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Degenerative Pathology

Adjacent segment disease

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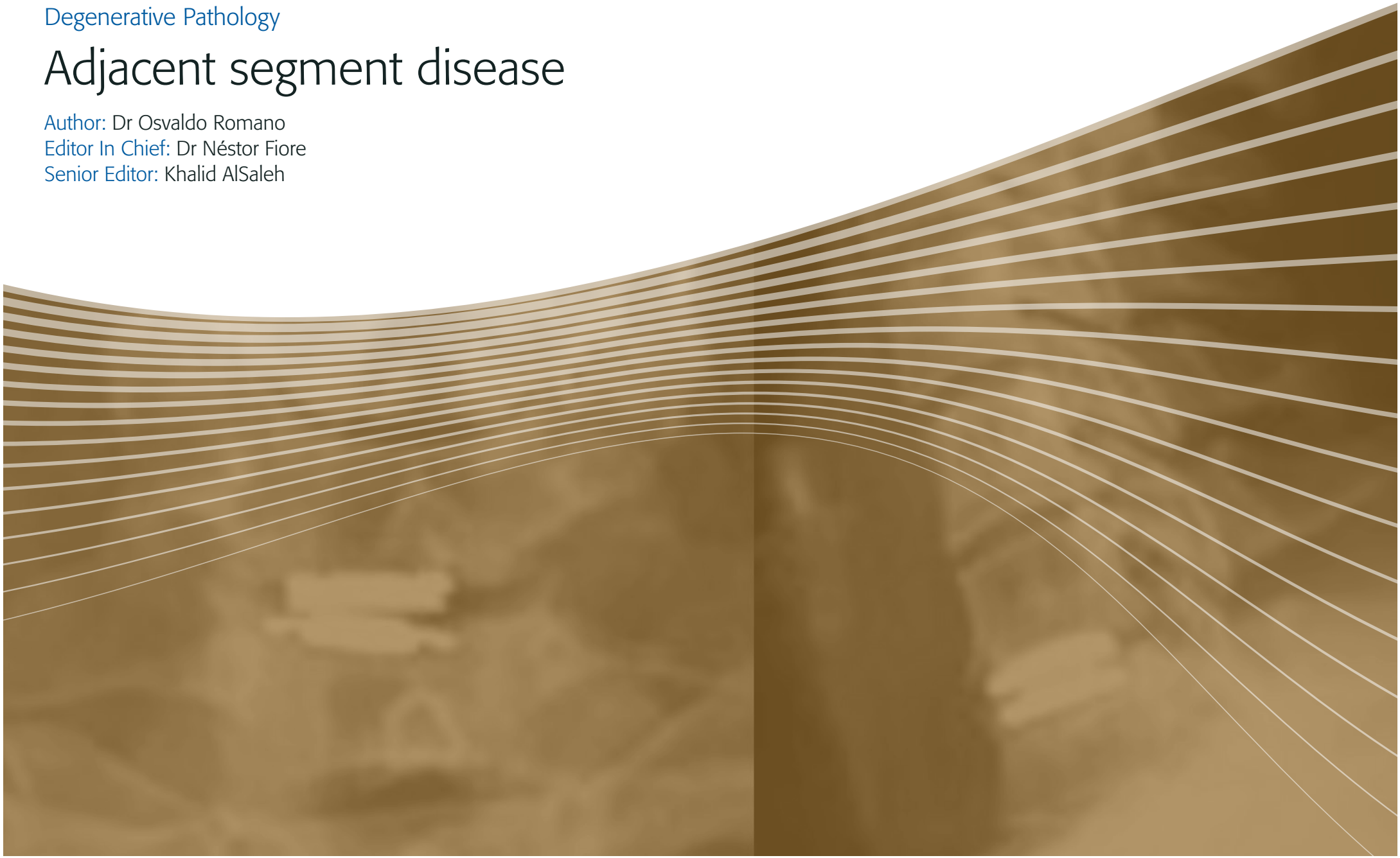

OBJECTIVES

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Degenerative Pathology

Adjacent segment disease

- To describe adjacent segment disease.
- To analyze adjacent segment disease.
- To identify therapeutic options for this disease.

CONTENTS

1. INTRODUCTION

Overview

Adjacent segment disease (ASD) is the name given to the development of alterations due to overload on segments above or below a fused vertebral segment.

In general terms, the changes that appear are degenerative in nature, although fractures can also be included (Kim, Choi, Jeon and Choi, 2010; Park, Garton, Gala, Hoff and McGillicuddy, 2004; Vavken and Krepler, 2008). Some authors also understand ASD to refer to degenerative changes in segments that are more proximal or distal than the segment immediately adjacent to the fusion (Park et al., 2004).

ASD can present after various vertebral segment surgeries:

- discectomy
- arthrodesis
- disc replacement

In a recent publication, the term "adjacent segment disease" was proposed for this complication (Anderson et al., 2012), in an attempt to standardize the name of pathological findings adjacent to an operated segment.

> There has been a long debate as to whether ASD is caused by surgery or is the product of the natural evolution of the degenerative process. Nonetheless, there is evidence of the role played by fusion in ASD genesis (Ekman, Möller, Shalabi, Yu and Hedlund, 2009; Lee, Dettori, Standaert, Brodt and Chapman, 2012).

In many cases, the changes found in imaging are found in asymptomatic patients. Therefore, cases of ASD with signs of compromise in both the clinical examination and imaging studies must be distinguished from those cases which present changes in imaging studies alone, i.e., without a clinical impact:

- 8% to 100% in imaging studies
- 5.2% to 18.5% if the patient's clinical manifestations are taken into account (Park et al., 2004)
- 2.6% if repeat surgery for ASD is taken into account (Lee et al., 2009).

It is then possible to classify cases as being Adjacent Segment Disease (ASDis) for symptomatic cases and Adjacent segment Degeneration (ASDeg) for the asymptomatic cases

It is difficult to determine which patient or surgical factors increase the risk of ASD:

- facet degeneration (Lee et al., 2009)
- age (Chen et al., 2011)
- sagittal imbalance
- long arthrodesis
- etc

Little is known about how to prevent the development of ASD. As regards lumbar fusion surgery, certain authors favor placing an interspinous device over the arthrodesis or ending with a flexible system, but there is no data available to support these ideas (Chou, Lau, Skelly and Ecker, 2011). However, this is a controversial subject that seriously affects health. Further research into the subject is needed (Norvell et al., 2012).

2. CERVICAL ADJACENT SEGMENT DISEASE

It appears that ASD of a congenital fused segment is less frequent than in a segment that has undergone surgical arthrodesis (Lee, Dettori, Standaert, Ely and Chapman, 2012).

Images of a patient with C4-C5 instability (adjacent level below the fused block of the C2, C3, C4 posterior arch) are presented below as an example.

C2, C3, C4 posterior block is visible, as well as instability at C4-C5.

Lateral X-ray of cervical spine

Clear compression can be seen at C4-C5.

MRI of cervical spine, T2-weighted sequence, sagittal section

Images of a patient with C6-C7 disc herniation at the level below an apparent congenital block due to C5-C6 fusion are presented below as an example.

C5-C6 fusion is visible.

Lateral X-ray of cervical spine

A herniated disc is visible at C6-C7.

MRI of cervical spine, T2-weighted sequence, sagittal section

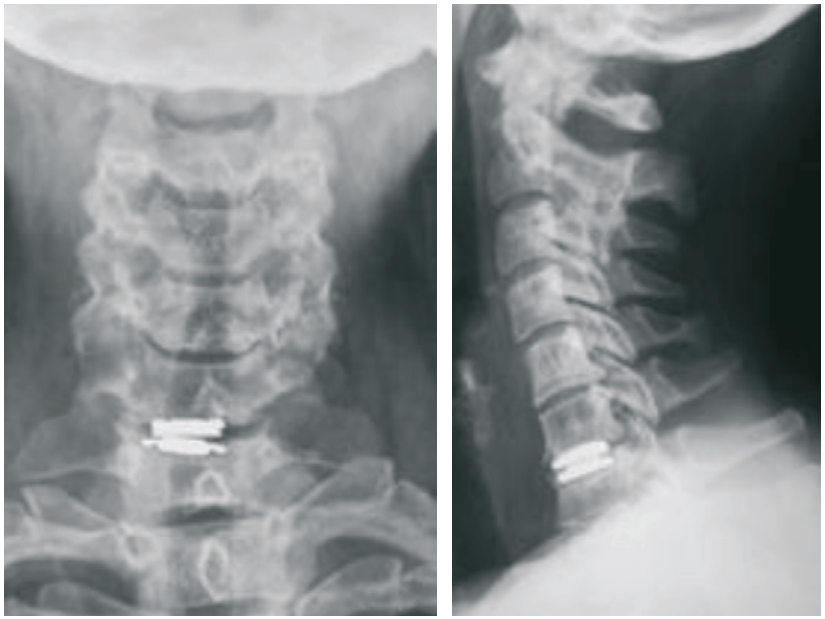
Cervical ASD can occur at a rate higher than degeneration from natural causes (Lee et al., 2012).

2

The following are certain aspects related to the appearance of cervical ASD:

- It is estimated that the annual risk of developing symptoms of ASD after cervical fusion surgery is between 1.6% and 4.2%, with a mean rate of annual repeat surgery of 0.8% (Lawrence, Hilibrand, Brodt, Dettori and Brodke, 2012).
- There is evidence that placement of an anterior plate near the adjacent disc (less than 5 mm away) may increase the risk of ASD (Kim, Kelly, Ely, Riew and Dettori, 2012; Riew and Angevine, 2007).
- The risk of ASD developing is also greater at C5-C6 and C6-C7 if these segments have previously suffered degeneration or spinal cord compression (Lawrence et al., 2012).
- One of the arguments that supports the use of disc prosthesis over arthrodesis is based on the notion that conserving movement will help to reduce the risk of ASD, but there is still currently no evidence to support this hypothesis (Harrod, Hilibrand, Fischer and Skelly, 2012; Riew, Schenk-Kisser and Skelly, 2012).

Images of a patient with a C6-C7 disc prosthesis implanted three years earlier and signs of C5-C6 disc degeneration are presented below.



Degenerative changes are visible at the level overlying the prosthesis.

Anterior and lateral X-rays of the cervical spine

Clinical aspects

Forms of presentation

The clinical picture can present with the following symptoms:

- axial pain
- radicular pain
- myelopathy
- a combination of symptoms

Axial pain

This pain is the most frequent and can be located in the midline or paravertebral line. It is frequently located in the posterior area of the skull base and in the medial region of the scapular girdle. It usually has mechanical characteristics, improves with rest and common pain killers, very rarely requiring opiates.

Radicular Pain

This pain is less frequent and can present
with radiation of insidious onset, is generally irritating and with predominance of paresthesia
and hypesthesia.

Spinal cord pain

This can present in upper and lower limbs and is not associated with a clear radicular area. It is a dull, less burning sensation of pain and is generally accompanied by a motor function condition.

2

Physical examination

Findings on examination of a patient with ASD are similar to those found in cervical degeneration disease (disc herniation, cervical arthrosis).

- Physical examination usually detects reduced mobility.
- Lateral tilt is limited at an early stage, followed by rotation and flexion-extension.
- When stiffness is accompanied by muscle spasm, palpation reveals hypertonia on the sides of the cervical spine.
- If the spinal cord is compromised, fine motor function of the hand may be impeded, in addition to gait disorders, claudication or instability. Sphincter disorders are uncommon.
- Examination can reveal upper limb muscle atrophy directly related to the time period and magnitude of radicular or spinal cord compression.
- Palpation of the spinous processes can cause local pain. Palpation can detect both paravertebral contracture and limb hypotonia and hypotrophy.
- Joint stiffness can be detected in the physical examination, although this is a non-specific symptom that can be present as the natural evolution of cervical aging, as well as in other diseases.
- Possible findings in the neurological examination are associated with radicular compression (hypostasis, decreased muscle strength and areflexia) or with spinal cord compression (hypertonia, hyperreflexia, clonus, Babinski's sign, alterations of superficial abdominal reflexes).

Complementary studies

Radiography

Radiographic imaging shows degenerative changes and instability.

Discovertebral degeneration is shown more clearly in lateral X-rays:

- disc impingement
- endplate irregularity and sclerosis
- osteophytosis
- empty disc space

Facet degeneration can be seen particularly well in oblique X-rays:

- impingement
- sclerosis
- hypertrophy
- subluxation

X-ray findings can reveal instability of the segment with listhesis and changes in the overall position of the cervical spine, with frequent loss of lordosis.

The X-ray of a patient with signs of degeneration in adjacent discs above a fused block of several vertebral bodies is presented below as an example.

Notable sclerosis is visible at the level over the congenital block.

Lateral X-ray of cervical spine

2

Magnetic resonance (MRI)

Magnetic resonance (MRI) findings of degeneration focus on the disc, the vertebral endplates and/or the facets. In many cases, a combination of these findings is observed in the patient.

Furthermore these changes can lead to the presence of spinal cord and root compression.

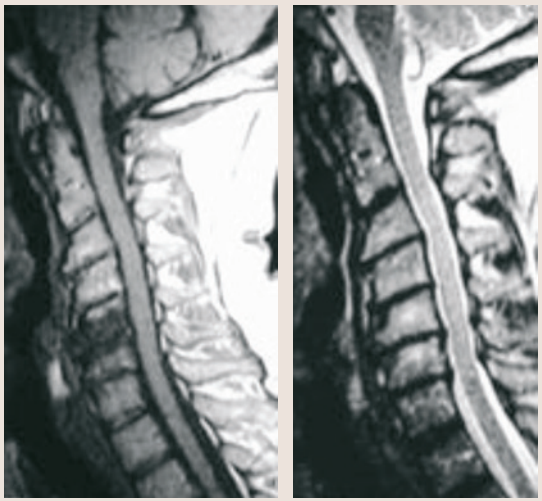
Signs of disc degeneration

Discs show both dehydration and loss of height, as well as signs of tears and migration of disc material from its natural location.

Signs of discovertebral degeneration

These are identified by a change of signal in the vertebral endplates above and below the adjacent disc level. Modic's classification is useful to assess these.

A hypointense signal in T1 and a hyperintense signal in T2 (sign of inflammation) at the endplates are less frequent than in the lumbar spine.



A Modic I signal is visible at C5-C6.

MRI of cervical spine, T1 and T2-weighted sequences, sagittal section

Signs of facet degeneration

Findings are impingement and facet hypertrophy revealed particularly by a hyperintense intra-articular signal in T2-weighted and STIR MRI sequences caused by the presence of synovial fluid. It may also present a rounded juxta-articular lesion which is hypointense in T1 and hyperintense in T2 and STIR sequences, corresponding to an articular cyst.

Another likely finding is a hyperintense signal for the spinal cord in T2 and STIR, indicating myelomalacia. On rare occasions there could be a syringomyelia cavity.

Signs of degeneration can be global and may be associated with stenosis accompanied by a reduction in signal intensity of the cerebrospinal fluid around the spine.

A hyperintense signal is visible in the spinal cord at the level of the disc above a fused block in a patient with cervical ASD.

MRI of cervical spine, T1 and T2-weighted sequences, sagittal section

2

Computed tomography (CT)

Computed tomography (CT) is not a study of choice; in most cases of ASD, diagnosis and treatment can be planned with X-rays and MRI.

CT can be useful in evaluating signs of facet degeneration, foraminal stenosis and disc or posterior longitudinal ligament calcification.

Discography

Discography is a very rarely indicated surgeon-dependent study.

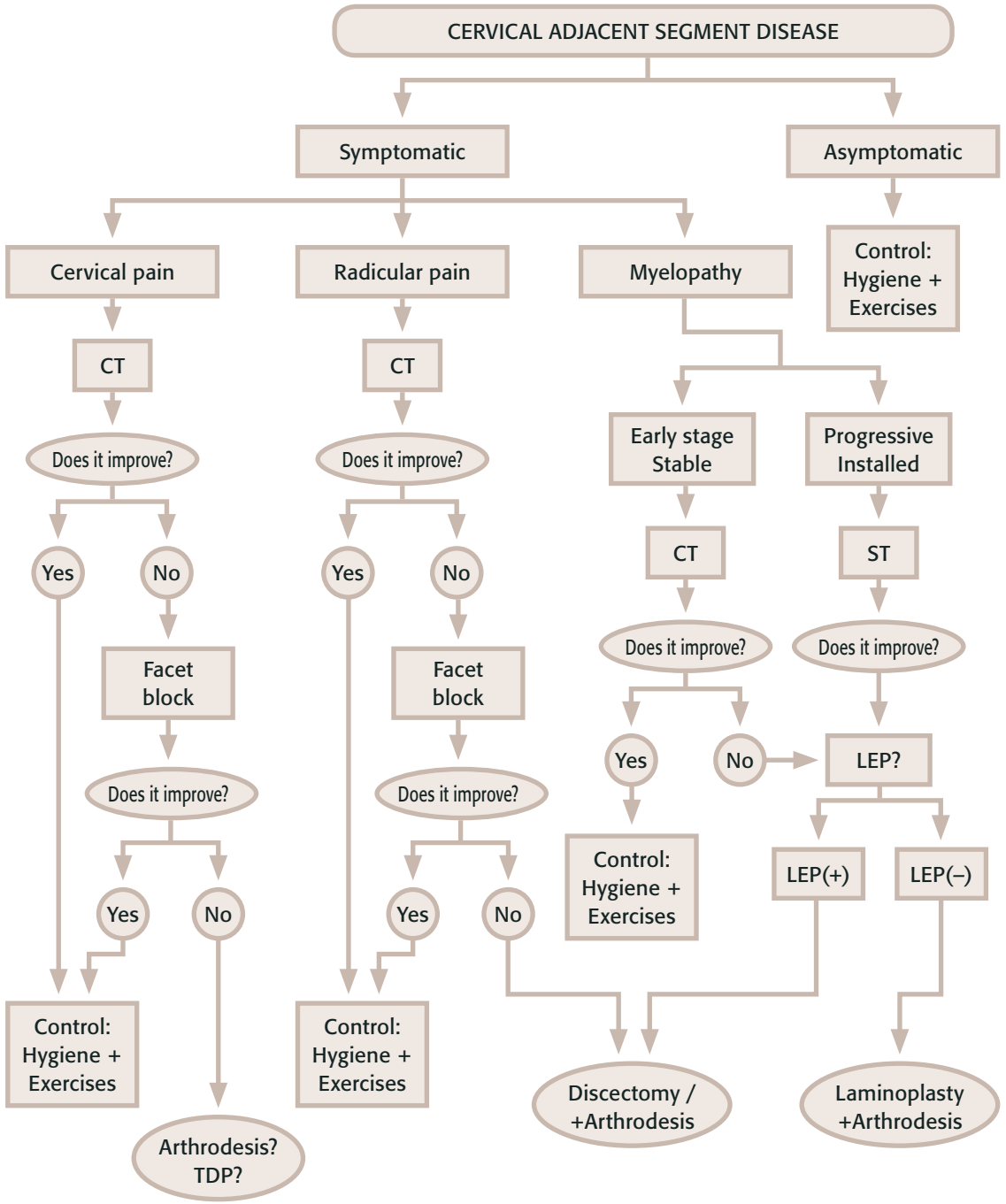
Its use is controversial in the literature (Derincek, Mehbod, Schellhas, Pinto and Transfeldt, 2007; Manchikanti, Glaser, Wolfer, Derby and Cohen, 2009).

Treatment

As in all degenerative conditions, conservative treatment is indicated initially.

Treatment can be conservative (invasive or non-invasive) or surgical.

The presence of myelopathy with clear images of a narrow canal, with or without myelomalacia, portends surgery without previous conservative treatment.



Algorithm for the management of a patient with cervical ASD

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Medical treatment

Medical treatment is frequently enough to control patient symptoms. There are no comparative studies on the efficacy of conservative treatment versus surgical treatment (Fourney, Skelly and DeVine, 2012).

Surgical treatment

Medication

Medication type and dosage will depend on symptom intensity and patient characteristics.

NSAIs are recommended, although corticoids, opiates, muscle relaxants, antidepressants and vitamin complexes can also be used, among others. The oral route is recommended, if possible.

Physiokinetic therapy

In many situations, kinesiology and physiotherapy are useful and help to improve the clinical picture.

Braces

If radicular pain is acute and intense, a cervical collar may be useful for a short period of time, no longer than one month,
due to the secondary effect of muscle hypotrophy.

Contraindicated in chronic clinical conditions.

Retraining and hygiene

Strengthening the muscles, accompanied by elongation and posture control are important for sustained improvement from conservative treatment.

Blocks

Blocks can be foraminal or facetary.

The possibility of adverse effects from a foramen block at the cervical level can be higher than at the lumbar level (Ludwig and Burns, 2005; McMillan and Crumpton, 2003; Wald et al., 2012). Therefore, it is generally indicated in patients with a monoradicular clinical picture, signs of foraminal compression and conservative treatment failure.

Surgical procedures can involve isolated root or spinal cord decompression or be performed in association with arthrodesis or arthroplasty. Arthrodesis or arthroplasty alone are sometimes indicated (Fourney et al., 2012).

Anterior, posterior or combined approaches can be performed, depending on the surgical procedure.

Surgical treatment

- A) Anterior approach
- B) Posterior approach
- C) Combined approach

2

A) Anterior approach

An anterior approach is indicated in the following cases:

- central or posterolateral hard disc herniation with radiculopathy;
- stenosis with negative spinous process line (Fiore, Romano, Mengotti, Lambre and Dittlar, 2006);
- spinal cord compression which, according to the surgeon's preferences, could be resolved by decompression and anterior arthrodesis or a disc prosthesis.

Some aspects of the surgical technique to be taken into account are listed below:

- The head should be firmly set in a neutral position, with the neck in lordosis, achieved by using an interscapular bolster.
- The lengthwise approach is preferable if more than two levels need to be exposed.
- The height of the approach will depend in the level of the lesion. An upwardly concaved arch-shaped incision may be useful at higher levels.
- In all cases the approach is between the vascular axis and the visceral axis.
- Decompression may be obtained solely by discectomy or corpectomy. In the former case, decompression is combined with arthrodesis (graft + cage, graft + plate or graft alone) or arthroplasty. Arthrodesis with a graft and a cage is preferable. If corpectomy is performed, graft or cell with a graft and plate is used.

Post-operative requirements will depend on the procedure performed. The use of a collar can be indicated for arthrodeses. The time of use will depend on the number of levels fused, the condition of the patient and the surgeon's opinion as regards stability achieved during surgery. In the case of arthroplasty, early post-operative mobilization is essential.

B) Posterior approach

A posterior approach is indicated when spinal cord decompression or realignment without balance correction is required, especially if associated with a constitutionally narrow cervical canal.

A laminoplasty or laminectomy can be performed, both with or without associated arthrodesis.

In a recent review, Fourney et al. (2012) found publications that only supported laminoplasty for ASD via a posterior surgical procedure, while mentioning the lack of evidence supporting the usefulness of foraminotomy or laminectomy.

Some aspects of the surgical technique to be taken into account are listed below:

- The head must be set firmly in place. Head holders (Mayfield® or similar) are used to correctly position the midline and open up the lordosis, while adhesive tape helps to pull the shoulders down.
- Neurophysiological monitoring is recommended.
- During the approach, incision in the midline is important to minimize bleeding.

Post-operative use of a Philadelphia collar will depend on the stability achieved during surgery and on each patient. They are commonly used for walking and sitting until the soft tissues heal.

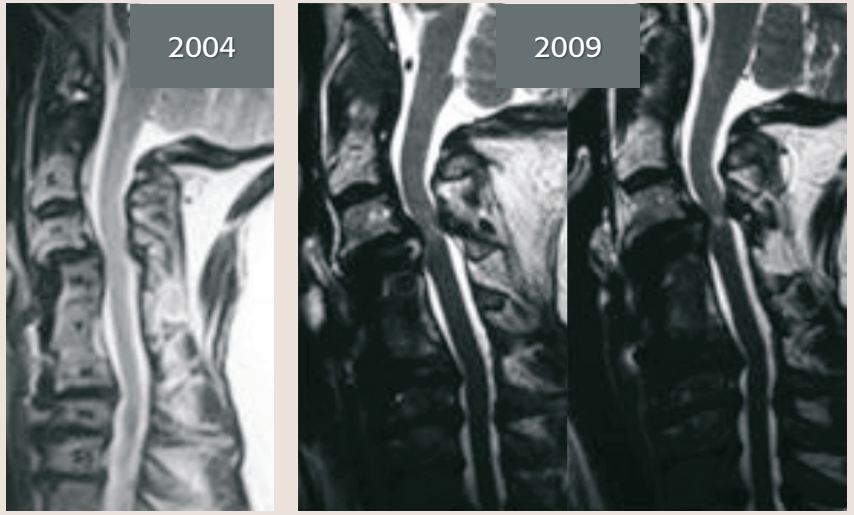
2

CLINICAL CASE

Female, 64-year-old patient operated on 15 years earlier via an anterior approach to resolve cervical pain and brachial radicular symptoms. Initial complaint was for symptoms of cervical myelopathy with signs of gait instability and pyramid syndrome.

C4-C6 arthrodesis can be seen.

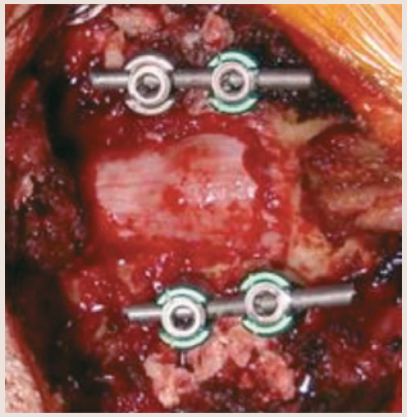
Lateral X-ray of cervical spine after the first intervention



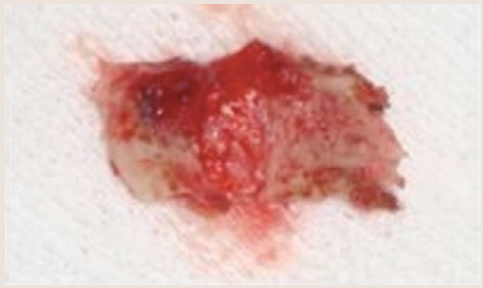
C3-C4 compression progress after five years is visible.

MRI of cervical spine after first intervention, T2-weighted sequence, sagittal section

The surgical team opted for a posterior approach to decompress C3-C4 by block laminectomy and C3-C4 stabilization with articular screws and rods.



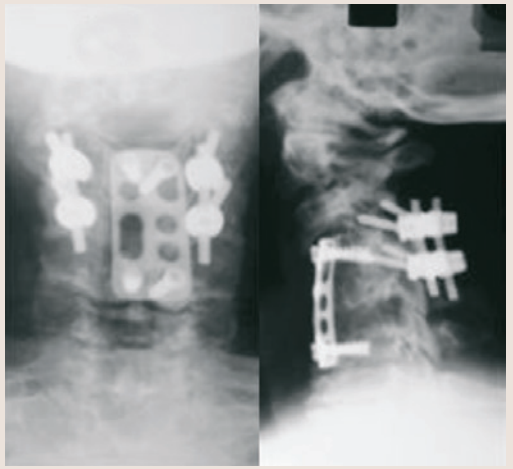
The decompression obtained and C3-C4 arthrodesis rods are visible.



Posterior arch resected in one piece.

Intra-operative photographs

The patient presents good evolution with clinical improvement.



Posterior C3-C4 osteosynthesis is visible.

Post-operative anterior and lateral X-rays

2

C) Combined approach

If the reason for the addition is instability with deformity or fixed deformity with compression, a combined approach may be required (dual or triple approach).

> The number of approaches will depend on the stiffness of the cervical spine.

Correction analysis in dynamic X-rays helps to evaluate flexibility and decide which surgical strategy to follow:

Flexible deformities

The first phase should preferably be via an anterior approach to decompress, recover lordosis and provide anterior bone support, this is then completed with posterior fusion.

Stiff deformities

A triple approach is used: firstly, a posterior approach to increase flexibility, decompress and perform temporary osteosynthesis; secondly an anterior approach to decompress, support and achieve lordosis; and a final step via a posterior approach to fix posterior osteosynthesis in lordosis.

These cases require the operating position to be changed during surgery, thus the patient must be mobilized and the surgical field prepared thoroughly.

Summary:

CERVICAL ADJACENT SEGMENT DISEASE

Cervical ASD presents with degenerative changes adjacent to the operated level. These are frequently asymptomatic.

The predominant clinical picture is pain and, less frequently, neurological conditions (radicular and spinal cord).

The complementary studies of choice are radiography and MRI.

Conservative treatment is commonly useful and sufficient.

Surgery is indicated if there is no response to conservative treatment or in the presence of spinal cord compression symptoms. An anterior or posterior approach can be chosen, depending on the case.

3. LUMBAR ADJACENT SEGMENT DISEASE

There are some differences between lumbar ASD and cervical ASD. Since the spinal cord ends at L1, clinical presentation will be axial or radicular pain alone. At the thoracic and lumbar levels, the possibility of vertebral collapse (fractures) is added to the characteristic ASD degenerative condition.

The following factors have been suggested to increase the risk of lumbar ASD:

- Instrumented surgery (Park et al., 2004);
- Pedicle instrumentation (Park et al., 2004);
- Long fixations (Ahn, Park, Choi, Kim and Yang, 2010; Park et al., 2004);
- 360° fusion (Kasliwal et al., 2012);
- Loss of balance (Ahn et al., 2004; Park et al., 2004; Kasliwal et al., 2012; Kim, Lenke, Shaffrey, Van Alstyne and Skelly, 2012);
- Facet injury at the adjacent level during surgery, more frequent when placing the superior screw is placed (Lee et al., 2009; Park et al., 2004, Liu et al., 2012);
- Previous degeneration of adjacent levels (Ahn et al., 2004; Anandjiwala, Seo, Ha, Oh and Shin, 2011; Park et al., 2004; Kasliwal et al., 2012);
- Age (Ahn et al., 2004; Calcagni and Sarramea, 2012);
- Female patient (Calcagni and Sarramea, 2012; Park et al., 2004);
- Male patient (Ahn et al., 2004);
- Osteoporosis and post-menopausal state (Park et al., 2004);
- Association of decompression procedures when setting isthmic spondylolisthesis (Ekman et al., 2009).

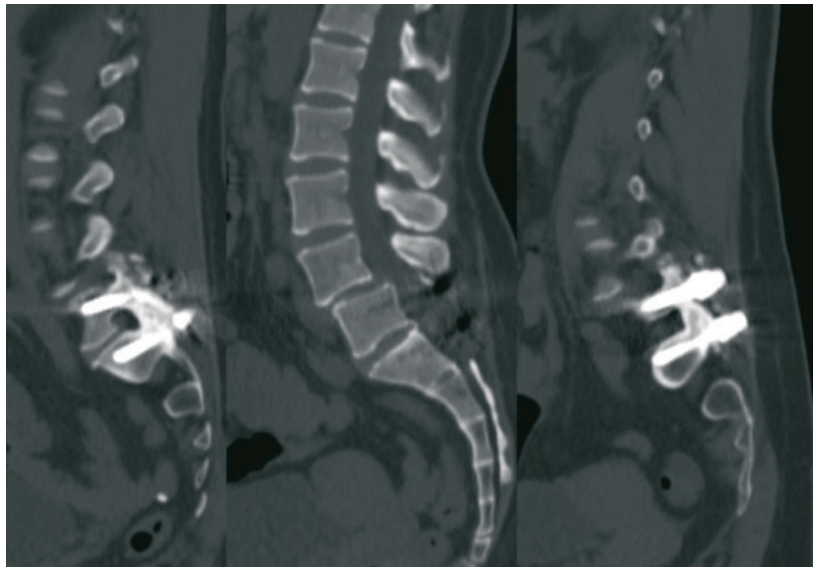
Although ASD is generally associated with long fusions (Kasliwal et al., 2012), short fusions in adult high-angle scoliosis could favor ASD onset (Cho et al., 2008).

ASD incidence after lumbar disc fusion or prosthesis is controversial. Although there appears to be a greater chance of ASD in patients with fusion, the risk continues to be low (Wang, Arnold, Hermsmeyer and Norvell, 2012). There is no evidence that mobility preservation systems are more efficient than fusion in preventing the appearance of ASD.

Lumbar ASD is more frequent at the cephalic level than at the distal level (Calcagni and Sarramea, 2012; Lee et al., 2009).

Described below is a clinical case of simple ASD at L4-L5 that presented four years after an instrumented arthrodesis at L5-S1.

> Simple ASD, where only the adjacent level is affected, can be distinguished from complex ASD, where the changes in the adjacent level are only one more ingredient of the overall imbalance.



Signs of disc space deterioration and L4-L5 displacement are visible.

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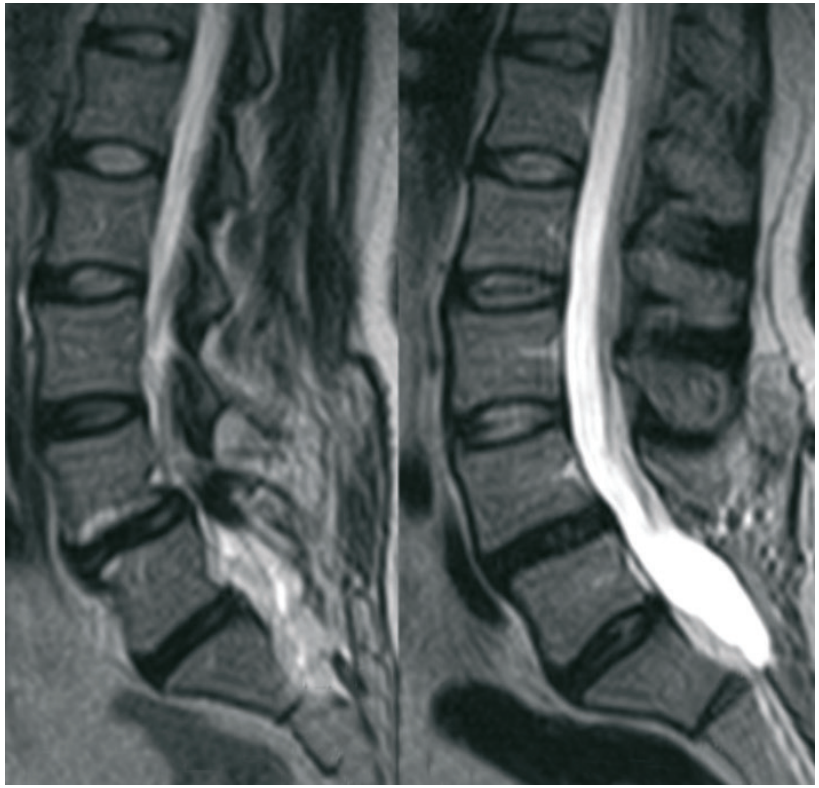
Described below is a clinical case of complex ASD after canal stenosis surgery and L1-S1 instrumentation.



Deterioration is seen at L4-L5.

MRI of lumbosacral spine, T2-weighted sequence, sagittal section

Kyphosis imbalance is visible over the instrumentation, affecting the sagittal axis.

Lateral spinograph of thoracolumbar spine

Clear evidence of empty space in high discs.

Computed tomography of thoracolumbar spine, anterior reconstruction

3

Clinical aspects

Forms of presentation

Pain is the predominant symptom, both in isolation and associated with other manifestations.

Axial pain (lower back pain)

This pain is the most frequent and is located in the midline or paravertebral line of the lumbar region. It usually has mechanical characteristics, improves with rest and common pain killers, very rarely requiring opiates. On the other hand, radicular pain can radiate to the crural nerve or sciatic nerve, it can be mono or multiradicular, as well as irritative or with deficit.

Radicular pain

In long-term compression disorders, the patient will probably present gait claudication rather than the typical radicular pain associated with disc herniation. Paresthesia is usually found
in the affected radicular area.

Pain due to fractures

When pain is due to a fracture, the location will depend on whether there is a collapse at the cephalic level of the arthrodesis or a sacrum fracture in the lumbosacral fusion (Vavken and Krepler, 2008). Lumbosacral mobility is usually reduced.

Physical examination

Examination is helpful to evaluate overall vertebral column balance, in which a deformity with lateral or anterior inclination may be visible, as well as to assess lower limb atrophy. In cases of collapse due to fracture, local kyphosis may be encountered.

Palpation of the spinous processes can cause local pain and reveal paravertebral contracture and hypotrophy in the limbs. Mobility is usually reduced.

Complementary studies

Radiography

X-ray findings cover two inter-related aspects: degenerative changes and instability.

X-rays are also useful in the evaluation of anterior and sagittal balance.

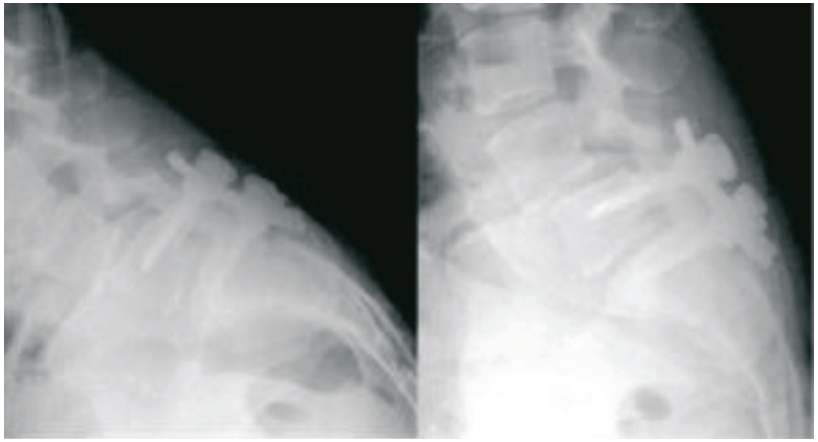
Lateral x-rays are the most useful modality to assess changes associated with ASD such as:

- disc impingement
- endplate irregularity and sclerosis
- osteophytosis
- empty disc space

Facet degeneration changes can be seen particularly well in oblique X-rays.

X-ray images can reveal monoaxial segment instability (spondylolisthesis) or combined instability (rotary subluxation, scoliosis).

Images of changes in the L4-L5 space of a patient with posterior fusion performed two years previously at L5-S1 are presented below as an example.

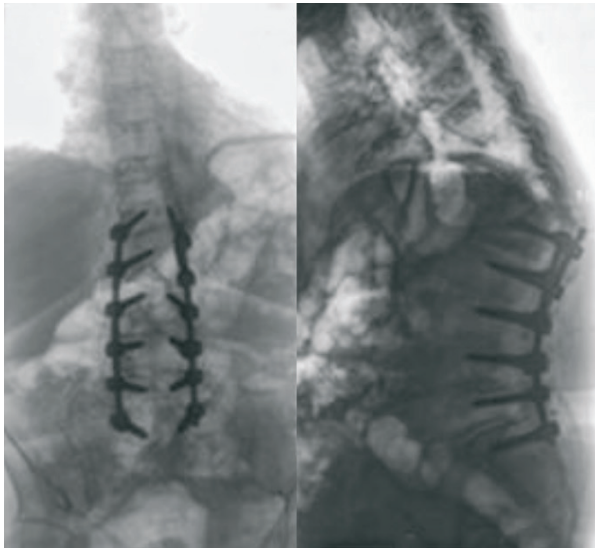


L4-L5 hypermobility is visible.

Lateral X-ray of lumbar spine

Post-traumatic collapse of the vertebral body can sometimes be seen in the level adjacent to a generally, long arthrodesis.

Images of a patient with angular kyphosis subsequent to L1-S1 fusion six years previously are presented below as an example.



Angular kyphosis is visible due to collapse of T12 and adjacent level overlying the fused block.

Anterior and lateral X-rays of thoracolumbar spine

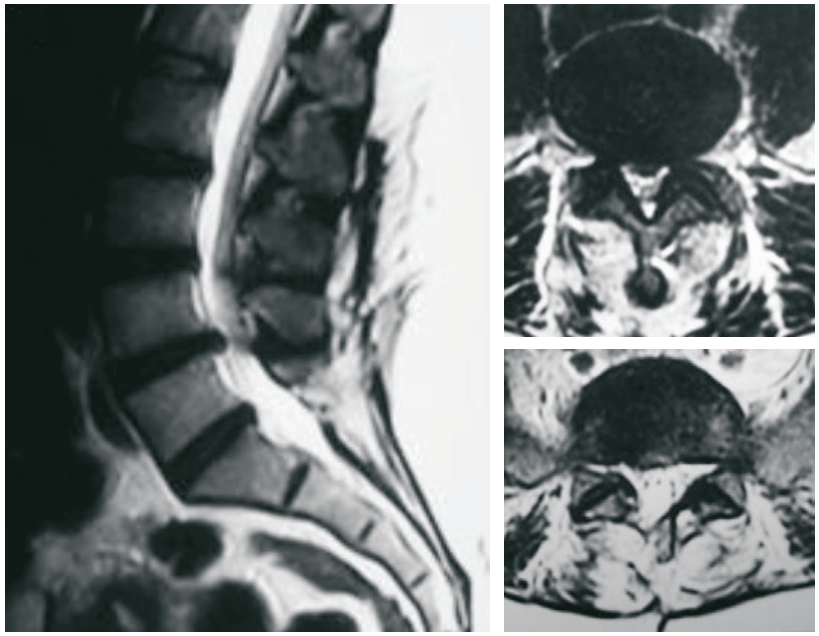
It is important to take X-rays that also include the cervical spine, the thoracic spine and the hips. This helps to evaluate vertebral column balance, pelvic morphology and the lumbopelvic position.

Care must be taken in evaluating the findings in complementary studies. Some authors mention the poor correlation frequently observed between imaging changes and clinical impacts (Anandjiwala et al., 2011; Chen et al., 2011; Okuda et al., 2004).

Magnetic resonance imaging (MRI)

Discovertebral degenerative changes reveal themselves as dehyrdation, impingement, disc herniation or a change of signal in the upper and lower endplates.

Images of a patient with L5-S1 laminectomy due to disc herniation 15 years previously are presented below as an example.



L4-L5 disc herniation is visible over the operated level.

MRI of lumbosacral spine, T2-weighted sequence, sagittal and axial sections

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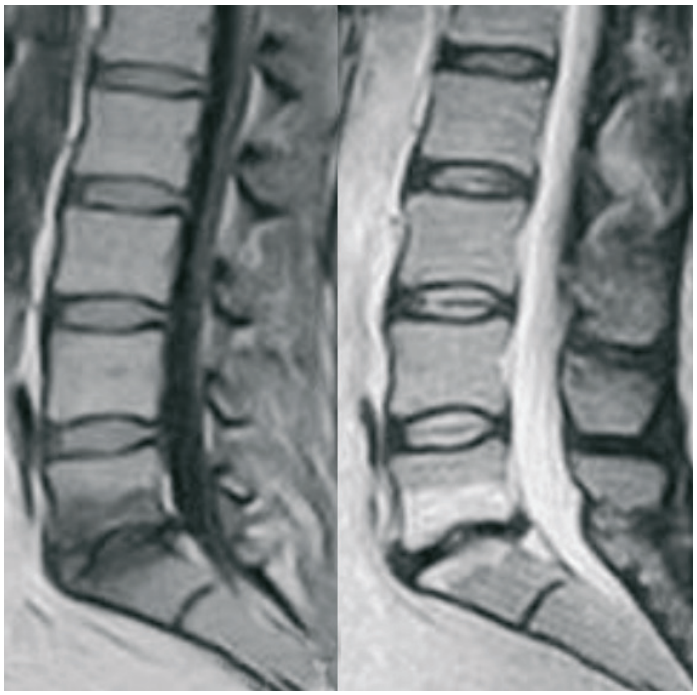
Vertebral endplates presenting a hypointense signal in T1 and a hyperintense signal in T2 are considered inflammatory and an objective finding in patients with lower back pain (Modic, Masaryk, Ross and Carter, 1988).



Modic type 1 changes are visible for the L5-S1 disc endplates: hypointense signal in T1 and hyperintense signal in T2.

MRI of lumbosacral spine, T1 and T2-weighted sequences, sagittal section

MRI findings for facets are:

- joint impingement
- hypertrophy
- hyperintense intra-articular signal in T2-weighted and STIR sequences due to the presence of abundant synovial fluid

It may also present a rounded juxta-articular lesion which is hypointense in T1 and hyperintense in T2 and STIR sequences, due to the appearance of an articular cyst, associated with signs of facet degeneration.

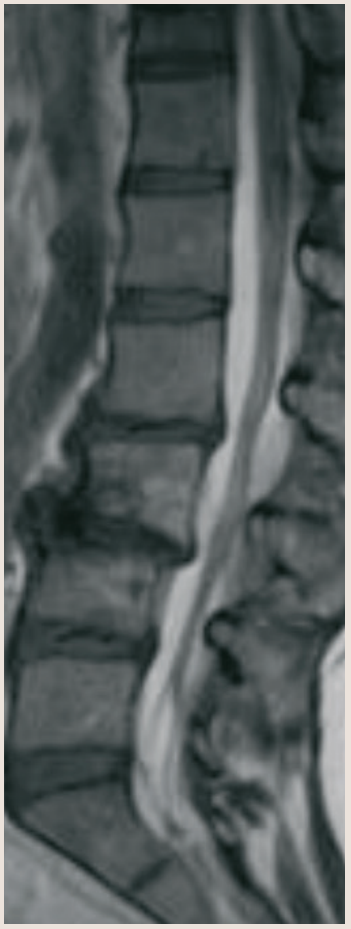
Signs of overall degeneration can progress to a stenosis of variable topography and magnitude, depending on how significant the changes are and the presence of instability.

CLINICAL CASE

A 52-year-old patient with lower back pain and stenosis in L3-L4, for which L3-L4 decompression and arthrodesis were performed a year earlier.

Serious impingement is visible at L3-L4 with local kyphosis.

Lateral X-rays



L3-L4 stenosis is visible.

Pre-operative MRI of lumbosacral spine, T2-weighted sequence, sagittal section

3

L3-L4 arthrodesis can be seen with anterior opening of the disc space.

Post-operative lateral X-ray of lumbosacral spine

One year after surgery, the patient presented poor evolution with progressive pain, requiring further studies.

L2-L3 kyphosis is visible.

Post-operative lateral X-ray, one year after surgery

Underlying ASD with a hyperintense signal in the endplates and stenosis are visible.

Post-operative MRI, T2-weighted sequence, sagittal section, one year after surgery

The patient was treated with medical and orthopedic measures to relieve their pain.

If the manifestation of ASD is a traumatic lesion, the vertebral body may present a hypointense signal in T1 and a hyperintense signal in T2 and STIR sequences, commonly accompanied by anterior collapse.

When the sacrum is the affected area, the fat suppression sequence is usually the most useful to diagnose the fracture, if there is no clear evidence of a trace.

Computed tomography (CT)

CT is not the study of choice. In most cases of ASD, diagnosis and treatment can be planned with just radiography and MRI.

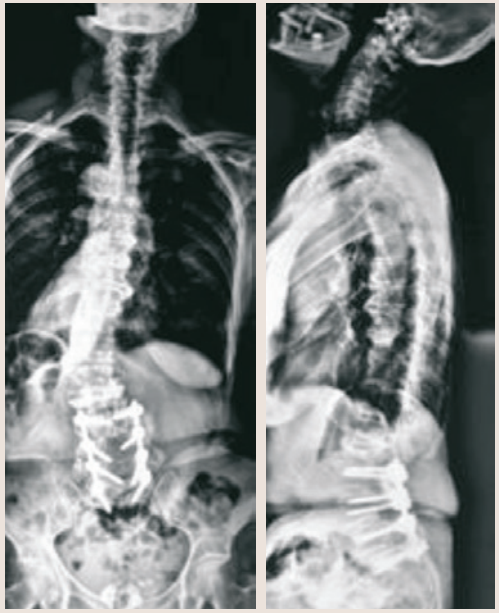
CT can be useful in evaluating signs of facet degeneration or recess or foraminal stenosis.

It can also be useful in cases of repeat surgery to evaluate the presence of bone callus and to plan bone resection.

3

CLINICAL CASE

A 73-year-old patient referring lumbar pain. The patient underwent vertebral fixation surgery from L3 to the sacrum 14 months earlier.

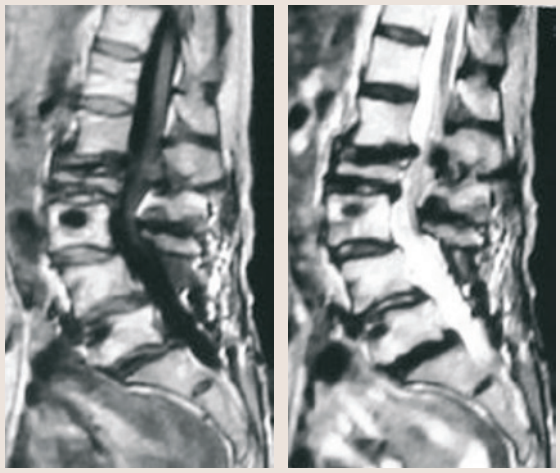


A fracture can be seen over the arthrodesis from L3 to the sacrum.

Anterior and lateral spinographs

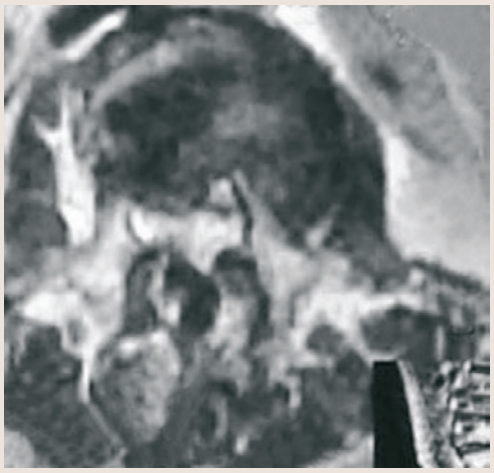
Collapse of L2 is visible.

Computed tomography of the lumbosacral spine, 2D reconstruction, sagittal section



Collapse of L2 canal and stenosis are visible.

MRI of lumbosacral spine, T1 and T2-weighted sequences, sagittal section



Post-traumatic stenosis in L2 is visible.

MRI of lumbosacral spine, T2-weighted sequence, axial section

The patient was treated with medical and orthopedic measures and has shown satisfactory progress to date.

Discography

Discography is as important as it is in the cervical region.

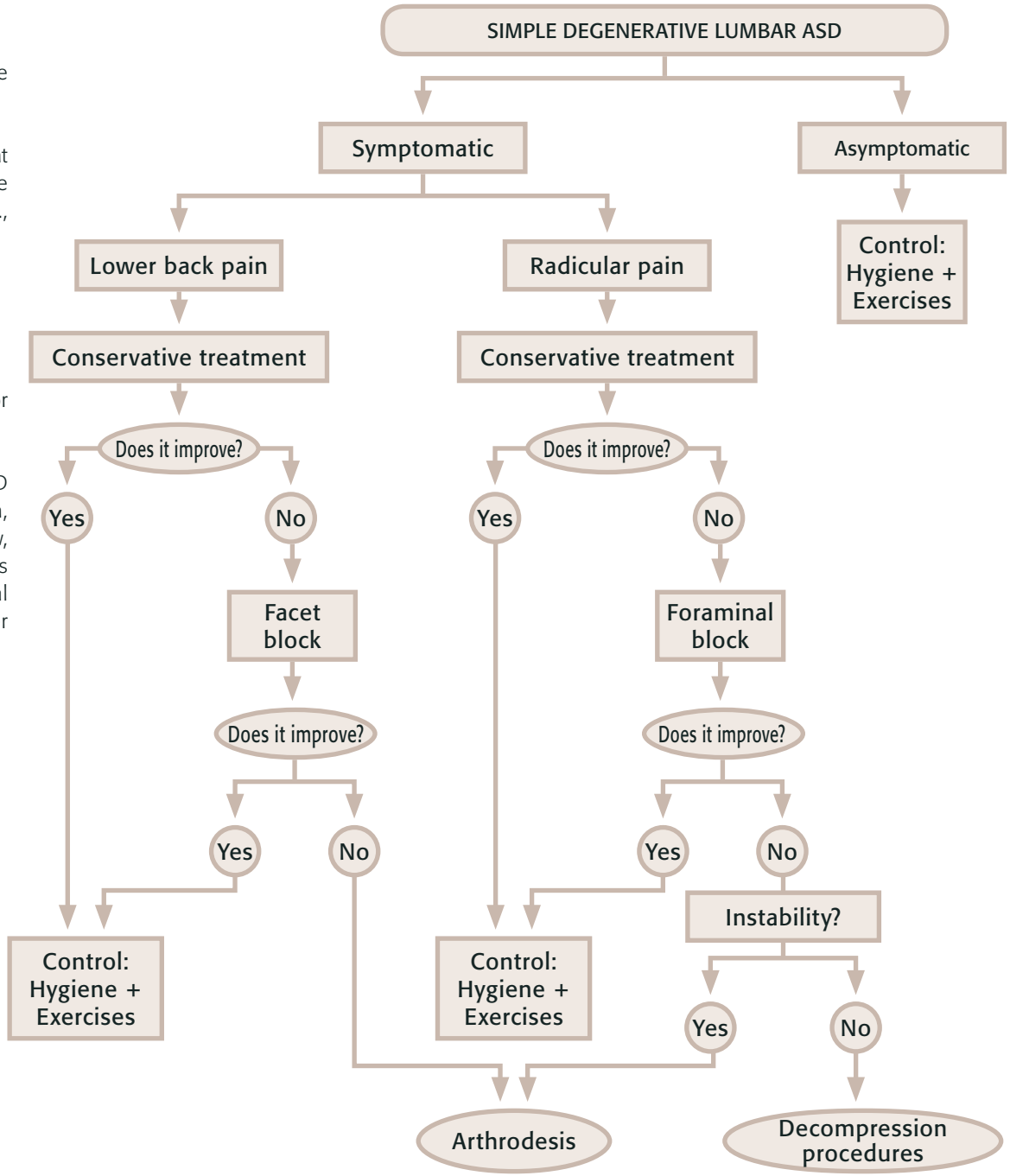
It is a very rarely indicated surgeon-dependent study. Its use is controversial in the literature (Derincek et al., 2007; Manchikanti et al., 2009).

Treatment

Treatment can be conservative (invasive or non-invasive) or surgical.

Only certain patients with lumbar ASD undergo surgery (Riew, Norvell, Chapman, Skelly and Dettori, 2012). In a recent review, Chou did not find comparative studies on conservative treatment versus surgical treatment (Chou, Dekutoski, Hermsmeyer and Norvell, 2012).

Conservative treatment should be initiated in both degenerative and traumatic ASD.



Algorithm for the management of a patient with lumbar ASD

3

Medical treatment

Calcagni (Calcagni and Sarramea, 2012) reported that 77% of cases had favorable outcomes with conservative treatment.

Different medical treatments are required for cases of ASD secondary to degenerative disease compared to cases of ASD caused by a traumatic collapse.

Manifestations of degeneration

These are the most frequent and the medical treatment should be chosen from the following alternatives:

- medication
- physiokinetic therapy
- braces
- retraining
- hygiene

The use of semi-rigid braces, such as a dorsolumbar corset, is especially useful in patients with lumbar scoliosis. Rigid braces provide greater containment but are poorly tolerated in general and are therefore not usually indicated in these patients.

Traumatic collapse

Initial rest is indicated. Braces, such as a cross brace, a Jewett, Knight or TSLO brace are used to improve dorsolumbar flexion.

Blocks

Blocks can be applied to the foramen, epidural or facets. Lumbar block is much more frequent than cervical block.

Foraminal block	In the event of a monoradicular clinical picture, foraminal block is indicated, guided by CT.
Epidural block	Epidural block is useful when compression is multiradicular with narrowing at more than one level.
Facet block	If the clinical picture is caused by posterior arthrodesis, the patient may benefit from facet blocks.

Percutaneous techniques for vertebral cementing

In the case of vertebral collapse, percutaneous vertebral cementing could be indicated and performed as vertebroplasty, kyphoplasty or stentoplasty.

Surgical treatment

Surgical treatment is indicated in the event of conservative treatment failure or a cauda equina syndrome (Chou et al., 2012).

There are various alternatives for surgery:

Surgical treatment

- A) Anterior approach
- B) Lateral approach
- C) Posterior approach
- D) Combined approach

3

The most suitable route to resolve discovertebral compromise with or without minimal compression, and with a loss of segmental lordosis, may well be an anterior approach.

A) Anterior approach

Anterior approach alternatives include anterior lumbar interbody fusion (ALIF) and disc prosthesis.

- For ALIF, the patient is placed in dorsal decubitus position, with support for the lumbar region. Vascular monitoring in both halluces is recommended, especially on the side of the approach.
- The incision will depend on the level under treatment. Anterior incisions or a retroperotineal can be performed. A left side approach is recommended.
- Both the midline approach and lumbotomy will reach the anterior face of the left iliopsoas via the retroperitoneal space. This allows an anterior approach to the disc and vertebral endplates.
- It is important to mark the midline so the reference is not lost.
- The normal procedure is discectomy and anterior arthrodesis with a cage and a graft, which is either fixed with screws from the cage or by adding a plate. The use of screws in the cage reduces access needs, preserves the segmental vessels and reduces mobilization of the large vessels. In any event, the cage is filled with bone graft from the patient's iliac crest, if possible.
- Symmetrical positioning is controlled with an image intensifier.

If the surgeon chooses disc prosthesis, the approach is similar.

Other possible complications are ureter and lumbar root injuries, sympathectomy, retrograde ejaculation, deep vein thrombosis and infection (Hrabalek, Adamus, Gryga, Wanek and Tucek, in print). In addition to the possibility of infection, more long-term complications are associated with the implant:

- failure in consolidation
- loosening,
- loss of implant location

Vascular injuries are the most significant surgical complications. The team should include a vascular surgeon if the spine surgeon is not experienced enough to resolve these complications.

B) Lateral approach

In recent years, the minimally-invasive lateral lumbar interbody fusion (XLIF) has become increasingly popular. This technique achieves three goals:

- indirect decompression
- anterior arthrodesis
- lordosis improvement

Some of the characteristics of this approach are as follows:

- The patient is in lateral decubitus and with neurophysiological monitoring.
- The approach is trans-psoas.
- A discectomy is performed with placement of a lateral cage resting on the endplates and their lateral edges, with anterior and posterior vertebral ligaments untouched.
- The ribs may make it difficult to reach the upper levels. It may be difficult to perform an XLIF below L4 in function of iliac crest height.

The lateral transpsoas approach can involve complications such as radicular injuries, which are usually transient.

3

The posterior approach should be performed in cases of radicular compression that require decompression.

C) Posterior approach

Most surgical treatment for lumbar ASD is performed through a posterior approach.

Some of the characteristics of this approach are as follows:

- Given the need for decompression, it is recommended to achieve this first, until good sacroradicular mobility is obtained.
- If arthrodesis is necessary, bilateral pedicle instrumentation is recommended before placing the iliac crest graft.
- If implanting a graft on the body (360°) is considered necessary, this can be done using either a PLIF or TLIF. Many authors (Miwa, Sakaura, Yamashita, Suzuki and Ohwada, in print; Parker et al., 2012) recommend the use of an anterior graft, although the large majority of cases can be solved with posterolateral arthrodesis alone.
- Part of the facets can be preserved and prepared to favor the arthrodesis, increasing the likelihood that the patient will not require an anterior graft.
- Although certain authors (Korovessis, Repantis, Zacharatos and Zafiropoulos, 2009; Fabrizi, Maina and Schiabello, 2011) mention the use of interspinous devices in the transition (topping off), there is no evidence that their use reduces the appearance of ASD in comparison with arthrodesis (Siewe et al., 2011).

The most frequent surgical complication is damage to the dural sac. This must be detected and sutured during the operation.

CLINICAL CASE

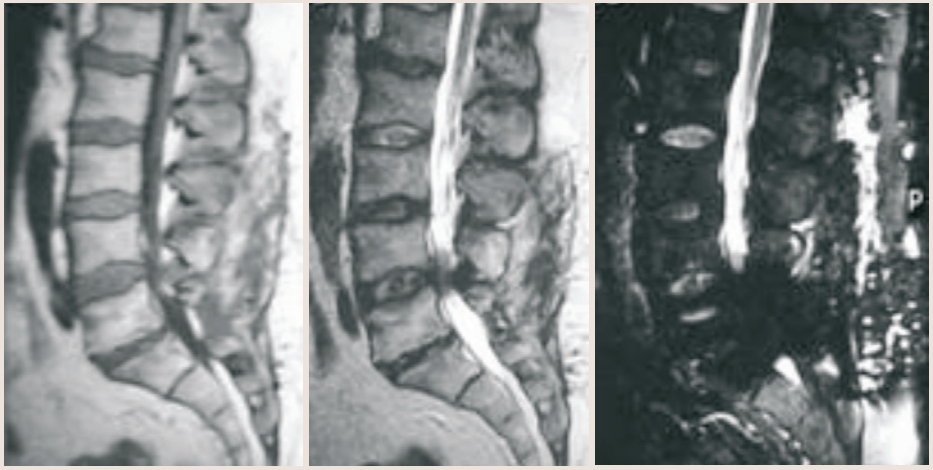
Patient, aged 41, suffering from back pain with radiation to lower limbs. The patient underwent surgery with L5-S1 decompression and instrumented posterolateral arthrodesis.

L5-S1 osteosynthesis is visible.

Post-operative anterior and lateral X-rays of lumbosacral spine

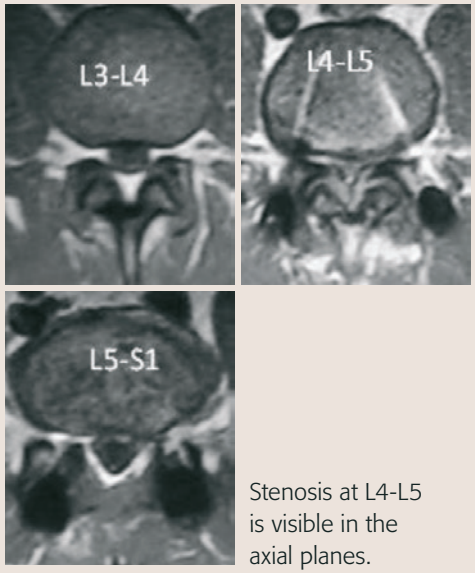
3

Two years after surgery, the patient suffered the onset of persistent lumbosciatic pain.



Stenosis at L4-L5 is visible.

MRI of lumbosacral spine, T1 and T2-weighted and STIR sequences, sagittal section



Stenosis at L4-L5 is visible in the axial planes.

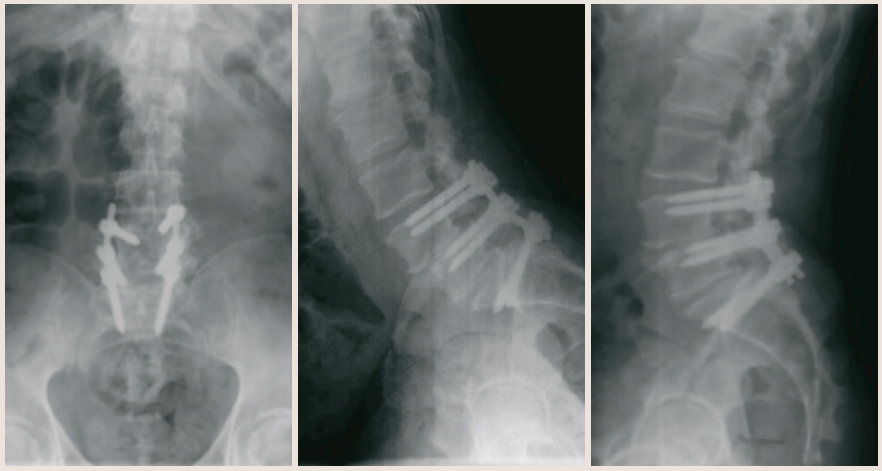
MRI of lumbosacral spine, T1-weighted sequence, axial section

The symptoms were deemed to be the result of ASD at L4-L5 and a new surgical treatment was performed with extension of decompression and instrumented arthrodesis reaching L4.

Arthrodesis extension to L4 can be seen.

Post-operative anterior and lateral X-rays of lumbosacral spine

Two years after surgery, the patient again presented mechanical lower back pain.



Evidence of hypermobility is visible in segment L3-L4.

Anterior and lateral X-rays during flexion and extension

Degenerative changes are visible at L3-L4.

MRI, T2-weighted sequence, sagittal section

Apparent L3-L4 segment hypermobility is visible.

Computed tomography, sagittal reconstruction

The pain symptomatology was interpreted as ASD at L3-L4. Medical treatment was provided and the patient continues in a rehabilitation program.

If a combined approach is necessary, it can be started with either an anterior or posterior approach, depending on each patient and surgeon preference.

If the approach stages are performed on the same day and the anterior approach is performed via lumbotomy, it is recommended that the patient be properly immobilized with stops and straps so the operating table can be rotated 90º, to facilitate a smooth transition from the anterior to the posterior approach.

In some situations, this calls for simultaneous control of both approaches by two surgical teams.

Summary:

LUMBAR ADJACENT SEGMENT DISEASE

Lumbar ASD generally presents with degenerative changes, although presentation as a fracture adjacent to an operated vertebral segment (usually arthrodesis) is also possible.

Clinical presentation can be lower back pain, radicular pain or intermittent nerve claudication.

The complementary studies of choice are X-rays and MRI.

Degenerative lumbar ASD can be asymptomatic. In the event of clinical manifestations, conservative treatment is commonly useful.

When surgery is indicated in cases of simple ASD, surgical procedures usually involve decompression alone and/or fixation of one segment, generally via the posterior approach. In cases of complex lumbar ASD, surgery usually requires the addition of osteotomies or combined approaches.

4. THORACIC ADJACENT SEGMENT DISEASE

ASD presenting in the thoracic spine has been underestimated, possibly because this region has less mobility than the cervical or lumbar spine and due to the higher frequency of ASD in the two latter regions.

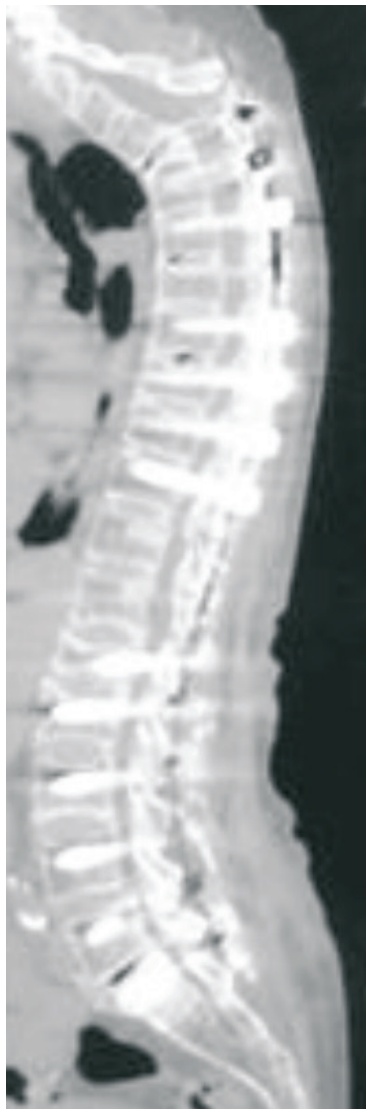
Improvements in the rigidity of instrumentation, as well as extension to the thoracic spine using implants, have increased the interest in thoracic ASD in recent years.

Although degenerative phenomena are infrequent, it is important to recognize (superior) proximal junctional kyphosis with a Cobb angle greater than 10° in the vertebra overlying a long arthrodesis. Proximal junctional kyphosis is caused by wedging of the vertebral body, although it can also be due to a discoligamentous injury or the patient's advanced age, in general terms.

The cause of this complication is not completely clear and is present in 39% of adults who have undergone surgery with long arthrodesis due to deformities (Mendoza-Lattes, Ries, Gao and Weinstein, 2011).

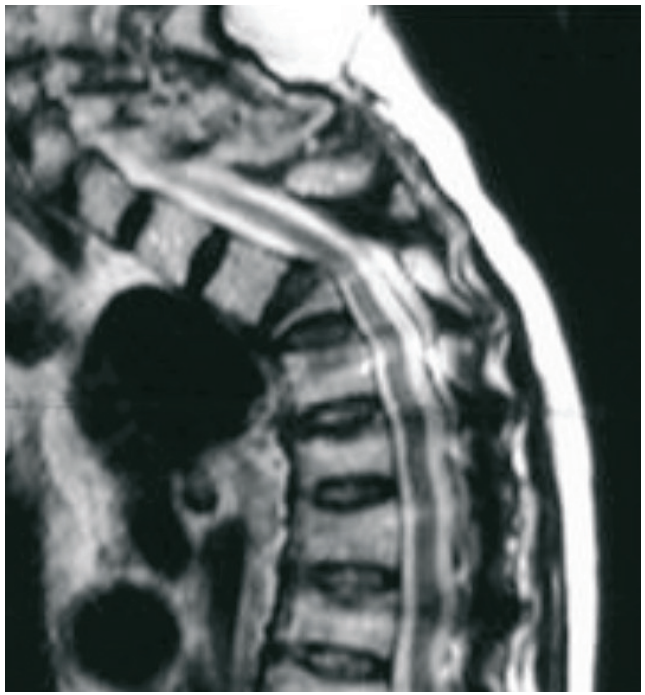
The guidelines for clinical evaluation, complementary studies and treatment are similar to those described for the lumbar spine.

Images of a patient with a T2 fracture indicating ASD overlying an arthrodesis from T3 to the sacrum is presented below as an example.



Arthrodesis performed from T3 to the sacrum and T2 fracture are visible.

Computed tomography of thoracic spine, sagittal reconstruction



Arthrodesis performed from T3 to the sacrum and T2 fracture are visible.

MRI of thoracic spine, T2-weighted sequence, sagittal section

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