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Anatomy and Techniques

Anterior lateral approach to the upper cervical

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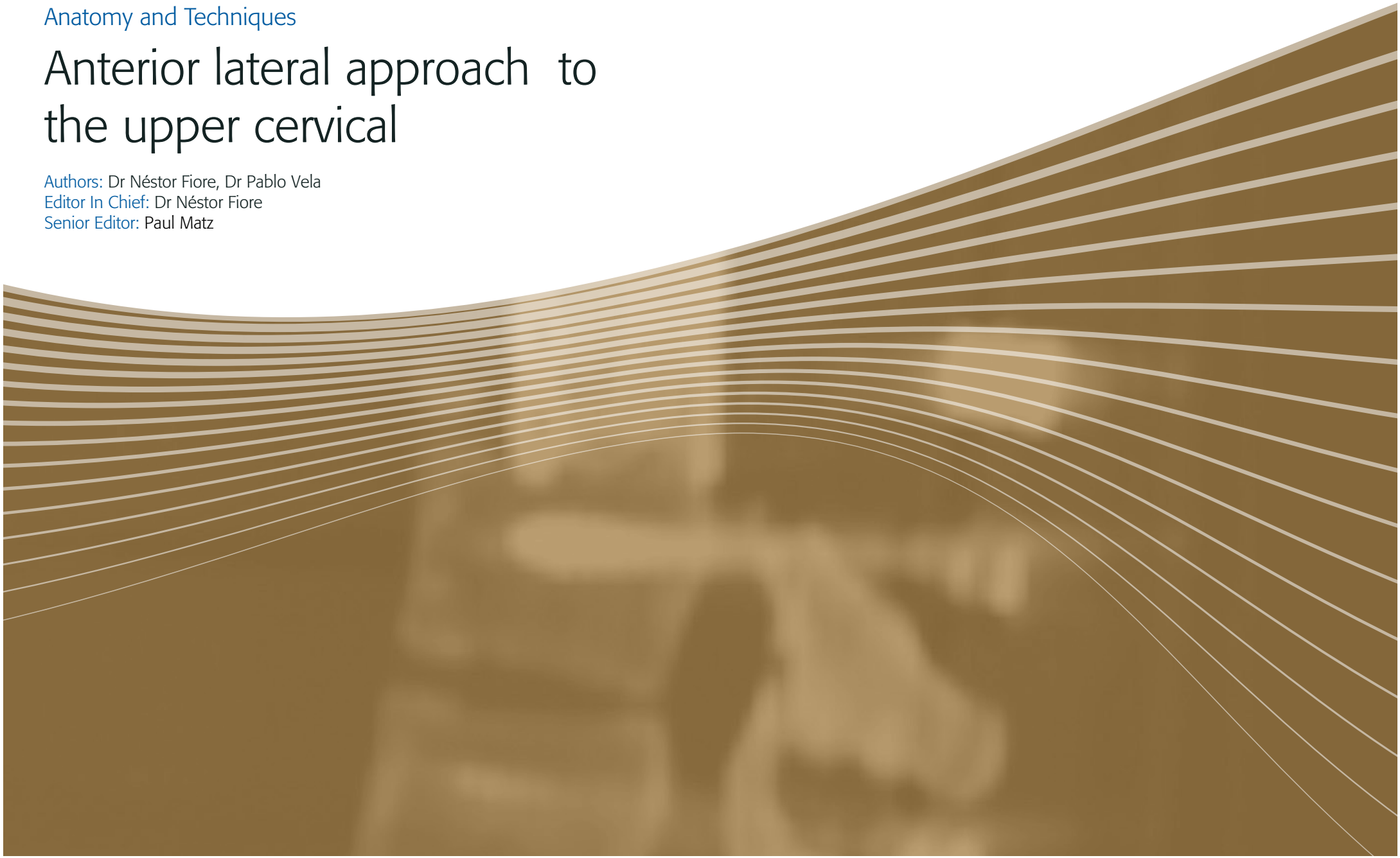

OBJECTIVES

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Anatomy and Techniques

Anterior lateral approach to the upper cervical

Authors: Dr Néstor Fiore, Dr Pablo Vela

- Describe the technique for the anterolateral approach to the upper cervical spine.
- Point out possible complications and how to avoid them.

CONTENTS

1. INTRODUCTION

Overview

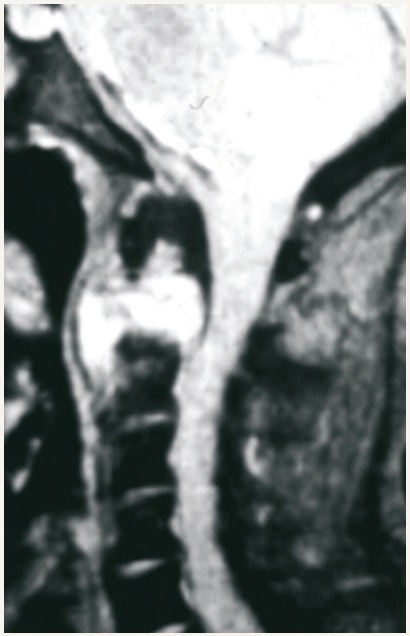
The anterior approaches to the spine are always a challenge for the surgeon. This situation is more challenging in the transition regions and, particularly, in the upper cervical spine, which can be defined as the anterior arch of the atlas, the C2 body and the odontoid process, C2-C3 disk and the upper half of C3.

Due to the relatively low frequency of conditions involving this region and to the fact that many of these cases may be addressed through a posterior approach, the need to perform an anterior approach is quite low.

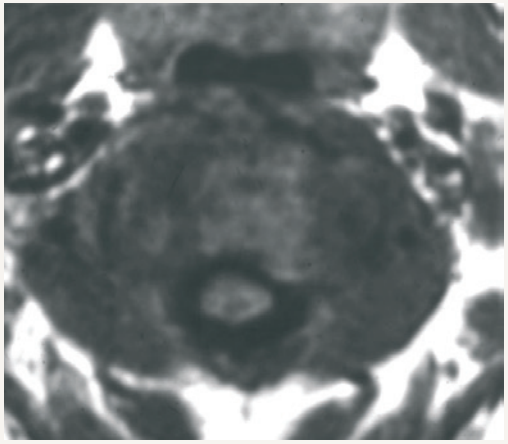
In this paper, the high cervical extracavitary approach to the above mentioned region will be described; this procedure is known in the literature as the anterior retropharyngeal approach (ARPA).

EXAMPLE

Patient with hemangiopericytoma in C2, treated with resection of the posterior arch and C5-occipital arthrodesis, followed by intratumoral resection via a high cervical anterolateral approach with a C1-C3 graft.



In this sagittal image there is evidence of clear damage to the C2 body.



Compromise of the C2 vertebral body and posterior arch is apparent in this axial view.

Cervical spine MRI, sagittal T2 sequence and axial T1 sequence.

The patient's outcome was good and a radiographic follow-up was performed 18 years after surgery.

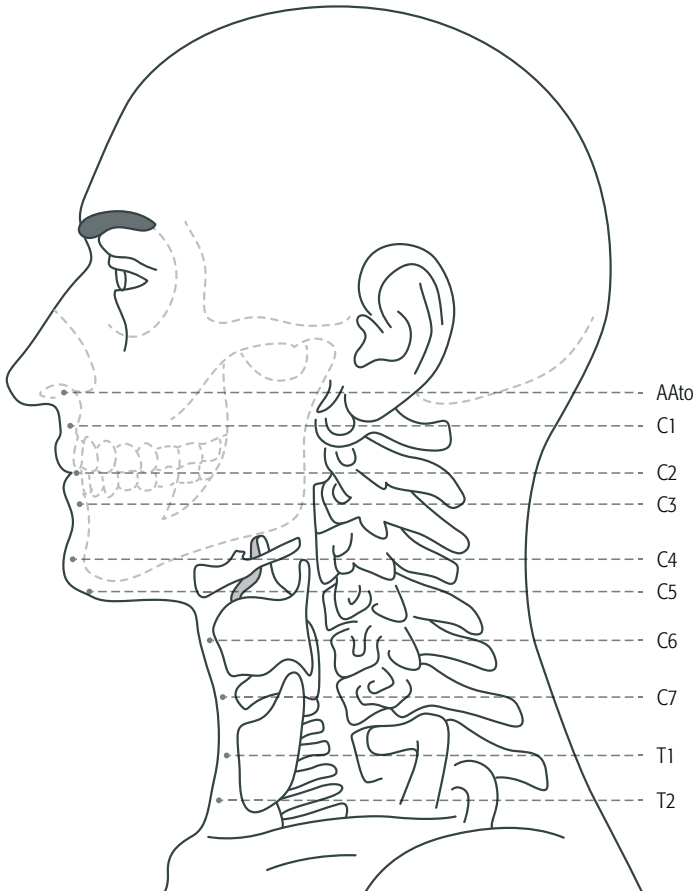
Eighteen years post-surgery a stable construct remains.

Post-operative lateral X-rays of the cervical spine.

2. PREOPERATIVE WORKUP

Accurate knowledge of anatomical structures in this region is critical for:

- good surgical planning;
- complications avoidance;
- resolution of complications that may arise during the operation;
- a good clinical outcome.



The mandible is the first hurdle to overcome in order to accomplish a complete anterior approach to this region, specifically to access the anterior arch of the atlas, the odontoid process and the upper half of the axis. Accordingly, work has to be done with some obliquity, and this anatomical limitation implies that the patient selection is paramount

In a preoperative lateral X-ray, the relationship between the spine and the mandible can be evaluated. At the level of the C2–C3 disk and C3 body, one must have direct anterior vision.

VERTEBRAL PROJECTIONS

AAto: floor of the nasal cavities

C1. lower portion of the medulla and upper pole of the superior cervical ganglion of the sympathetic trunk

C1/C2: soft palate and palatine tonsil

C2: buccal opening

C3: angle of mandible and inferior pole of superior cervical ganglion of the sympathetic trunk and superior edge of epiglottis

C4: hyoid bone, submandibular gland and carotid bifurcation

C5: upper border of the thyroid cartilage

C6: laryngeal ventricle and mid cervical ganglion of the sympathetic trunk

C7: cricoid cartilage and beginning of the trachea and the esophagus

T1: stellate ganglion

T2: upper edge of the first rib and subclavian artery

Anatomical projections of the face and neck (Rouviére and Delmas, 2005).

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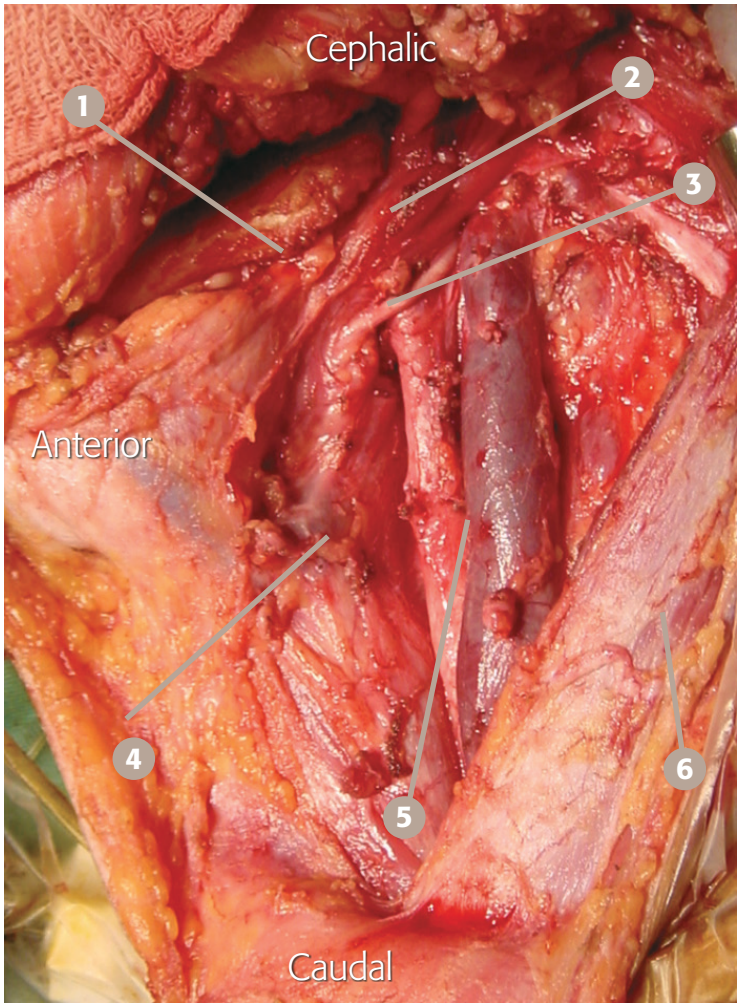
Spine surgeons must be very familiar with the aerodigestive tract, the neurovascular bundle of the neck plus its branches and the local muscles.



1. Angle of the mandible
2. Digastric muscle
3. Hypoglossal nerve
4. Visceral axis
5. Neurovascular bundle, aponeurotic sheath laid open
6. Left sternocleidomastoid muscle

Anatomical detail in the region anterior to the upper cervical spine, left side view.

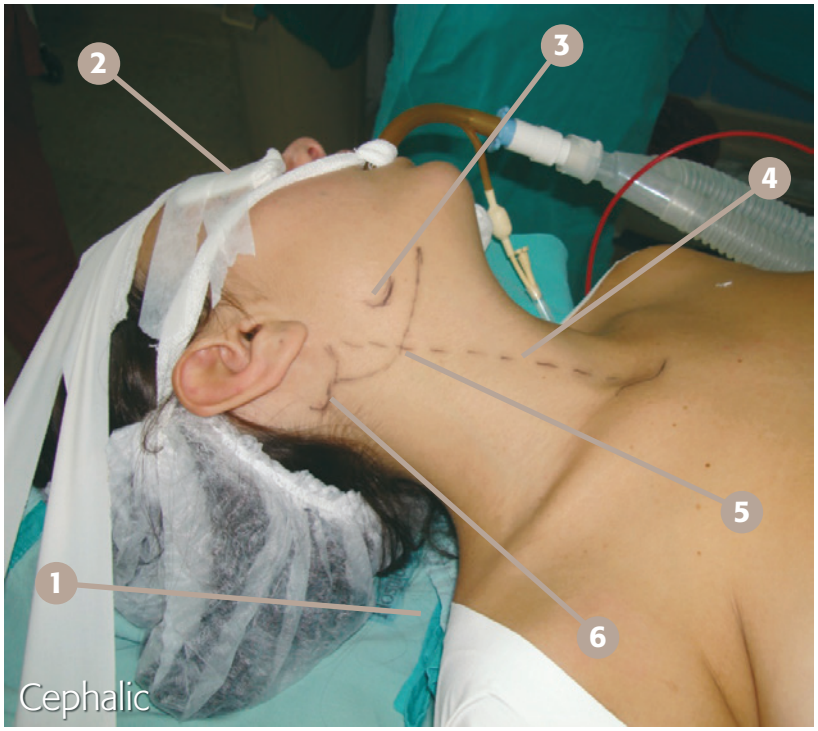
Once the decision is made that the patient requires a high cervical anterolateral approach, based on the type of condition, it is important to evaluate for pathological or anatomical situations that may prevent using an this surgical technique and that might become an absolute or relative contraindication. The following situations should be considered:

- obese patients with a short neck,
- previous operations in this region,
- infections in the oral cavity or in any neck structure,
- soft tissue tumors,
- severe and symptomatic carotid atheromatosis.

3. SURGICAL POSITION

The procedure is performed under general anesthesia, with orotracheal intubation or tracheostomy if deemed necessary according to the injury. The patient is in supine position, with the head hyperextended by about 15° and rotated about 30° to 45°, towards the opposite side of the incision.

It is convenient to place a small raised pad between the scapular bones.



1. Raised pad in the posterior region of the neck and scapular bones
2. Head rotated towards the left between 30° and 45°
3. Projection of the angle of the mandible
4. Projection of the anterior edge of the sternocleidomastoid muscle
5. Marking of a curved incision of caudal convexity
6. Projection of the mastoid process

Photograph of surgical position and site marking for a right-sided approach

4. TECHNICAL DETAILS

This approach can be right-sided or left-sided. It will depend on the location of the pathology and on the surgeon's choice.

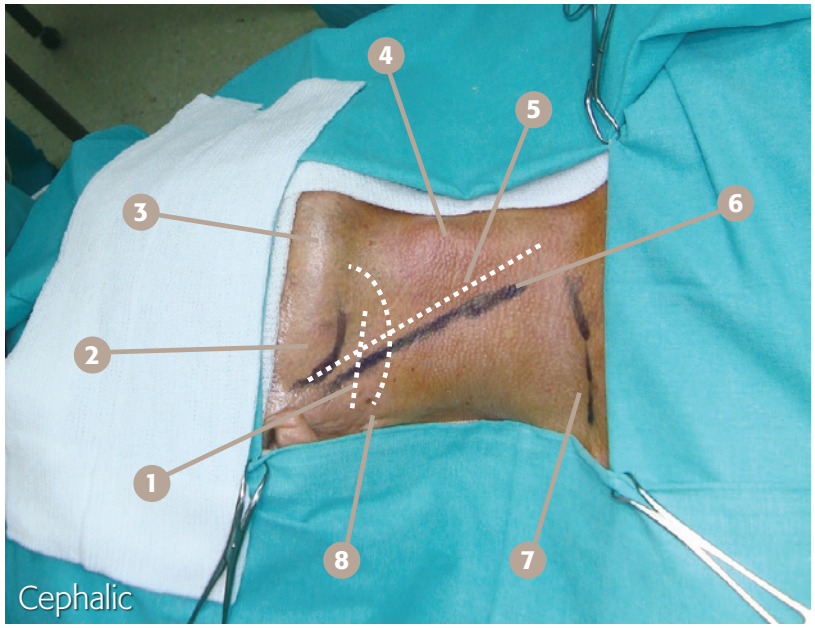
Types of skin incision

Three types of skin incision can be used, according to the cases to be treated:

- For the C2-C3 level, it is possible to use a paramedian transverse incision, similar to the one used for the lower cervical spine, centered on the anterior edge of the sternocleidomastoid muscle, 2 cm from the inferior ridge of the mandible and parallel to it.

- If it is necessary to work more cephalically, on the anterior arch of the atlas and C2 body, a better view may be achieved with a convex C-shaped incision, caudally, centered slightly in front of the anterior edge of the sternocleidomastoid muscle. With this incision the flap can be moved upwards, providing greater access to the more cephalic region. If it is also necessary to work on a more caudal vertebra, the flap should be wider (McAfee et al., 1987).

- If it is necessary to work on the upper cervical spine (C2-C3) and reach down to the lower cervical spine (C6-C7), a pre-sternocleidomastoid longitudinal incision may be chosen, as in a standard approach, but longer.



1. Straight horizontal incision
2. Projection of the angle of the mandible
3. Projection of the mandible
4. Projection of the cricoid cartilage
5. Long presternocleidomastoid longitudinal incision
6. Projection of the anterior edge of the sternocleidomastoid muscle
7. Projection of the right clavicle
8. C-shaped incision

The three possible incisions are shown.

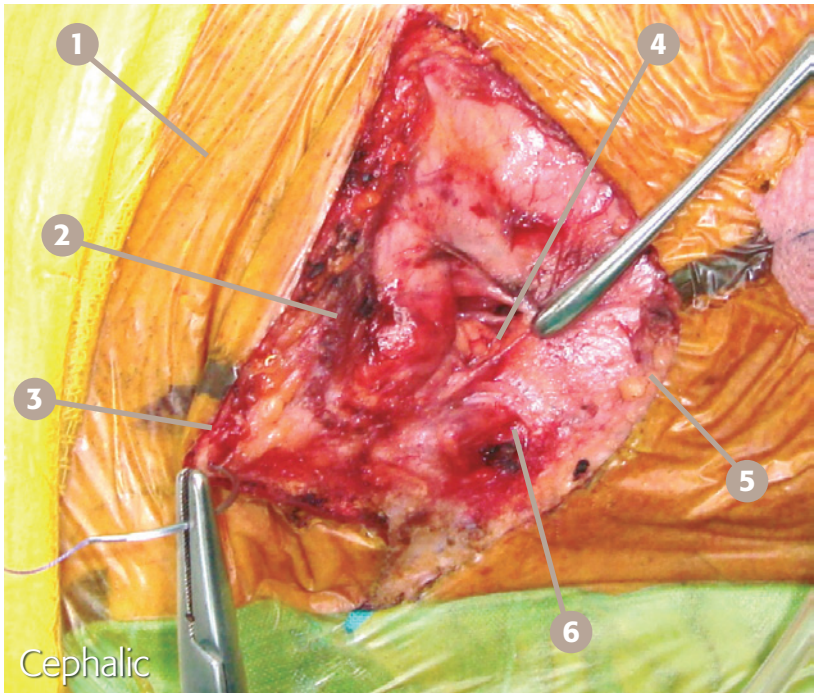
Photograph with site marking of the different approaches on the right side

Regardless of the incision chosen, the planes lying deeper than the platysma muscle are always dissected in a similar fashion.

4

Dissection of superficial planes

- The platysma muscle is generally sectioned perpendicular to its fibers.
- Then, the anterior edge of the sternocleidomastoid muscle is identified and the superficial aponeurosis is longitudinally opened, 0.5 cm in front of the muscle.
- Dissection is continued with blunt-tipped dissectors between the visceral axis, on the inside, and the neurovascular axis, on the outside.



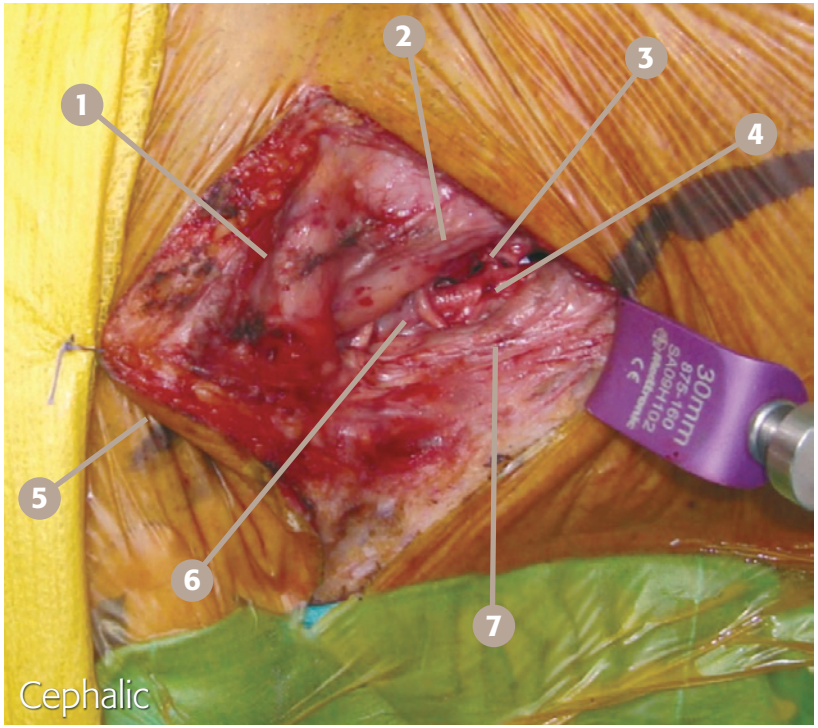
1. Projection of the mandible
2. Submaxillary gland
3. Upper flap of the wound
4. Region in front of the anterior edge of the sternocleidomastoid muscle, where access should take place, deep enough to reach the anterior aspect of the spine
5. Inferior edge of the wound from concavity to cephalic
6. Sternocleidomastoid muscle covered by superficial aponeurosis

Superficial planes can be seen.

Photograph of surgical position and site marking for a right-sided approach

Dissection between the neurovascular bundle and the visceral axis

- Cephalically, the digastric muscle must be identified along with the hypoglossal nerve below. The muscle can usually be displaced upwards and only occasionally needs to be divided. The nerve should be protected and retracted superiorly.
- Caudally, the branches of the external carotid artery are identified (superior thyroid and facial arteries), as well as the veins confluent to the deep jugular vein (facial and thyroid veins), which are dissected, fixed and ligated.



1. Submaxillary gland
2. Visceral axis
3. Superior thyroid artery
4. Neurovascular bundle
5. Upper flap of wound sutured superiorly
6. Digastric muscle and hypoglossal nerve
7. Sternocleidomastoid muscle

Dissection between the neurovascular bundle and the visceral axis is shown.

Intra-operative photograph of C-shaped approach, right: neurovascular bundle and visceral axis

4

There is no need to isolate each of these structures; they should remain protected by their aponeurotic sheath.

- Then, the neurovascular bundle is retracted laterally (external and internal carotid, jugular vein and pneumogastric nerve).
- The larynx, pharynx and muscles of the floor of the mouth are retracted medially; superiorly, the inferior edge of the mandible is palpated, and superiorly and laterally, the parotid gland can be identified.

1. Hypoglossal nerve
2. The spatula is advanced towards the anterior aspect of the spine, between the neurovascular bundle (outside) and the visceral axis (inside)
3. Ligated superior thyroid artery
4. Neurovascular bundle
5. Sternocleidomastoid muscle
6. Digastric muscle

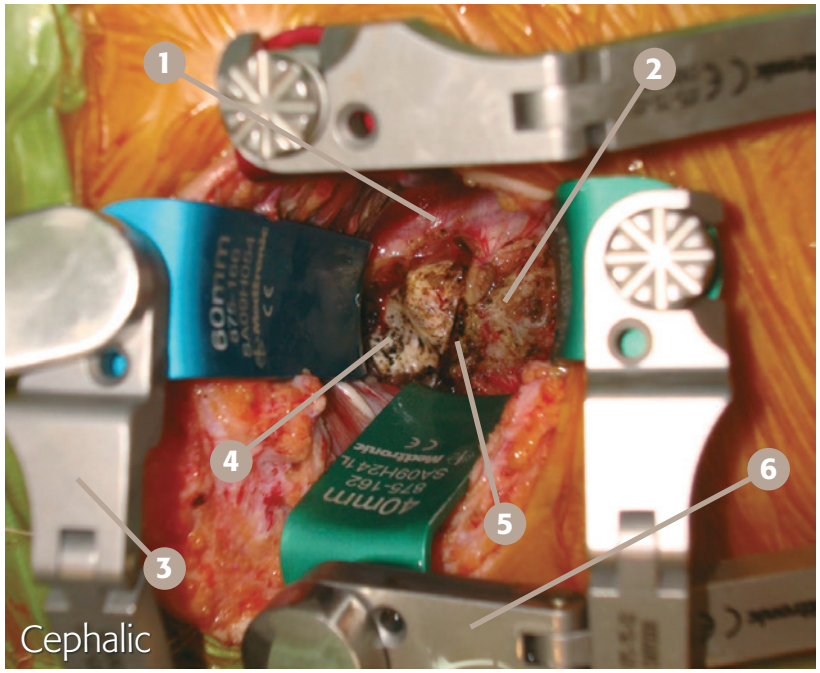
Note the approach towards the anterior aspect of the spine between the neurovascular bundle (laterally) and the visceral axis (medially).

Intra-operative photograph of C-shaped approach, right: neurovascular bundle and visceral axis, focused.

Exposure of anterior aspect of the cervical spine

- The paravertebral muscles can now be identified, dissected along the midline and laterally retracted on both sides.
- Now, the C3 body, the C2-C3 disk and the C2 body can be palpated and visualized. Obliquely and superiorly, the base of the odontoid process and the anterior arch of the atlas can be easily palpated.

At this point, it is recommended to take an image using an image intensifier. Then, and as needed, self-retaining retractors can be placed.



1. Left prevertebral muscles
2. C3 body
3. Cephalic-caudal retractor to the right
4. Body of the axis
5. C2-C3 disk
6. Right-left retractor caudally

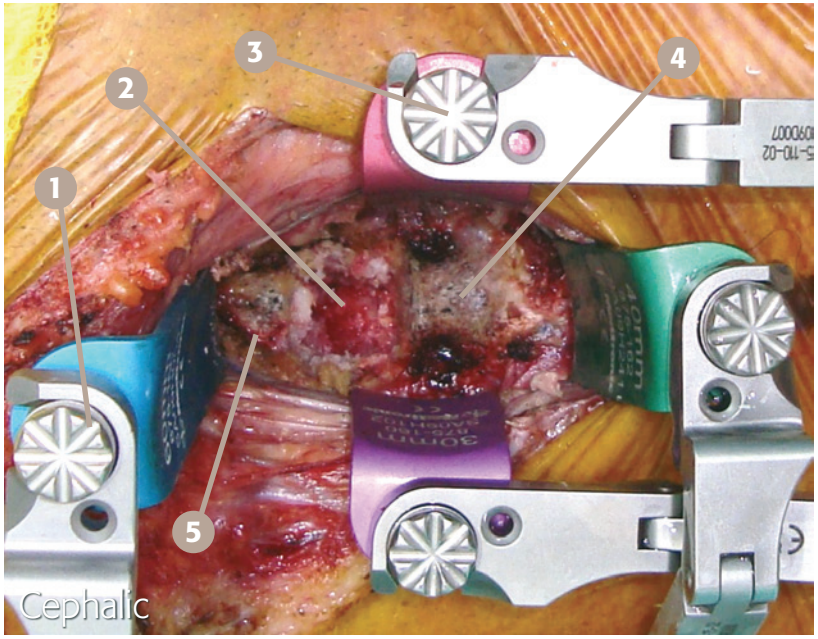
Anterior aspect of spine visible in deepest part of wound.

Inter-operative photograph of C-shaped approach, right: cervical spine exposure.

4

Phase of the procedure specific to the spine

- From this point on the intervention proceeds according to the surgical indications and the elements involved, from the body of C3 to the anterior arch of the atlas.



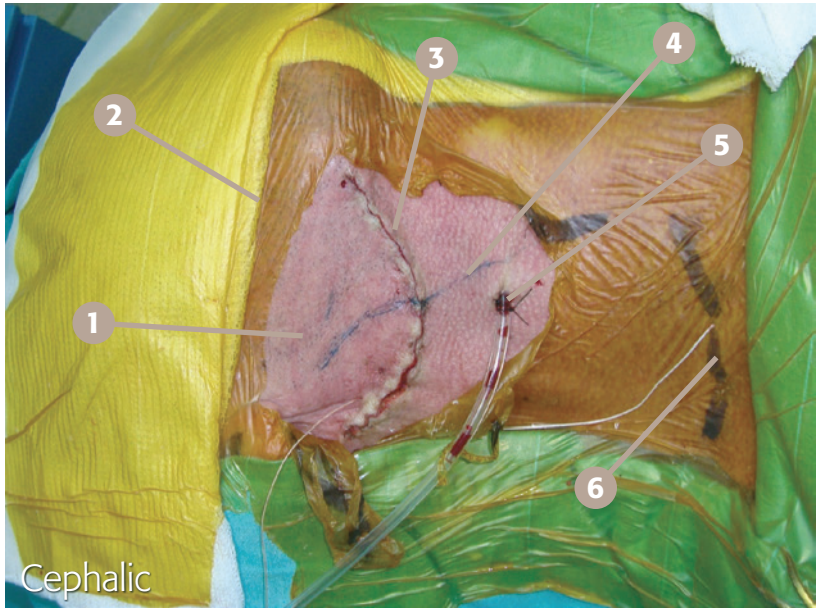
1. Cephalic-caudal retractor to the right
2. Site of C2 body resected because it had a tumor
3. Right-left retractor caudally
4. C3 body
5. Body of the axis

Anterior aspect of the spine in the deepest part of the wound and partial resection of body of C2 are visible.

Intra-operative photograph of C-shaped approach, right: specific work on the spine

Closure

- Wound closure should be thorough, paying meticulous attention to hemostasis. A suction drain is always left in place for a sufficient period usually for 24–48 hours, depending on the intervention performed.



1. Projection of the angle of the mandible
2. Projection of the mandible
3. Wound closure
4. Mark on the skin from the anterior border of the sternocleidomastoid muscle
5. Suction drain
6. Projection of the clavicle

Wound closure and drain placement are shown.

Intra-operative photograph of C-shaped approach, right: closure

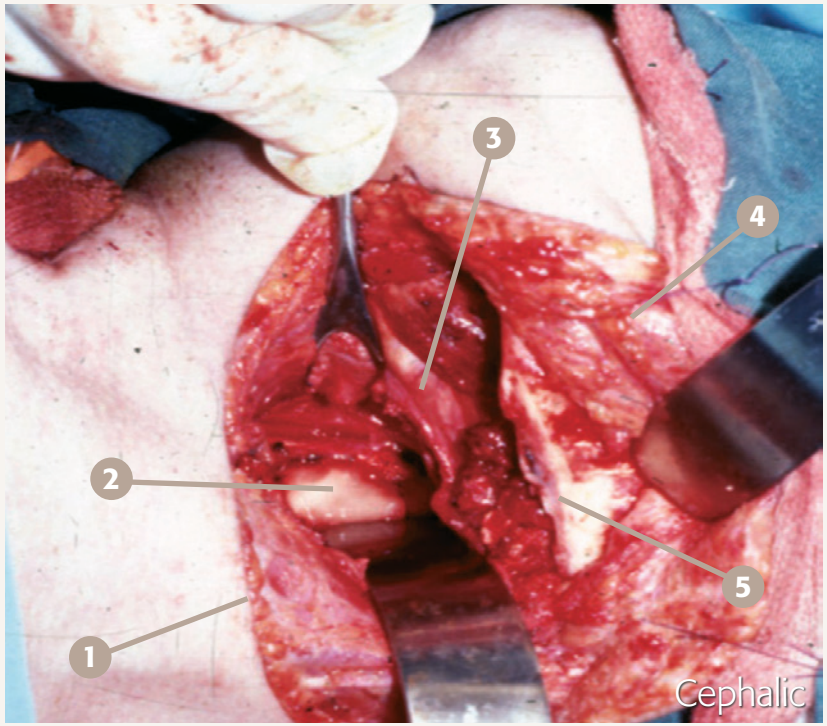
5. SPECIAL CONSIDERATIONS

Osteotomy—mandibular angle resection

In certain cases, for greater ease of approach, it is possible to perform a resection of the angle of the mandible, i.e., mandibular angle resection osteotomy.

EXAMPLE

Patient who underwent an osteotomy with mandibular angle resection in order to improve access to C1.



1. Caudal edge of concave incision superiorly
2. Graft placed between the atlas and C3
3. Digastric muscle and hypoglossal nerve retracted cephalically
4. Flap cephalically
5. Osteotomy of the mandibular angle for better access

The atlas can be visualized, with difficulty, after an osteotomy of the mandibular angle.

Intra-operative photograph of C-shaped approach, left.

Graft placed between the atlas and C3.

Post-operative lateral X-ray

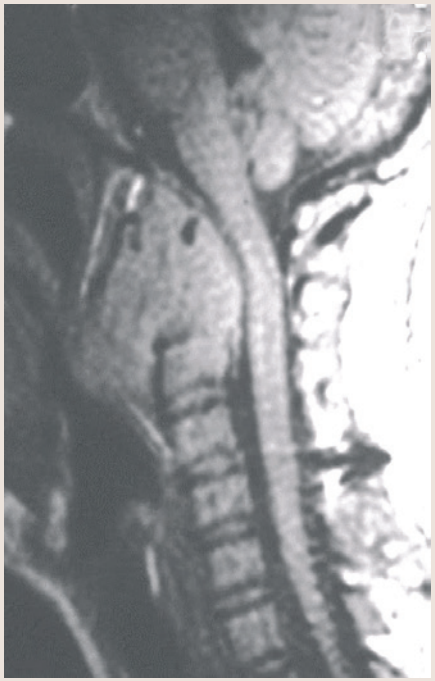
5

C-shaped incision with larger flap

When it is necessary to visualize not only the upper cervical region (C1, C2 and C3) but also more caudally (C4 and C5), a C-shaped incision with a larger flap can be used.

CLINICAL CASE

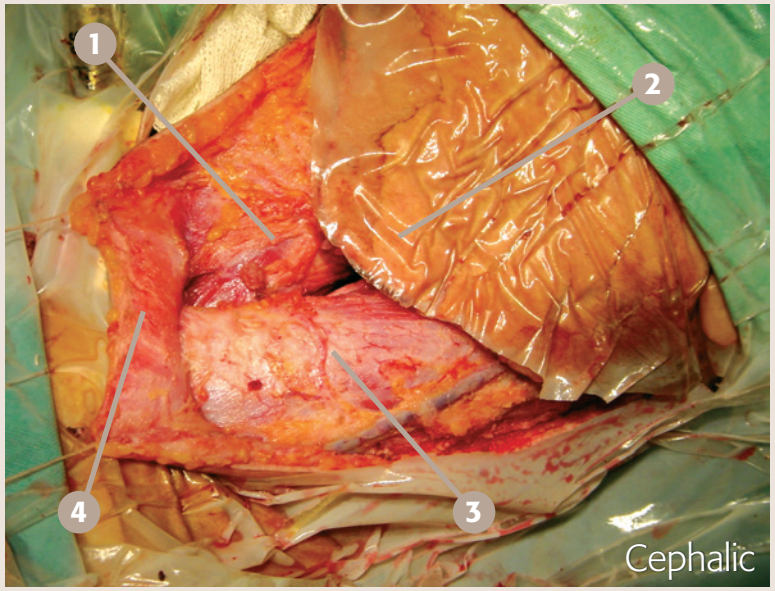
Female patient aged 29, with cervical pain. Neurological examination was normal. She had previously undergone surgery for giant cell tumor of axis via a posterior approach.



There is a significant tumor formation affecting the axis, which blocks the view of the atlas and covers the body of C3.

MRI of cervical spine, T1-weighted sequence, sagittal section

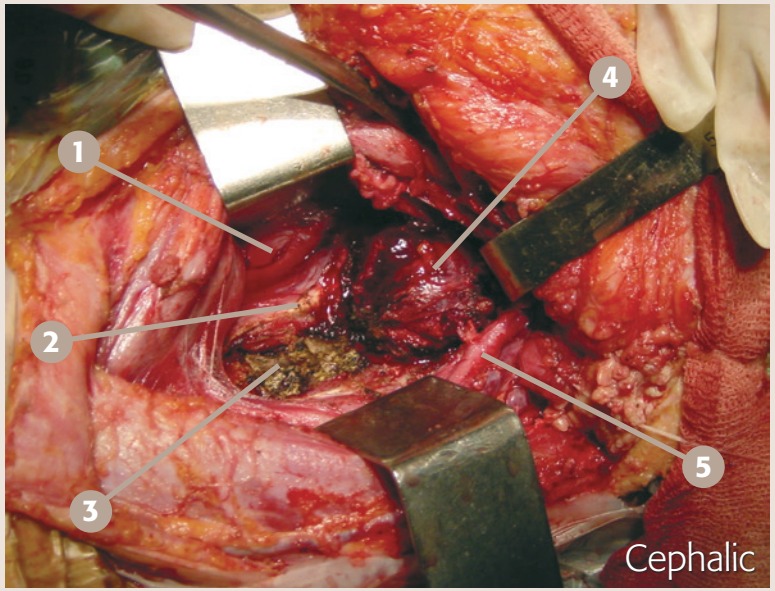
A double approach was selected in which the anterior phase involved a left side C-shaped incision with a larger flap.



1. Visceral axis
2. Proximal flap
3. Sterno-cleido-mastoid muscle
4. Caudal edge of wound

Size and orientation of the flap in the anterior approach.

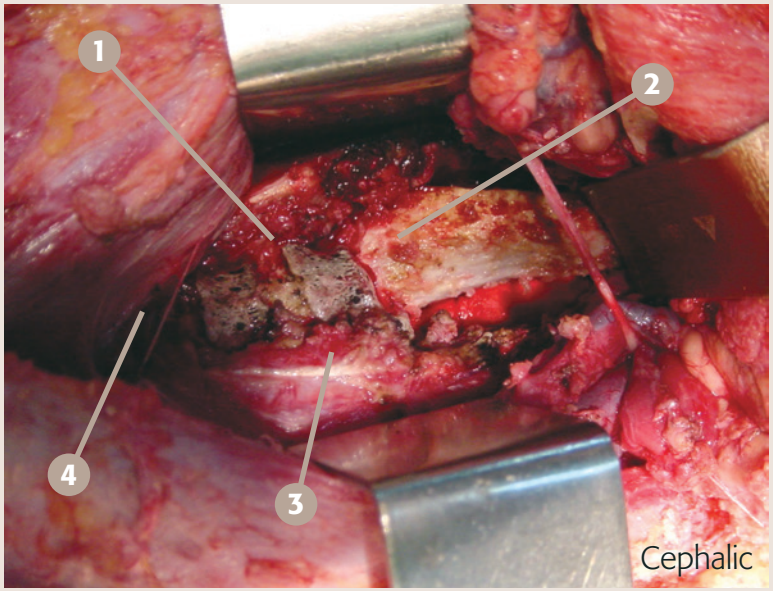
Intra-operative photograph of the anterior approach: C-shaped skin incision



1. Visceral axis inclined medially
2. Right prevertebral muscles
3. Anterior aspect of C5
4. Tumor mass reaching the base of the skull, verified by palpation
5. Neurovascular bundle

A tumor is observed to cover the C3 body caudally; palpation confirms it extends cephalically to the base of the skull.

Intra-operative photograph of the anterior approach: tumor dissection

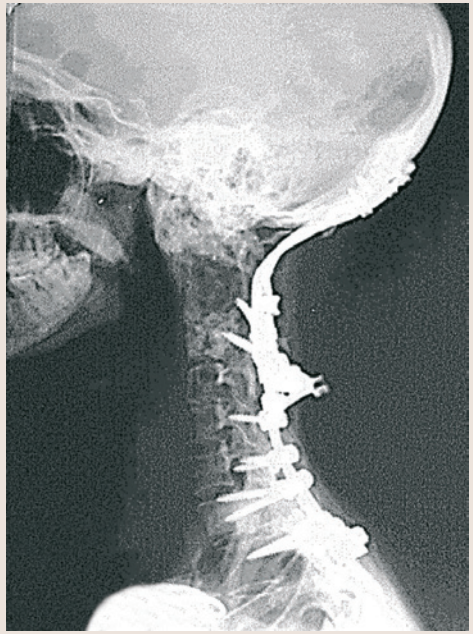


1. Bone graft
2. Hypoglossal nerve
3. Neurovascular bundle
4. Anterior aspect of C5

The implanted graft is supported by the superior aspect of C4.

Intra-operative photograph of the anterior approach: graft implanted

The patient presented good evolution during the follow-up period (10 years).



Ten years after the surgery, there is good engraftment from C4 to the skull.

Post-operative lateral X-ray of the cervical spine

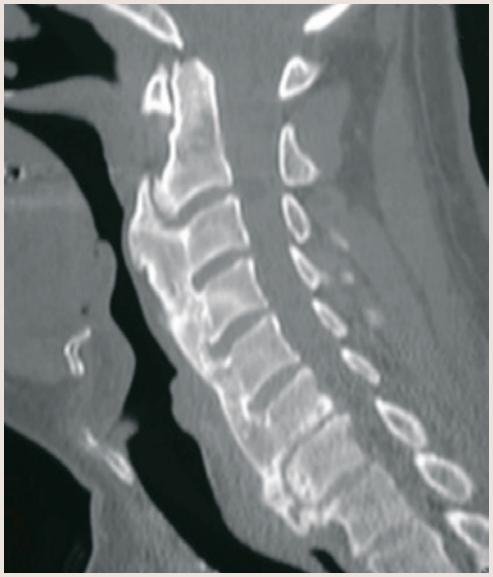
Large oblique incision

Sometimes, there may be pathological situations affecting both the upper cervical spine (C2-C3) as well as the lower cervical spine (C6-C7) and the upper thoracic spine (T1-T2). In these cases, it is possible to perform a pre-sternocleidomastoid, longitudinal, oblique incision, providing an approach with access from C1 to T2.

CLINICAL CASE

Male patient, aged 56, with persistent dysphagia and dysphonia, along with severe cervical pain. Clinical symptoms began six months earlier with weakness in the lower limbs.

Upon physical examination, lower limb clonus and hyperreflexia were detected.



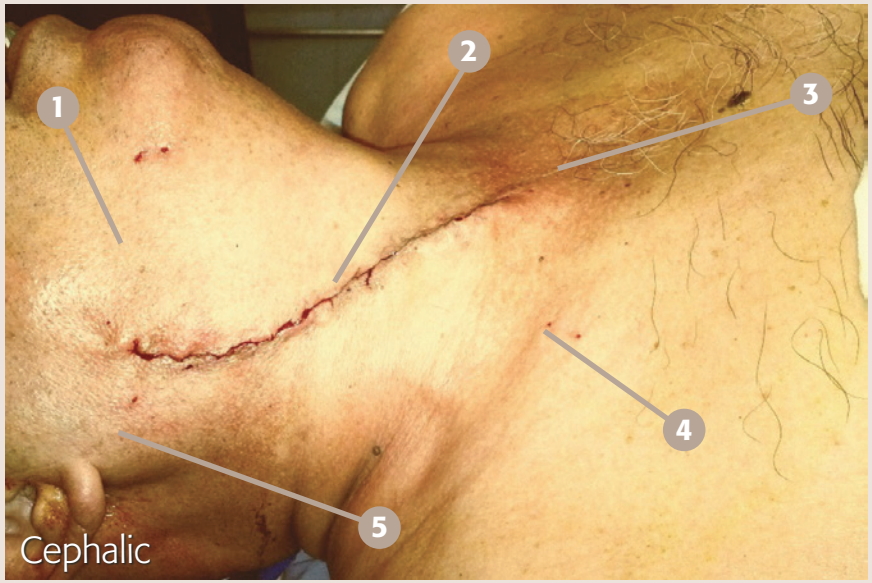
A significant calcification of the anterior longitudinal ligament is visible between C2 and T1.

Computed tomography of the cervical spine, 2D reconstruction

C6-C7 disc disease with stenosis and cord compression.

Cervical spine MRI, T2-weighted sequence, sagittal section

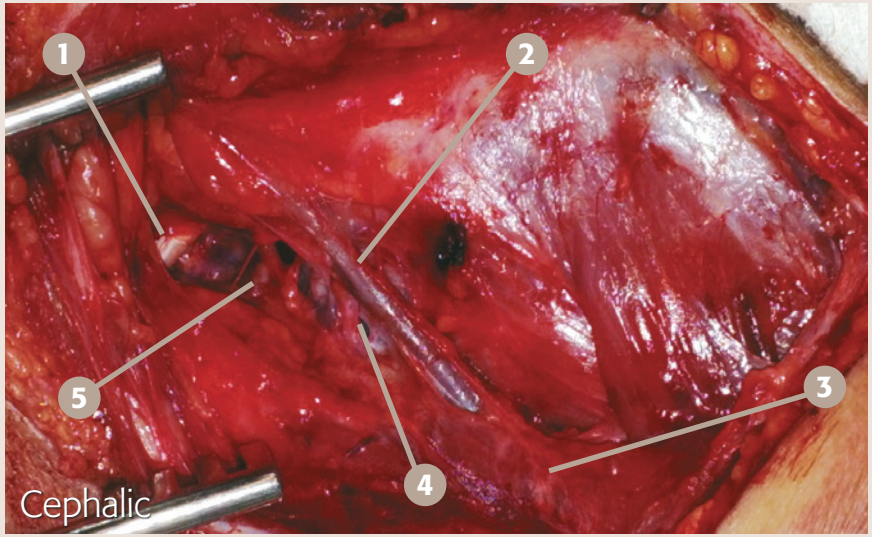
Resection of the prevertebral bone and C6-C7 discectomy and arthrodesis were performed. A pre-sternocleidomastoid longitudinal incision was planned as part of a right-sided anterior approach.



1. Projection of the mandible
2. Pre-sterno-cleidomastoid longitudinal incision
3. Projection of the manu-brium sterni
4. Right clavicle
5. Projection of the mastoid process

Landmarks on the skin are observed.

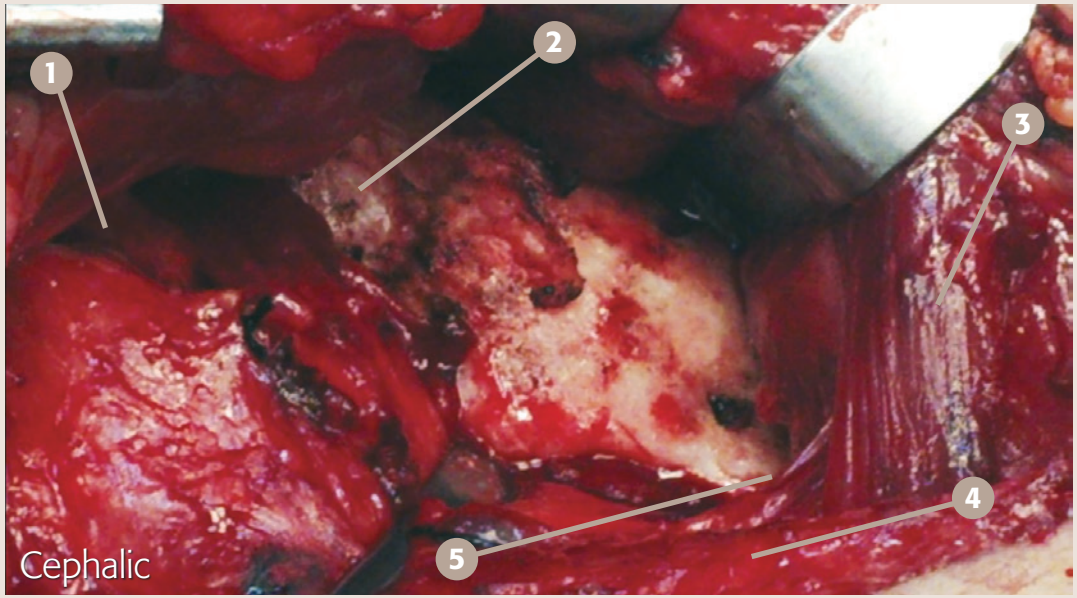
Intra-operative photograph of the anterior approach: longitudinal skin incision



1. Digastric muscle
2. Anterior jugular vein
3. Sterno-cleido-mastoid muscle
4. Superior thyroid artery
5. Lingual artery

Soft tissue dissection can be observed.

Intra-operative photograph of the anterior approach: soft tissue dissection



1. Hypoglossal nerve
2. C2 (superior edge) calcification
3. Omohyoid muscle
4. Sternocleidomastoid muscle
5. Calcification C4-C5 boundary

The large prevertebral bone mass is observed.

Intra-operative photograph of the anterior approach: exposing the anterior aspect of the spine

So far, the patient has progressed with a good clinical evolution.

Appearance at six months of anterior en bloc bone removal and placement of cage at C6-C7 level.

Post-operative lateral X-ray of the cervical spine

6. COMPLICATIONS

Given the overall similarities with respect to the mid and low cervical approaches, complications are comparable. However, certain particularities must be taken into account:

- Bear in mind that large-scale dissections may give rise to swallowing dysfunctions which require a re-education plan for optimal recovery.

- The most frequent complication is probably hypoglossal nerve deficit, manifesting as ipsalateral paralysis of the tongue. More often than not, this occurs due to nerve traction and stretching and, in general, this complication is transient. However, if there is complete anatomical injury, then it may be permanent. In these cases, it is very important to identify the injury; end-to-end neurorrhaphy should be considered in order to try to prevent permanent paralysis from developing.

- Pharynx, larynx or floor of the mouth injuries are rare. These should be identified in the intra-operative period and managed with primary sutures. It is convenient to place a temporary nasogastric tube. In these situations, it is advisable to turn to a consultant general surgeon for optimal intra- and post-operative treatment.

- Both arterial and venous injuries, which are relatively frequent because this region contains several branches of the external carotid artery and many veins flowing to the jugular, are generally resolved with simple ligatures.

It is very important to be careful with hemostasis, because early post-operative hematomas are a potentially serious complication (similar situation to that present in the lower cervical spine which, generally, renders reintubation difficult for reoperations and requires a drain and hemostasis in emergency situations).

7. SUMMARY

The anterior aspect of C1, C2 and C3 can be approached by an anterolateral route but with certain limitations upon working in the most cephalic segment (anterior arch of C1).

The radiological visualization of the relationship between the mandible and the spine is important to assess the possible technical difficulties that may arise.

The following incisions can be used, as appropriate:

- horizontal incision centered on the anterior edge of the sternocleidomastoid muscle, providing good access to the C2-C3 disc and the anterior aspect of C2;
- C-shaped incision of caudal convexity, centered slightly in front of the anterior edge of the sternocleidomastoid muscle, which seemingly allows a better visualization at C1-C2 level and it also affords greater caudal access when using a larger flap;
- long pre-sternocleidomastoid longitudinal incision, advisable if a very extended approach is needed, which could go from C2 to the first thoracic vertebrae.

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