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Inflammatory, Metabolic and Genetic Pathology

Rheumatoid Arthritis in the Cervical Spine: Surgical Treatment

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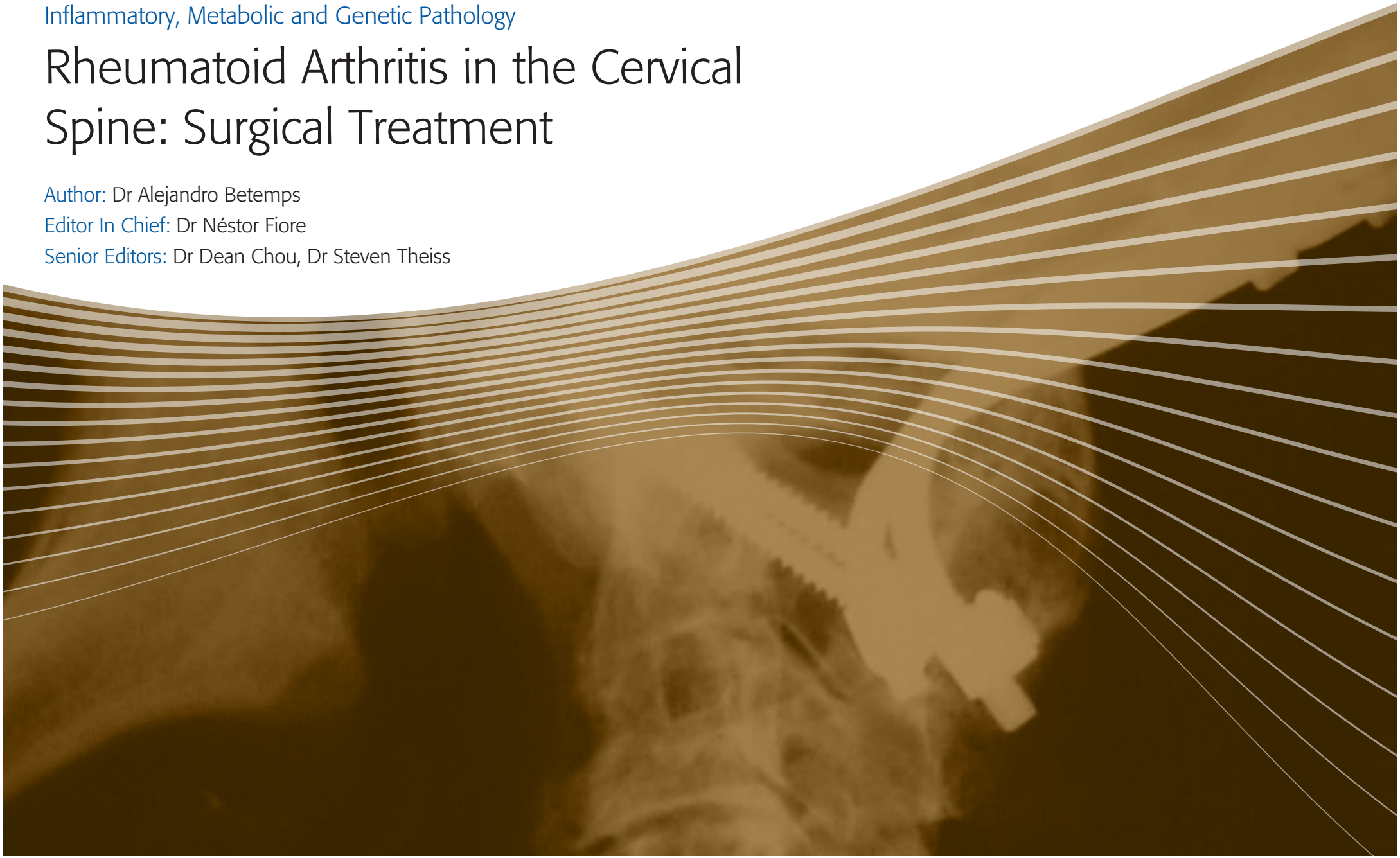

OBJECTIVES

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Inflammatory, Metabolic and Genetic Pathology

Rheumatoid Arthritis in the Cervical Spine: Surgical Treatment

- To define the surgical indications for rheumatoid arthritis in the cervical spine.
- To describe the details of recommended surgical techniques.

CONTENTS

1. INTRODUCTION

Overview

Surgical treatment should be considered in a patient with cervical pathology due to rheumatoid arthritis if certain conditions are met, as explained below.

With regard to surgical treatment in any rheumatic patient, it is important to check the oral cavity during the pre-operative evaluation; if not adequate, intubation with endoscopy should be planned.

Disabling pain or neurological deficit

C1-C2 subluxation with mobility between both vertebrae

- Neutral X-ray: PADI* ≤ 14 mm
- X-ray in flexion: PADI < 10 mm
  AADI** ≥ 10 mm
- Neutral MRI: Retro-odontoid pannus ≤ 14 mm
  Cervicomedullary angle < 135º
  SAC*** ≤ 13 mm
- MRI in flexion: SAC < 6 mm

Basilar impression with occipitocervical mobility or with medullar oblongata compression

Subaxial subluxation with mobility with anteroposterior diameter of the canal ≤ 14 mm

*PADI: Posterior Atlanto Dental Interval
**AADI: Anterior Atlanto Dental Interval
***SAC: Space Available for the Cord

This section addresses the upper and lower cervical spine.

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2. UPPER CERVICAL SPINE

Once surgery has been decided, the type of procedure must be planned. This requires analyzing two items:

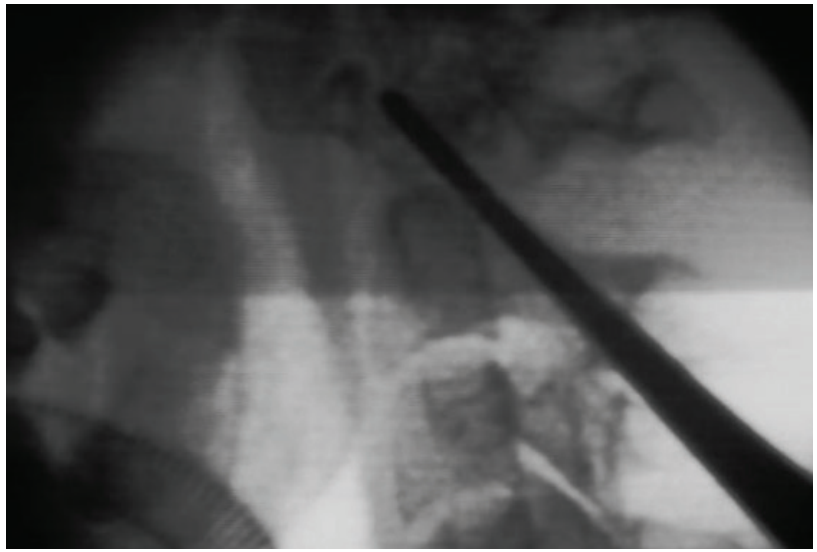
- the anatomy of the vertebral arteries (VAs) in order to choose the most appropriate instrumentation;
- the condition of the levels adjacent to the area that is to be operated on: if there are clear signs of instability or articular compromise in the imaging studies, such as dynamic radiology and magnetic resonance imaging (MRI), these should be included in the fusion.

C1-C2 stabilization

Surgical positioning

The following should be considered:

1. After intubation, place the patient in the ventral decubitus postion with a skull clamp. Neurophysiological monitoring: somatosensory evoked potentials (SEPs) and motor evoked potential (MEPs) should be performed before and after positioning.
2. Tape the shoulders to the feet of the operating bed with minimum traction to stabilize the trunk and improve fluoroscopy visualization. Prep-out the iliac crest to obtain the graft if necessary.
3. The arms should rest alongside the body. Lateral imaging with an image intensifier allows examination of the C1-C2 position and verification of the feasibility of placing the instrumentation in the correct path before prepping the operating field.



The position of the head should be corrected if the entry point of the screws is much lower than the cervicothoracic region.

Fluoroscopic check simulating the path of the C2-C1 transarticular screws

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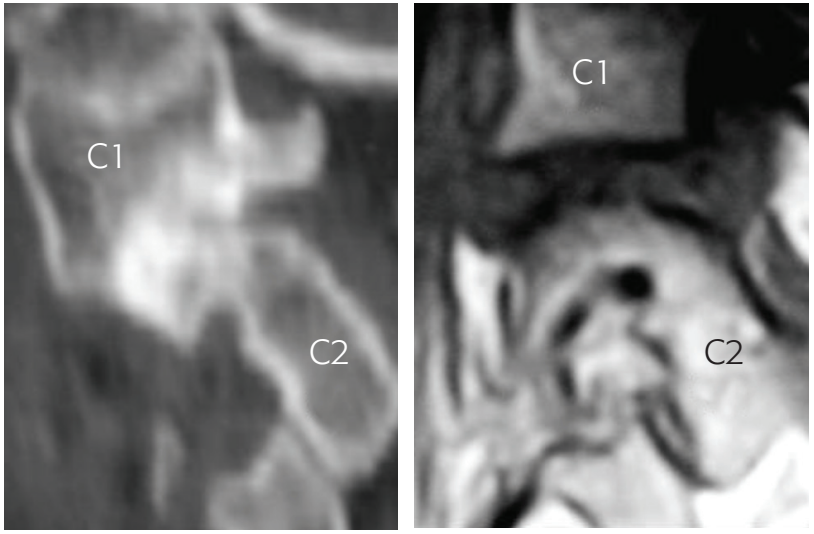
The VAs take a sharp lateral curve in 80% of individuals, immediately below the C2 superior articular process. If the curve takes places in a very superior, very posterior or very medial position, this may preclude a transarticular screw.

Technique

There are several instrumentation options for C1-C2. The choice depends on the vertebral arteries (VAs) path. Given that this path is variable, C2 pars dimension for the placement of the screw can also vary (Mandel, Kambach, Petersilge, Johnstone and Yoo, 2000).

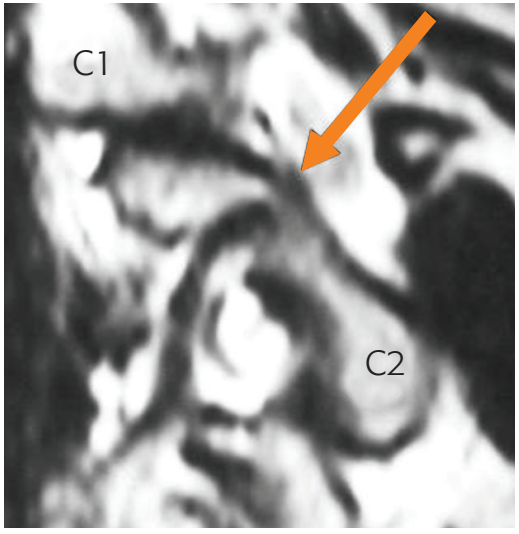
Axis dimensions and VA path must be identified in the pre-operative evaluation for adequate instrumentation planning.

- If the pars anatomy is favorable, transarticular C1-C2 instrumentation following the Magerl technique is one option.
- If sagittal sections from MRI or computed tomography (CT) reveal a significantly narrow pars, then other alternatives for C2 fixation should be considered, in addition to placing a screw in the C1 mass. The following alternatives are available in this situation:
  - A pedicle screw in C2 which is in a converging direction;
  - translaminar screw in C2;
  - unilateral instrumentation plus wiring.



C2 pars can be seen in both images, allowing for the placement of a transarticular screw.

Computed tomography and MRI, parasagittal sections



Narrow C2 pars and high-riding VA is visible. This patient has a higher risk of vertebral artery injury if a transarticular screw is placed on this side.

MRI, sagittal section

It is important to remember that the path of the VAs may not be symmetrical; therefore, the patient may require a different type of instrumentation on the right and left.

Regardless of the screw technique used, the procedure is completed with a Gallie arthrodesis using an autologous graft from the iliac crest if the C1 and C2 laminae are left intact.

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C2-C1 transarticular screw technique

The suggested technique for C2-C1 transarticular fixation is that described by Magerl, without using K-wires or opening the joint to check screw location (Magerl and Seemann, 1986).

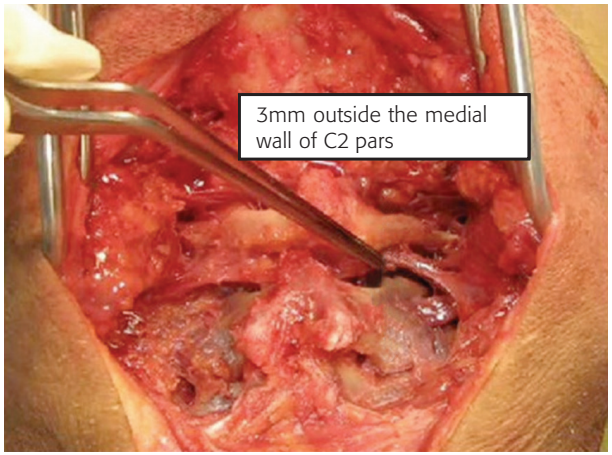
This technique uses two parallel cortical screws (one on the right and one on the left) with a diameter of 3.5 mm and 34–45 mm long, as well as the following elements for placement:

- a power drill;
- two drill bits;
- two drill bit guides (to protect soft tissue)
- a screwdriver.

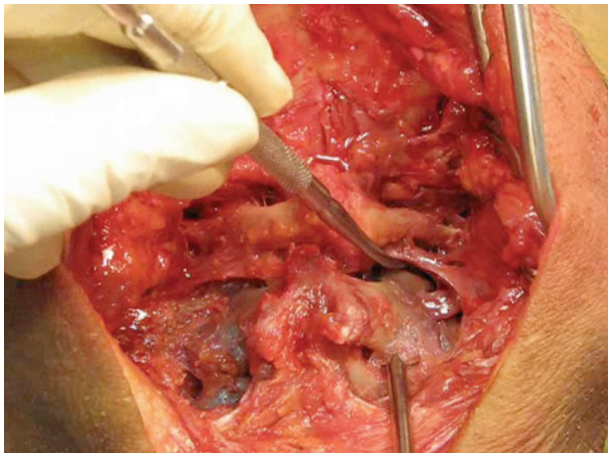
The technique is implemented in the following steps:

1. Move the spinous process of C2 cranially to obtain reduction.
2. Use the first bit to maintain the reduction, while placing the contralateral screw.
3. Place the structural bicortical iliac crest graft on C1 and C2 with non-resorbable suture or sublaminar wire.

The screws are placed with lateral fluoroscopy.



Note that the screw trajectory is strictly sagittal, following the direction of the arrow. The continuous black line marks the internal edge of the pars.



The point of entry is 2–3 mm above the C2-C3 joint space. It is useful to place a Penfield retractor to view the upper and medial aspects of the C2 pars.

C2-C1 transarticular screw

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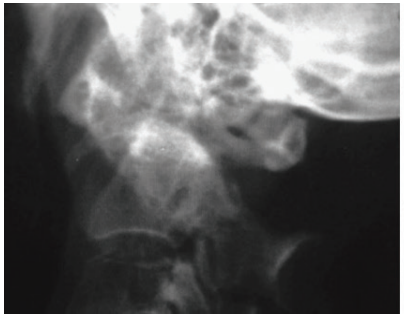
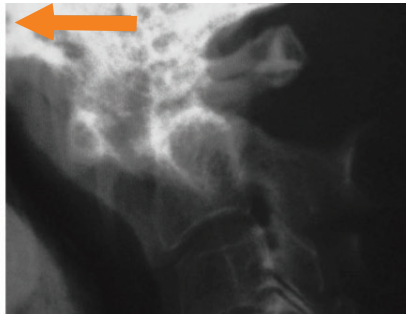
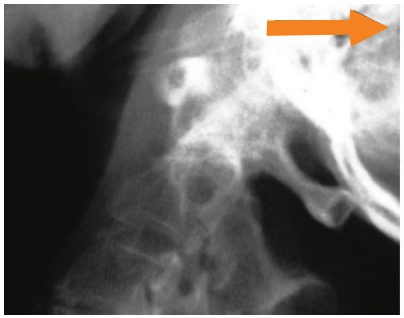
X-ray images in hyper-extension of a 62-year-old patient with C1-C2 subluxation that is not completely reduced are presented below as an example.



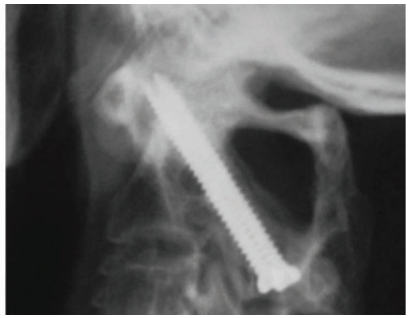
Neutral position.



In flexion.



In extension.



Post-operative control with two C2-C1 screws and consolidated graft.

Lateral X-rays before and after surgery

In these patients, the traditional path of the screws must be modified to reduce the possibility of vertebral artery lesions. Instead of directing the screws toward the upper half of the C1 anterior arch, they are placed in a more posterior position, following the posterior aspect of the C2 pars (Neo et al., 2003).

Technique for screw placement in C1 lateral mass

This technique was first described by Goel (Goel and Laheri, 1994). Afterwards, many authors published various options regarding screw entry points and direction (Christensen, Eastlack, Lynch, Yaszemski and Currier, 2007; Harms and Melcher, 2001; Ma et al., 2005).

It is recommended to analyze the size of the posterior arch of C1 in the sagittal view of the CT (Tan et al., 2003).

- If larger than 6 mm, one option is to place the C1 screw through the posterior arch, with entry at the lower edge of the arch.

  This is not the preferred option

- Alternatively, the screw can be placed directly underneath the posterior arch of C1 in the center of the lateral mass, retracting the C2 nerve downwards.

In both situations, the path is strictly straight, in the center of the C1 mass, toward the lower half of the C1 anterior arch.

The left CT shows the feasibility of placing a screw in C1 through the posterior arch. This is not seen on the right one.

Computed tomography, parasagittal sections

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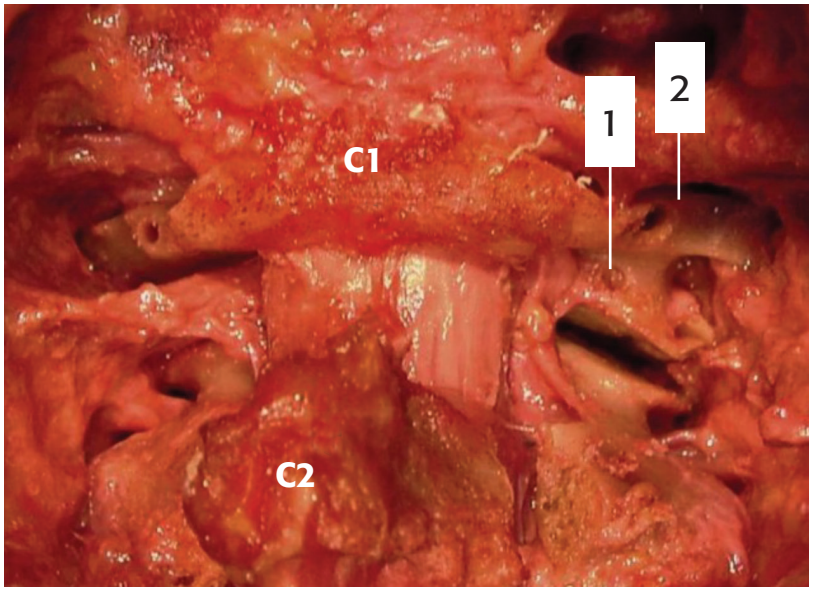
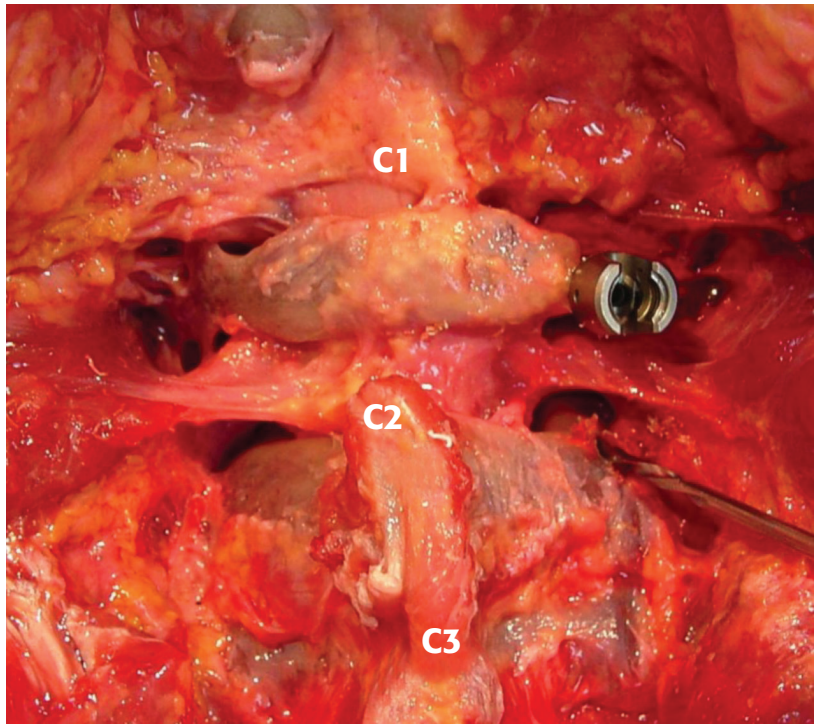


1. Point of entry for screws in C1 lateral mass

2. Point of entry for screws in C1 through the arch

The C2 nerve has been transected on the right side and the C1-C2 joint capsule is open.

Dissection of C1 and C2



The screw is placed in the right lateral mass of C1. The point of entry for the C2 screw is in line with the upper margin of the lamina. The direction is converging, following the medial aspect of the C2 pars, as shown by the drill bit.

Placement of the screw in the pedicle of C2.
(supero-external point of entr y in a converging direction)

Technique for screw placement in the C2 pars

Screw in the C2 pars with supero-lateral point of entry and in a converging direction.

The upper edge of the lamina is used as the guide for the point of entry. The path converges, following the medial edge of the C2 pars, under the superior articular facet of C2.

The indications for this type of screw and those for a transarticular screw are not interchangeable.

A patient can have a C2 pars that is suitable for transarticular instrumentation but unsuitable for the placement of a C2 pedicle screw with a supero-external point of entry in a converging direction.

The axial sections of the CT should be examined before surgery to ensure that the size of C2 pars pedicle allows this technique to be performed.

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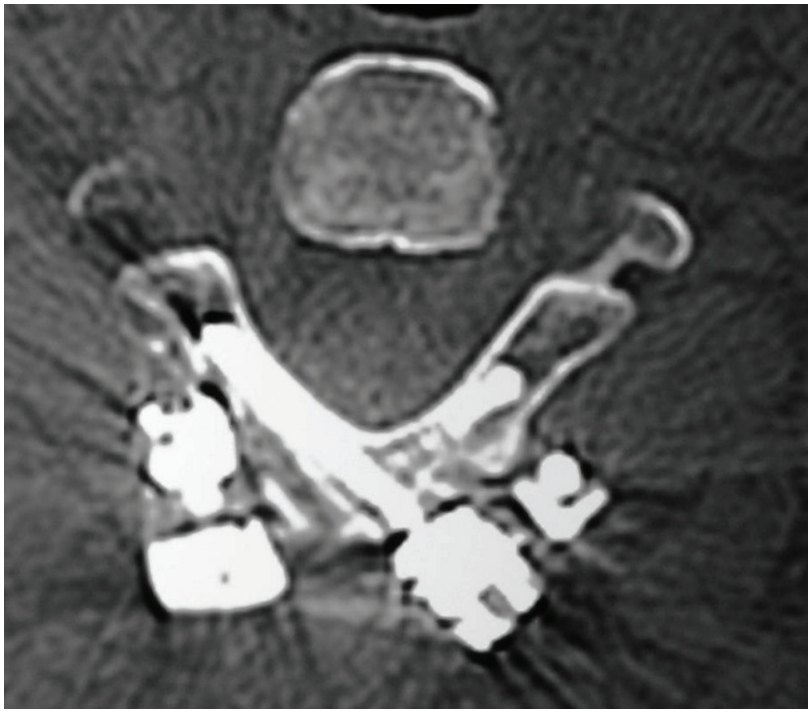
This is generally a straightforward screw to place since the lamina is directly visible and the VAs are distant.

Translaminar screw

This screw was first described by Wright (2004). It is placed in the thickness of the C2 lamina.

- The point of entry is over the lamina at the base of the spinous process and parallel to the posterior aspect of the lamina.
- For the screw to penetrate the right lamina, the point of entry must be the left lamina, and vice versa.

Placement of the first screw should leave room for the second screw. The screws will need to cross at the midline. They are generally up to 30 mm long.



Computed tomography of C2 with translaminar screw technique, axial section

Facet screw

The facet screw has the same point of entry and direction as the transarticular screw, but is shorter and does not pass through the superior articular facet of C2.

The length depends on the vertebral artery path.

Complications

Listed below are some of the possible complications that may appear during C1-C2 stabilization.

- Upper cervical spine surgery always involves the risk of vertebral artery lesion, either during the approach, the instrumentation or when using the drill (Wright and Lauryssen, 1998).
- Lesions of the internal carotid artery when passing through the anterior aspect of the C1 lateral mass has also been described; thus, some authors recommend not crossing the anterior cortical structure with the instrumentation (Currier, Maus, Eck, Larson and Yaszemski, 2008).
- Lesions of the hypoglossal nerve can be secondary to the placement of very long transarticular screws that affect the hypoglossal canal or its pre-condylar exit at the base of the skull (Ebraheim, Misson, Xu and Yeasting, 2000).
- C1 screws can invade the Occiput-C1 articulation if placed in an ascending or acutely converging direction.
- Patients may refer pain in the C2 nerve region caused by surgical manipulation, especially when the screws are placed directly at the level of the posterior aspect of the C1 lateral mass. This is because the space available for work has been reduced by the destruction of the C1-C2 articulation.

An anatomical analysis during pre-operative planning can help in the choice of the most appropriate screw placement technique for each patient, thereby reducing the rate of these complications.

Post-operative follow-up

The patient should mobilize quickly after surgery with or without any external immobilization. Fusion times vary, since C1 union is generally slower than C2.

Occipitocervical stabilization

Surgical positioning

The position is similar to the one described above. It is important to ensure that the head is aligned with the trunk, with no rotation or inclination. It is useful to mark the cranial midline before placing the drapes so it may act as a reference when the surgical incision is made.

Technique

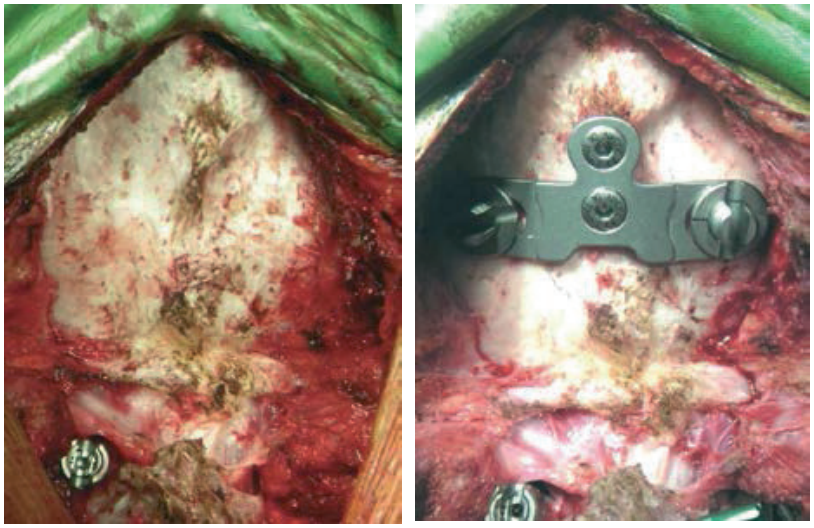
Occipitocervical instrumentation combines any of the previously mentioned techniques with fixation to the occipital bone. As mentioned above, the choice of upper cervical spine instrumentation depends on the path of the VAs.

The occipital screws should be placed on the midline, at the level of and below the superior nuchal line. This corresponds to the area of greatest occipital thickness, which is the external occipital protuberance (EOP). The EOP measures 11 to 17 mm in the center and its thickness diminishes radially. These screws fix a plate to the occipital bone and are joined to the rods by lateral connectors

Note that the thickness of the EOP diminishes radially outward.

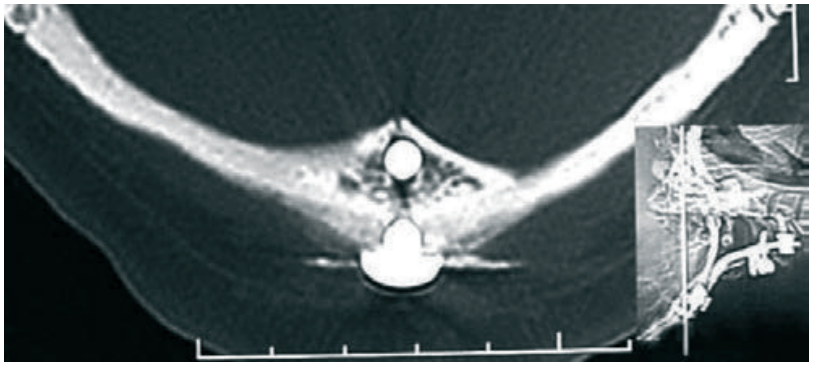
Computed tomography to monitor the screws in the occipital bone, axial section

(Ebraheim, Lu, Biyani, Brown and Yeasting, 1996; Zipnick et al., 1996).



The photograph shows an occipital plate screwed to the EOP at the level of and below the superior nuchal line.

Intra-operative images of occipital plate



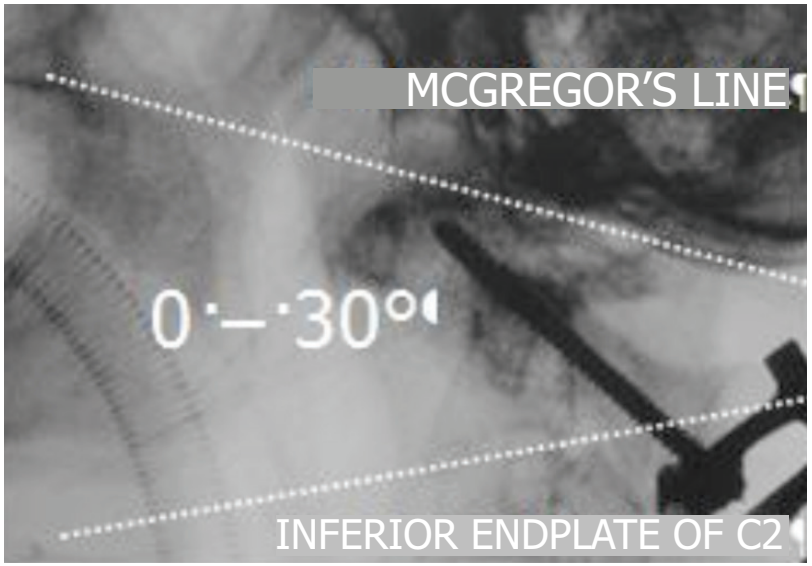
Note that the thickness of the EOP diminishes radially outward.

Computed tomography to monitor the screws in the occipital bone, axial section

The external table contributes 45% of occipital bone thickness, while the internal table contributes only 10%; thus, there are authors who prefer unicortical screw placement. This reduces complications without significantly diminishing resistance to pullout.

Once both instrumentations have been performed, and before placing the connecting rods, the angle between the skull and the cervical spine should be checked by fluoroscopy.

It is crucial that the patient's head is positioned properly, as it could affect swallowing and gaze. A guideline is to measure the angle between McGregor's line and the interior endplate of C2. This angle should be no greater than 30°.



The guiding angle can be seen between McGregor's line and the base of C2, which should be no greater than 30 degrees

Intra-operative fluoroscopic control of the cranial position in relation to the cervical spine

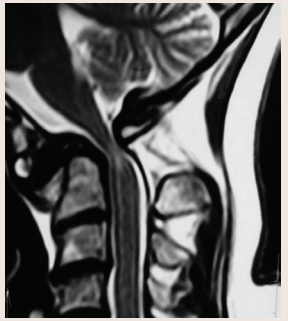
The procedure is completed by placing the bicortical autologous iliac crest graft, usually from the occipital bone to C2.

CLINICAL CASE

A 52-year-old patient diagnosed with rheumatoid arthritis two years ago. The patient presented Class 1 pain and Class IIIA neurological impairment.

Established deformity with little mobility in extension is visible.

Pre-operative lateral X-ray of the cervical spine

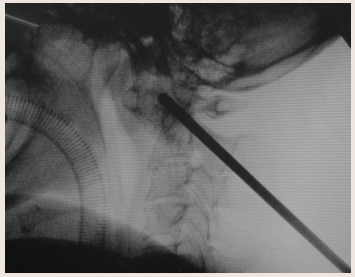


Deformity and severe spinal cord compression is visible.

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

It was decided to perform occipital stabilization at C2, using plate fixation to the occipital bone and C2-C1 transarticular screws.

View of external mark to indicate the direction of the C2-C1 screws.



Control view on the monitor.

Intra-operative photographs

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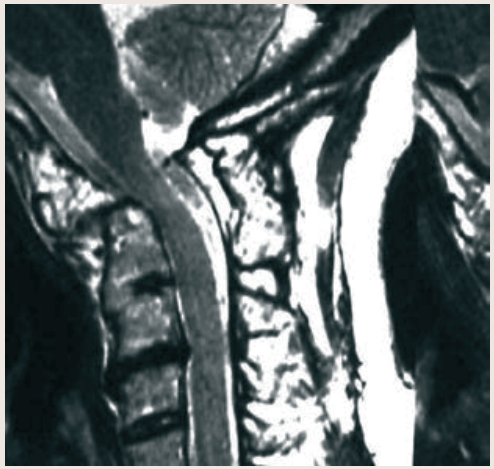
The patient presented well post-operatively.

Control image showing the graft in place.

Post-operative lateral X-ray of the cervical spine



Decompressed spinal cord is visible.

Post-operative MRI of the cervical spine, T2-weighted sequence, sagittal section

Complications

The following are related to over penetration of the inner table of the occiput:

- dural lesion;
- cerebellar lesion;
- penetration of a venous sinus;
- subdural hematoma.

Unicortical screw placement reduces the likelihood of these complication, without significantly reducing the resistance to pullout.

Post-operative follow-up

Post-operative follow-up is similar to the follow-up for upper cervical spine stabilizations.

Summary:

UPPER CERVICAL SPINE

The choice of the type of instrumentation to use in the upper cervical spine depends on the path of the vertebral arteries.

In occipitocervical instrumentation, the head should remain in a position that allows the patient to see the floor while walking and does not impede swallowing. It must not be left in flexion or extension under any circumstances.

On the other hand, "watchful waiting" is not recommended in rheumatoid arthritis, in patients with frank instability and impending neurologic deterioration as defined by the parameters outlined above.

3. LOWER CERVICAL SPINE

Anterior approach

The anterior approach can be performed in isolation or used as a complement to a posterior approach in patients with frank anteroposterior instability.

Surgical positioning

The patient is placed in the supine position. The position is similar to the one used in degenerative diseases. In instances of myelopathy, the surgeon must only extend the neck to the limits of voluntary extension, or rely on pre and post positioning neuromonitoring to ensure positioning has not caused any neurologic compromise.

Placement of cervical traction is useful in patients with severe instability, since it facilitates the reduction of anterior subluxations.

The upper limbs of the patient must be handled with care to prevent fractures, avoid performing traction from the wrists.

Technique

The Smith-Robinson approach is used, medial from the internal margin of the sternocleidomastoid muscle and the neurovascular bundle. Decompression is performed in the conventional manner.

The autologous bone of the iliac crest may have poor resistance to load; therefore, the use of cages filled with cancellous bone graft may be considered. The use of bicortical screws may be necessary, given the loss of bone quality in the vertebral bodies.

Post-operative follow-up

When the anterior approach is completed with posterior stabilization in the same surgical intervention, post-operative follow-up is similar to that mentioned above.

If the anterior approach is the first step of a combined procedure, activity should be restricted between both stages, and a Philadelphia collar should be used to reduce the probability of instrumentation failure.

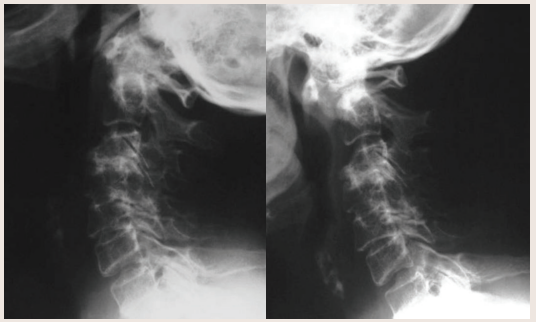
Posterior approach

Instrumentation of the lower cervical spine can be done in addition to fixation in the upper cervical spine with the aim of stabilizing unstable segments or segments with degenerative joint changes.

CLINICAL CASE

A 53-year-old patient with unstable gait, cervical pain and RA, receiving rheumatology therapy.

Lateral X-ray of the cervical spine in neutral position



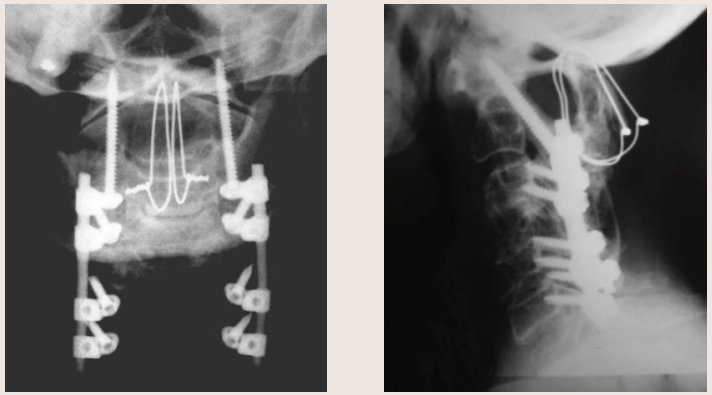
Instability in C1-C2 is visible.

X-rays in flexion and extension

C3-C4 compression and C4-C5 and C5-C6 disc disease can be seen.
The C6-C7 segment does not present instability and the disc appears intact.

MRI, T2-weighted sequence, sagittal section

Release at the level of compression was performed, as well as arthrodesis from C1 to C6.



Frontal and lateral post-operative control X-rays

It would be ill-advised to end a fusion of the upper cervical spine in a motion segment that presents evident signs of degeneration, since this could quickly trigger a distal mechanical overload. This criterion makes it sometimes necessary to extend the fixation to the upper thoracic spine.

Surgical position

The surgical position is similar to the one described for the posterior approach of the upper cervical spine.

Technique

The usual technique in the lower cervical spine is screw placement in the lateral masses. At C7, pedicle srews can be used as an alternative.

- Certain previous anatomic variations should be checked during pre-operative planning.
- The size of the lateral masses should be verified in the sagittal sections of the CT. Joint erosion frequently causes enough destruction of the lateral mass to impede screw placement or force a change of entry point or conventional screw trajectory.
- It is also useful to verify the path of the vertebral artery, since an anomaly in this path can change the shape of the lateral masses.
- Osteoporosis can prompt the need to place screws with bicortical fixation.
- It is useful to determine the point of entry of the C7 pedicle screws with the assistance of direct palpation of the superior and medial aspects of the pedicle by performing a minimal laminotomy at C6-C7.

- It is important to confirm beforehand that the vertebral artery does not enter the spine at C7, as occurs in 5% of the population. These screws are placed at a 10º to 15º angle in the caudal direction, relative to the inferior vertebral endplate of C7, and at a converging angle of between 25º and 45º. In many patients, it is impossible to view the C7 vertebral body with lateral fluoroscopy.

Complications

One of the complications of this technique is the possible injury of the vertebral artery and the spinal nerves.

Given the progressive nature of the underlying disease, over time the patient may require the fusion to be extended due to lesions in adjacent segments.

Post-operative follow-up

The type and period of post-operative immobilization will depend on screw resistance to pullout, which must be evaluated by the surgeon during placement.

Combined approach

As mentioned above, anterior approach is rarely performed in isolation for rheumatic patients with significant deformity or instability.

If the patient presents with frank instability and kyphosis, then general recommendations are to plan an anterior approach followed by a posterior approach. The same is recommended for patients with multi-level synostosis and unstable lesions in the remaining mobile segments. These two surgical stages can be performed on the same day or different days.

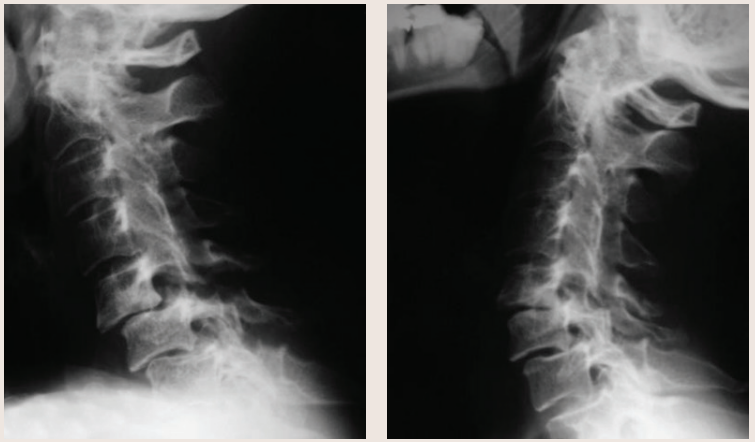
If a single posterior approach is planned, but a segment with anterior support deficit remains after finishing the procedure, then a second operation should be planned for the placement of an anterior support.

CLINICAL CASE

A 47-year-old patient with severe chronic cervical pain and difficulty walking.

Posterior C3-C5 synostosis and C5-C6, C6-C7 and C7-T1 listhesis can be seen.

Lateral X-ray of the cervical spine



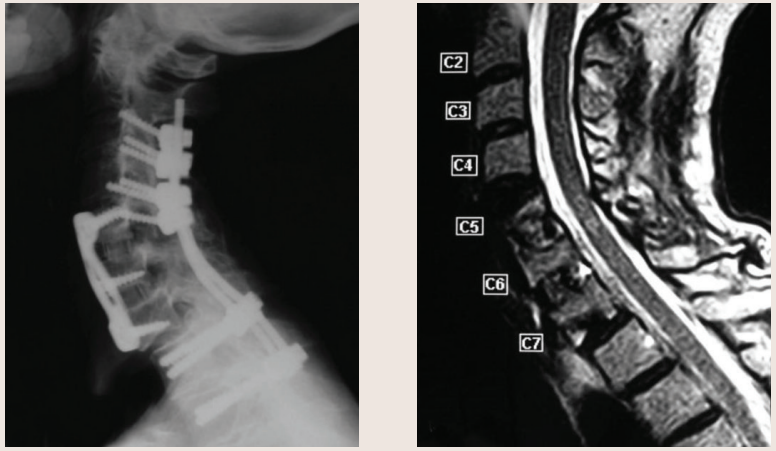
Severe C5-C6 and C6-C7 instability and erosion of C6 lateral masses are visible.

X-rays in flexion and extension

Stenosis is visible with signs of myelomalacia, predominantly in C5-C6.

Preoperative MRI, T2 weighted sequence, sagittal section

Discectomy and anterior arthrodesis with autologous iliac crest graft + PEEK cages + anterior C5-C7 plate were performed. This was followed by stabilization and posterior arthrodesis of C3-T2 on the same day. Screws could not be placed in C6 masses due to bone destruction.



Good reconstruction and stabilization can be seen.

Post-operative lateral X-ray and MRI, T2-weigthed sequence, sagittal section

Surgical position

The surgical position is similar to those described above.

Technique

The technique is similar to those described above.

Complications

The complications are similar to those described above.

Post-operative follow-up

Post-operative follow-up is similar to the follow-up described above.

Summary:

LOWER CERVICAL SPINE

Advanced osteoporosis in the lower cervical spine mandates the need for combined approaches. This must also be taken into consideration when choosing the levels to be fused, since it can contribute to imbalance caused by degeneration of the segments adjacent to the fusion. In initial surgery, the lower limit of the fusion is commonly the upper thoracic spine.

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