that prolonged immobilization favors joint stiffness and para-vertebral muscle atrophy thus aggravating instability. It can be temporary and should be associated with rehabilitation of neck muscles. Finally, it is not advisable to be engaged in occupations subjecting the spine to repetitive microtraumas and / or severe injuries. ++++

II-SURGICAL TREATMENT

The choice of the surgical technique is guided by the preoperative analysis of clinical and radiological findings, which in tend will determine the approach used. An anterior approach is performed in 85% of the cases by French-speaking European neurosurgeons; a posterior approach is performed in 15% of the cases while the use of a combined anterior-posterior approach is exceptional (12).

1. Anterior Cervical Decompression (see: 71)

Described in the 1950s in the United States by Smith and Robinson (82) and in Europe by Dereymaker Mulier (22), this technique became popular from the 1970s through the work of Cloward (17) and Verbiest (90) to become a routine procedure in most cases. To the extended discectomies proposed by these authors have been added techniques median or anterolateral corpectomy.

The cervical spine is approached through an anterolateral route. The skin incision is horizontal (transverse) in a neck crease (Langer's line) for a one or two level decompression and an oblique incision along the anterior border of the sterno- cleido-mastoid mucle for a more extensive decompression. After opening of the subcutaneous tissue and the platysma, the middle layer of the cervical fascia is incised along the anterior edge of the sterno- cleido-mastoid. The spine is approached in the space between the vascular sheath that is laterally retracted and the visceral sheath (pretracheal sheath) which is retracted medially. Usually, no vessels or muscles are sacrificed however it may sometimes be necessary to bind the superior thyroid artery and / or the omohyoid muscle. For right sided approaches to the lower cervical spine retraction should be moderate as not to cause injury by stretching the recurrent nerve whose course approximates the bisector of the angle formed by the inferior thyroid artery and tracheo-esophageal axis. For this reason, some authors prefer a left sided route where the left recurrent laryngeal nerve is deep and less exposed.

1.1. Discectomy with or without grafting (see: 71)

After radiological confirmation of the level, the anterior longitudinal ligament is incised using a scalpel and the disc is partially excised using curettes and fine rongeurs. At this stage, the operating microscope is introduced. After placing an interbody spreader, removal of the disc is done, leaving the cartilaginous end plates in place. If a sequestrated fragment has been expelled into the extradural space through a breach of the posterior longitudinal ligament, the latter may be partially resected to access the entire fragment expelled.

Resection of osteophytes is done if need arises with appropriate size rongeurs with the help of a diamond drill under visualization with the operating microscope and image intensifier. We can concomitantly perform via the same route an uncusectomy by removing the posterior 5 mm of the uncus. Resection is done from inside to outside with a 5 mm drill and with the aid of micro-curettes. Preservation of the anterior two thirds of the uncus prevents injury to the vertebral artery and postoperative instability.

At this stage of the procedure according to some authors, an intraoperative image guided injection of contrast material can be performed in situ (epidurography) to assess the quality of disco-osteophytic resection and achieve an immediate appropriate correction in case of insufficient decompression (35).

This type of "wide" discectomy can be done in stages, usually one to three. A complementary interbody graft can be used. The latter aims at preventing narrowing of the disc space that can lead to closure of intervertebral foramina as well as an eventual post-operative kyphosis. However, an analysis of the literature shows no significant difference between clinical series with or without grafting (27).

The "best" graft (ie, one that provides the best fusion rate) is the autologous tricortical iliac bone graft but the morbidity associated with graft harvesting (80) often leads to the use of allografts, xenografts or interbody cages filled with bone substitutes (Figure 16). Some authors are accustomed to performing a systematic complementary anterior osteosynthesis combined with interbody graft. This technique seems to provide a better restoration of disc height and lordosis at the operated level, and a higher fusion rate. Here again, comparative studies have failed to demonstrate significant clinical impact for patients treated with interbody graft plus osteosynthesis versus bone graft only (84). In case of instability, which can be observed in cases of very advanced degenerative disease, complementary anterior fixation may be associated with interbody graft.

The practice of French-speaking European neurosurgeons is extremely variable and depends more on habit, personal beliefs, school and tradition than on a significant difference in results (13): about 35% do not insert a graft, 26% bone graft without osteosynthesis, 17% place the graft in a cage to improve the mechanical properties and 15% combine a graft with osteosynthesis.

1.2. Cloward's Technique (see: 17-18)

Once the discectomy and scraping off of the osteophytes is done, the width of the endplate is measured using a depth gauge. A strand of 12 to 18 mm in diameter selected according to the patient's morphology most often 14 or 16 mm-is endowed with an abutment adjusted to the width of the endplate.This enables the drilling of a circular hole with a diameter corresponding to the straddling on the intervertebral space, starting from the adjacent endplates. The drilling of this hole enables the complete and safe removal of the posterior edges of the vertebral endplates seat of osteophytic proliferation. A trephine with a slightly greater diameter permits the trimming of the iliac graft whose outer diameter is equal to the inner diameter of the inter-vertebral hole, thus the graft perfectly fits into the drilled hole. However, and this being the main limitation of this technique, the thickness of the iliac crest, where the graft is taken, is often less than the width of the inter-vertebral space, thus the graft is often "short ".

1.3. Median Corpectomy (see: 73)

The approach is classic until the attainment of the anterior border of the concerned vertebral body (74).

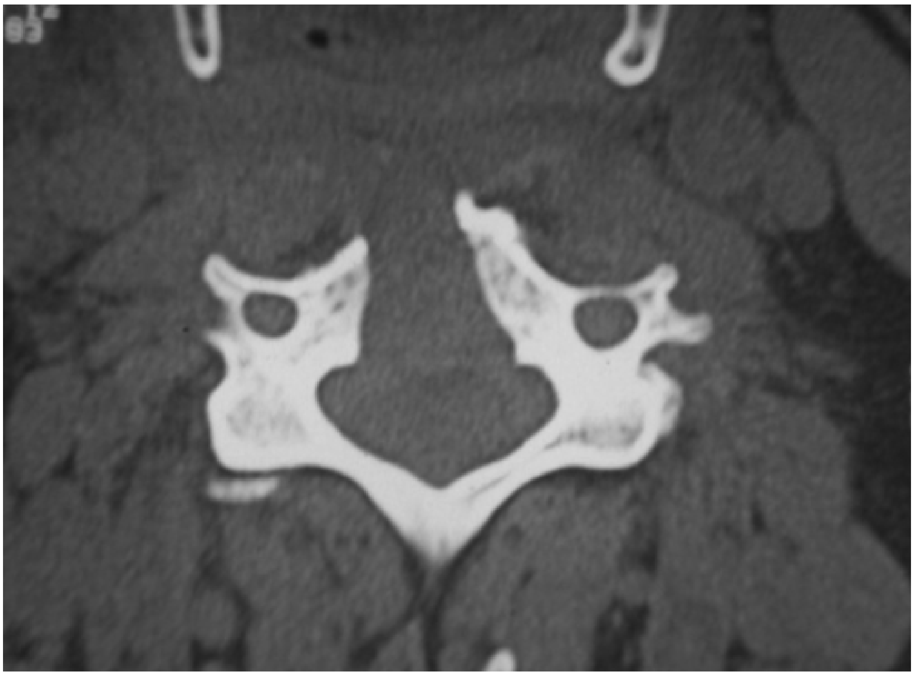
Two techniques are possible: (i) if the discs are still present, the classical interbody approach should be done with resection discs at the end of the area to be decompressed (ii) if the ventral surface of the anterior column has been deformed by osteophytic degenerations which are sometimes asymmetrical, identification of the limits of the cervical furrow is more difficult. In the latter case, the inter-vertebral discs are generally completely collapsed making the trans-discal route impossible. We therefore first of all do a median trans-corporeal approach with a cutting drill, then with a diamond drill until we abut the posterior longitudinal ligament.

Corpectomy is initiated with the gouge forceps and then with a mechanical drill within a width of 10 mm until the posterior cortex is abutted and removed with 1 to 2 mm thick rongeurs. Upon contact with the dura mater, the corpectomy is widened to 12 or 14 mm. To obtain a satisfactory cord decompression, all the disco-osteophytic bars anterior to spinal cord that can cause injury should be resected. Bone resection should also include the endplates of adjacent vertebrae at the extremities of bone trough (gutter). Similarly, the posterior longitudinal ligament should be resected whenever possible but its adherence to the dura may make this procedure difficult.

At the end of the procedure, re-expansion of the dural sheath and the spinal cord appears as much as after a cervical laminectomy. The bone trough has the shape of a dovetail, broader at the rear- abutting the spinal cord-than infront. From either side, the lateral portion of the vertebral bodies-at the uncus is respected (preserved) to maintain spinal stability. The vertical extension of the corpectomy is tailored according to the preoperative radiologic findings, essentially MRI.

For most authors, the bony trough is filled with iliac crest or fibular autograft (possibly associated with osteosynthesis) which prevents the risk of postoperative kyphosis. Just as for discectomy, surgical practices are variable: 18% of Europeans neurosurgeons do not use grafts, 16% use an embedded bone graft without osteosynthesis and 66% use an embedded graft associated with osteosynthesis. Grafting does not seem necessary if precautions are taken to preserve the uncus (uncinate process) and if active rehabilitation of the muscles of the neck is done (88) (Figure 14).

<a href="IMG/png/myelo-fig14.png" type="image/png" title="">



2. Posterior cervical (cord) decompression

These are the oldest performed interventions. The patient is placed in the prone position, head slightly flexed, rarely in lateral decubitus position or sitting position. The lateral decubitus position allows for simultaneous anterior and posterior procedures. The skin incision is marked in the midline and the spine is reached at on the white line (ligamentum nuchae) separating the neck muscles retracted laterally.

2.1. Laminectomy (see: 17)

Laminectomy is the oldest technique performed. Initially, the spinous processes of the vertebrae are cut at their bases at their junction with the laminae. Bone resection brings out "en bloc" all the concerned spinous processes and the interspinous ligament. Laminectomy itself is performed by gradually removal of the laminae using fine bone rongeurs or even a mechanical drill. It is carried as far laterally as possible, even up to the inner part of the joints of which the lateral 2/3 should be preserved to avoid creating instability. The ligamentum flavum are usually fragmented along with the bone resection. This phase should be conducted with great caution given the narrowness of the spinal canal and the disappearance of the posterior epidural space caused by the pathology and worsened by the operative position.

Laminectomy may cause long-term kyphosis. The latter appears to be the result of insufficiency of neck muscles rather than bone and ligament instability induced by surgery (70). It can be prevented by appropriate early rehabilitation. Repeated progression of the disease is sometimes observed after laminectomy and has been attributed to the formation of a compressive epidural fibrosis (post-laminectomy membrane) whose pathogenic role however remains questionable (46).

2.2. Interventions preserving the posterior arch

To prevent postoperative kyphosis (86) and the formation of post-laminectomy membrane alternative technical solutions are possible.

2.2.1. The laminoplasty (see 39, 67)

Proposed as from 1970 by Japanese neurosurgeons, they are more difficult to carry out and do not appear more dangerous. Several technical variants have been described. (i) The "open door" technique is the most frequently performed. It consist of initially creating two paravertebral troughs at the junction of the lamina and facet while preserving the spinous processes and interspinous ligament, with the aid of a drill or a fine rongeurs at the side of the larger lesion over the entire length of the lower cervical spine from C3 to C7 at least to exceed all lesions, including, if necessary C2 and the first two thoracic vertebrae.

In principle, the ligamentum flavum is respected and the instrument does not penetrate into the vertebral canal, thus preventing root or spinal cord injury. On the other hand, on the contralateral side in the corresponding location only the outer cortical bone is drilled creating a trough to allow for "hinge-opening" of the lamina. The whole structure composed of the spinous processes, the interspinous ligament and the lamina is moved backwards by rotation (as if a door is opened "open door laminoplasty"). It is recommended to "open the door" for a distance at least equal to the diameter of the spinal canal, ie at least 12mm. The bony block moved backwards is fixed away from the dura matter by attaching it to the paraspinal muscles or better still by interposition of a spacer (spacer), consisting mainly of hydroxyapatite bone substitute, autograft taken from the spinous processes, in bioabsorbable materials of lactic acid polymer filled with cancellous bone or allograft. If the yellow ligament is not adherent to the laminae and stays in place, it should be resected secondarily (91).

(ii) The "double door" technique consists of opening the cervical canal in the midline. By the means of a high speed mechanical drill the spinous processes and the laminae are divided in the mid line to their point of contact with the ligamentum flavum, and the thinning of the lamina to their insertion at the facet joints. The opening of the vertebral canal is performed by introducing a spacer between each half of the spinous process, as in opening the portal of a double door. It is recommended to introduce spacers of bone substitute between the two halves of the spinous to keep them apart.

2.2.2. Laminectomy with preservation the spinous processes

Described by C. Large (31) in the lumbar spine, it is a unilateral para-vertebral route where the spinous processes are cut at their base via a trough at the junction between the spinous process and the lamina. The tissue bulk consisting of the spinous processes and the interspinous ligament is retracted beyond the midline exposing the laminae. Laminectomy is then conducted in a conventional manner. During closure of muscles, the interspinous ligament and spinous process fit back into their natural position on the midline.

2.2.3. Skip laminectomy ("Alternate" Laminectomy) (see 79, 81)

It concerns only alternate laminae: for example to achieve decompression from C3 to C7, only the laminae of C4 and C6 are resected and decompression is performed by resection of the ventral surface of adjacent laminae left in place. In addition, the interspinous ligament is preserved: the laminae to be resected are targeted by sectioning of the spinous process in the midline using a high speed drill and each portion of the spinous process is retracted laterally to preserve the insertion of the supraspinatus muscle.

2.3. Posterior osteosynthesis

Due to the risk of kyphosis, some authors have proposed the routine performance of a complementary posterior osteosynthesis. This seems to be reserved for rare cases where surgical decompression requires resection of the facets and there is preoperative instability. The best technique is that of screw osteosynthesis of the facet associated with a posterolateral graft.

3. Combined Interventions (see 44)

In case of severe stenosis, a double approach simultaneously or in two successive staged operations can be performed. In this case, the risk of postoperative instability is relatively high, and decompressive surgery must be accompanied by grafting and anterior osteosynthesis with screwed plates into vertebral bodies.

4 -Lateral spinal decompression

Described by George (15), this approach may become an alternative to standards anterior approaches.According to its author, this lateral approach could be indicated where anterior compression is predominant and the spine is straight or kyphotic without instability and without bilateral radiculopathy.

With this approach, after a direct control of the vertebral artery, the lateral portion of the intervertebral discs, vertebral bodies, the posterior longitudinal ligament and ipsilateral unco-vertebral joint can be resected if necessary depending on the extent of the lesions.

The advantages of this technique are wide exposure, the lack of need for graft and / or osteosynthesis, no contra-indication in case of kyphosis without instability and the the possibility of reoperation after a prior standard anterior cervical approach.

5 - Indications

Early and simple forms in the elderly (JOA Score> 12) may justify trial of medical treatment with regular clinical follow-up (54).

Surgical treatment should not be delayed in young patients and when faced with any progressive form. It has been shown that the length of symptoms has more influences on the outcome than age, severity of illness, number of levels operated and/or pre-operative functional score (40).

Imaging allows for the assessment of the lesions:

- Anteroposterior and transverse diameter of the spinal canal,
- Overall appearance or segmental nature of the stenosis,
- Number of levels affected
- Predominant site of the compression: anterior or posterior
- Medial or lateral compression,
- Potential instability associated with stenosis assessed on dynamic films taken with caution
- State of the spinal cord: atrophic, intramedullary hyperintensity (cord signal). Evoked potentials (somatosensory and motor) (48, 60, 68) could possibly help in the choice of surgical approach in case of difficulty in identifying the responsible clinical and radiological elements causing the compression: anterior or posterior. The approach, anterior, posterior or combined, the extent of decompression and the indication for additional osteosynthesis will be chosen based on the results of these tests (93) bearing in mind that the anterior approach is preferred in terms of its simplicity and efficiency.

5-1 Indications of anterior approaches

The best indications for the anterior approach when there is myelopathy or myeloradiculopathy are represented by: (i) the presence of clinical signs predominantly in the upper limbs, from root lesion (myelo-radiculopathy) or central cord syndrome (brachial diparesis); (ii) the predominance of anterior compression elements (discs, osteophytes) over posterior factors (laminae, ligaments, facets), (iii) the existence of a preoperative cervical kyphosis.

5-1-1 Indications of discectomy:

Simple discectomy at one, two or three levels can be used if the lesions are limited to the disc levels responsible for segmental stenosis with the compressive elements close to the midline. Similarly, the anterior approach can be used as a complement to a posterior route if there is a persistence of anterior compression or as treatment for an evolving post-laminectomy kyphosis. The use of complementary interbody graft is more a matter linked to the schools of thought than the quality of long-term clinico-radiologic results (27). In general, the graft diminishes the severity of post-operative neck pain and frequency of late kyphosis, without being able to remove them completely. Complementary osteosynthesis is only exceptionally indicated in patients with preoperative instability; correctly performed isolated discectomy does not destabilize the spine.

5-1-2 Indications for median corpectomy

In affections involving three levels and / or in case of associated global stenosis a corpectomy can be discussed instead of the preferred laminectomy by some because in 75% of the cases the compression factors are anterior.

Additional graft is not necessary if the bony trough respects the uncinate processes (88). Reconstruction with bone graft and an eventual osteosynthesis is necessary when instability is certain (resection of one of the lateral columns) or when there is a tendency for instability, especially when associated with laminectomy. The grafts are generally autograft from the iliac crest, and sometimes from the tibia, allografts from graft bank, rarely xenograft or bone substitutes. Rare cases of instability with formation of kyphosis have been observed after simple corpectomy without grafting. It is therefore necessary to respect a rigorous technique and no hesitation to perform complementary grafting if in doubt of future stability.

5-2 Indications for posterior approaches

These approaches are preferred to anterior approaches when: (i) Clinically, patients show isolated or predominant signs of myelopathy, with a preponderance of posterior column affection over pyramidal signs (ii) anatomically, patients have extensive constitutional stenosis (rare situation) and / or predominantly posterior lesions: hypertrophic laminae, yellow ligament hypertrophy, hypertrophy of the facets.

"Standard" laminectomy is the easiest procedure to perform. The laminoplasty is preferred by Japanese and North American authors. The procedure is longer, more difficult and its superiority in terms of performance compared to standard laminectomy has not been demonstrated (57). Osteosynthesis is only associated in case of obvious preoperatively instability.

5-3 Indications for combined approaches

In our experience, the indications of mixed(combined) approaches are rare and are limited to severe stenosis with equivalent anterior and posterior lesions. They are sometimes indicated with incomplete results from an initial anterior or posterior decompression, or in case of recurrence of clinical signs after a period of improvement (44). A double approach can destabilize the cervical spine, thus the second operation should be accompanied by an additional fixation (44). If a double approach is done systematically, osteosynthesis with interbody graft should be done via an anterior approach: this is where it has the best biomechanical properties.

6 - Results of treatment

Langston t. HoLLy, M.D.,1 PauL g. Matz, M.D.,2 PauL a. anDerson, M.D., Clinical prognostic indicators of surgical outcome in cervical spondylotic myelopathy. J Neurosurg Spine 2009;11;112-118

In the English literature, the effectiveness of treatment is assessed by a modification (expressed in percentage) of the JOA score (more accurate than the Nurick classification) according to the following formula: (postoperative score - preoperative score) / (17 - preoperative score) × 100.

6-1 Results of medical treatment

Rigorously followed up medical treatment can stabilize the disease for several years when the affection is in its mild and slowly progressive form (95). Clinical follow-up of patients with mild forms (average JOA score = 14) and myelopathy from "soft disc" shows that 60% can be stabilized or improved on medical treatment consisting of: spinal immobilization and reduced physical activity. In contrast, about 40% will worsen and should be operated. The incriminated lesions may regress on MRI in approximately 50% of cases (51). The JOA score improvement may reach 80% in initially relatively benign forms.

6-2 The results of surgical treatment

Clinical improvement depends more on the quality of the decompression than on the choice of surgical approach when it is adapted to the type and topography of the lesions (93).

There are a few more complications related to surgery in patients over 70 years because of associated pathologies (34).

According to the JOA classification, clinical improvement for all techniques is on average 55% (range 20-80%).The quality of functional outcome deteriorates with time and is only more than 45% after 6 years of progression. This deterioration is related to the continued progression of degenerative lesions and spinal deformities, as well as the onset of associated diseases in older patients: for example; hip osteoarthritis, lumbar canal stenosis.

It is possible to identify many prognostic factors (41, 77, 94):

- Age is not determining (94) when the general condition, the degree of disability and associated pathologies are taken into account: same degree of improvement was observed before and after 65 years but only in younger subjects can complete recovery be observed. The aim moreover is not the same; young patients want to resume their full activities while older patients just want to gain sufficient autonomy.
- The duration of symptoms is one of the most important prognostic factors: better results are obtained if the duration of the disease is short, especially in patients over 65 years, which could correspond to symptoms of functional cord affection before the installation of irreversible anatomical lesions (43, 94).
- The severity of preoperative disability seems paradoxically a less important factor (94).

- The antero-posterior diameter of the cervical spinal canal and the surface area at its narrowest portion seems a determining prognostic factors regardless of age (43).
- Intramedullary T2 hyperintensity (cord signal) on MRI may influence prognosis (47), but it is quite controversial and inconsistently reported in the literature (43, 77, 94).
- Preoperative instability observed mainly in older subjects does not seem to influence the prognosis (41).

7 - Complications of surgical treatment (see 8, 30)

Degenerative cervical spine surgery is currently well mastered by specialized surgeons (11).
General complications common to all surgical procedures are rare approximately 1%. This type of surgery should not be feared regardless of the patient's age when functional disability justifies it. There are few contra-indications.

Specific complications related to the anterior approach can sometimes be observed, they are directly related to the surgeon's experience. The most classical and most common is that recurrent laryngeal nerve palsy which may be observed in 0.2 to 16.7% of the cases (29, 87), especially in the vicinity of the lower cervical spine (C6/C7 and C7/T1) via right approach. It is prevented by minimizing the retraction of tracheo-oesophageal axis or systematically using the left side approach that is less easy for a right handed surgeon. It is usually reversible. Pharyngeal or esophageal trauma may be observed but are exceptional, estimated to occur between 0.02 and 1.49% (20). Injuries of the great vessels are rarely observed (8). The occurrence of a postoperative hematoma is documented in 1-11% of cases in some observations (29). This complication in the form of a neck mass, is responsible for dysphagia and puts the patient at risk of respiratory distress.

One can observe aggravation in the neurologic status regardless of the approach. A common complication of extended decompression (but not often reported in the literature and in hospitalization summary) is paresis of the fifth and / or sixth cervical root, observed in 1-15% of cases (28, 89). Its physiologic mechanism is unclear. It is possible that it occurs during the installation of the patient on the operating table from a lesion of the radicular artery, but also from the particular fragility of this root stretched when the cord moves after decompression (89). It is usually regressive. Aggravation of clinical manifestations occur in 0.2 to 5% of the cases depending on the series (28, 29). These are the consequences of a spinal cord injury that may occur during the installation of the patient (for example excessive head flexion during a posterior approach) or during completion of the bone resection which requires the introduction of fine instruments (curettes, rongeurs or mechanical drills ...) in a much narrowed spinal canal. Vascular phenomena can sometimes be the cause of this type of complication. The most dangerous procedure is probably the resection of bony and disc calcifications, on the anterior aspect of the dura mater which we must not try to remove at all cost, thus limiting the procedure to decompression.

The evolution of this type of complication is unpredictable and depends on the severity of the neurological syndrome found during recovery from anesthesia. Some may be permanently quadriplegia.

Mechanical complications related to the surgery are the most important to know as they compel the surgeon to adapt the technique to the patient's semiology and spinal lesions:

- Interbody grafts can be displaced in about 2% of the cases (29). This is often the result of a misconfiguration of autografts or inappropriate choice of bone substitutes. Some surgeons advise wearing a cervical collar for several weeks. It has not been shown that this reduces the frequency of the incident.

Displacements of material for osteosynthesis used in complementing an anterior approach may be observed. This can cause destabilization of the spine and / or a wound of the posterior part of the esophagus. Although difficult to accurately estimate, the frequency of this complication is nevertheless exceptional, particularly because of the widespread use of systems including interlocking screws. In addition, the screw profile has been improved to the point that all "loosening" became very rare or occurs simply as a result of a technical foul.

- Pain occurring as a consequence of graft harvesting from the donor site are observed in 20% of the cases. This relatively high figure discourages many surgeons from using autografts in degenerative disease, although it is by far the best graft (80).
- A post-operative kyphosis is frequently observed after an anterior approach as in the posterior route. The realization of a graft and / or osteosynthesis reduces this risk (84) but does not completely eliminate it while increasing the burden of the operative procedures. This kyphosis seems more related to the inadequacy of neck muscles (70) which should be subjected to postoperative physiotherapy according to the extent of the decompression. Prolonged wearing of a collar could lead atrophy of paraspinal muscles and increase the risk of kyphosis. Finally, the preservation of the uncinate process during anterior approaches and anterior half of the joints during posterior approaches decreases the frequency of these complications. It has been shown that interbody graft is not absolutely necessary after a median corpectomy (88), which thus reduces the risk of complications and the cost of the intervention. Laminoplasty for many authors (86), decreases the risk of kyphosis compared to laminectomy, but this was not shown in the meta-analysis conducted by Ratliff and Cooper in 2003 (67).
- After a laminectomy, a fibrotic scar (post-laminectomy membrane) develops that could be at the origin of the late deterioration of postoperative outcome (67). This is one of the reasons that contributed to the development of laminoplasty. In fact, the pathogenic role of this fibrous scar is questionable (46).
- The fusion of one or more cervical segments leads to early degeneration of adjacent segments which could be the source of a new pathology in 3% of the patients each year and in 10 years, 15 to 20% of the patients could require further surgery (37). In our experience, this figure is much lower and it has been shown that if these lesions are frequent, they are often asymptomatic (45). There is no evidence till date (for lack of sufficient clinical experience) that the use of cervical disc prostheses reduces this risk significantly (9).
- All cervical spine procedures (with or without fusion) lead to a restricted range of neck movement. This usually remains mildly debilitating and well compensated for by adjacent segments, especially as these is most often in elderly patients with decreased activity and diffuse degenerative lesions of the entire spine. Despite the long list of potential complications each of which taken in isolation (beside donor site painful sequelae) is relatively unusual, surgical treatment should not be delayed in a patient with neurological signs related to cervical myelopathy. ++++

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