

Surgical technique

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Infraclavicular anterior thoracic approach for access to the upper thoracic vertebrae: case report and description of a new surgical technique

Abordaje torácico anterior infraclavicular para el acceso a las vértebras torácicas superiores: reporte de un caso y descripción de una nueva técnica quirúrgica

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ABSTRACT. Patient with spondylodiscitis who presented kyphosis deformity with neurological compromise at the upper thoracic level, who was treated with a new right infraclavicular anterior thoracic approach, as a new alternative surgical technique. 72-year-old male with kyphosis deformity secondary to T2-T3 ASIA «C» spondylodiscitis, treated with C5 to T6 posterior cervicothoracic instrumentation and right infraclavicular transthoracic anterior approach utilizing an expandable cylinder. Within the literature review carried out in the search engines, no similar techniques to the one described in this article were found. Given the complexity of the surgical approach, this new technique is described as a new way for accessing the upper thoracic spine, demonstrating that the right infraclavicular anterior thoracic approach is a new alternative to access the upper thoracic spine from T1 to T4.

Keywords: thoracotomy, spondylodiscitis, spine, thoracic vertebrae.

RESUMEN. Paciente con espondilodiscitis que presentó deformidad cifótica con compromiso neurológico a nivel torácico superior, quien fue tratado con un nuevo abordaje torácico anterior infraclavicular derecho, como nueva técnica quirúrgica alternativa. Varón de 72 años con deformidad en cifosis secundaria a espondilodiscitis T2-T3 ASIA «C», tratado con instrumentación cervicotorácica posterior C5 a T6 y abordaje anterior transtorácico infraclavicular derecho con colocación de cilindro expandible. Dentro de la revisión bibliográfica realizada en los buscadores no se encontraron técnicas similares a la descrita en este artículo. Dada la complejidad del abordaje quirúrgico, esta nueva técnica se describe como una nueva forma de acceder a la columna torácica superior, demostrando que el abordaje torácico anterior infraclavicular derecho es una nueva alternativa para acceder a la columna torácica superior desde T1 a T4.

Palabras clave: toracotomía, espondilodiscitis, columna, vértebra torácica.

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Introduction

The upper thoracic spine is a high complexity anatomic area due to the vital structures around the vertebral body and close relationship with the mediastinum.¹ Conventionally, according to the experience described in various spinal surgery centers and hospital resources, it is preferred to perform posterior approaches such as pedicle subtraction osteotomy, costotransverse resection or transforaminal intersomatic fusion; however, these approaches allow us only partial access to the vertebral body with high risk of neural injury.²

Due to the increase in the incidence of infectious pathologies, herniated discs, angular deformities, unstable fractures, and the increasingly frequent diagnosis of primary and metastatic disease, we chose non-conventional approaches that allow us better access to the retro-mediastinum.^{3,4,5} There are many surgical approaches such as the posterior parascapular approach with partial resection of the posterior costal arches or lateral intercostal at various levels.^{6,7} E.g. the lower anterior cervical and medial approach, where it can be visualized up to T3 level.⁸ Cervical path can be extended to the sternal manubrium with the possibility of uni or biclavicular osteotomies without damaging the insertion of the sternocleidomastoid.^{9,10} Another approach is the sternotomy to expose the vertebral body from C6 to T5. Due to the high complexity and lack of diversity of approaches, it requires meticulous and individualized preoperative planning as shown in the following case.^{1,2,11}

Clinical case

A 72-year-old male patient who underwent wide laminectomy surgery from C7 to T4 level without arthrodesis, due to a history of secondary metastatic disease of prostate cancer performed in an external institution (*Figure 1*). During that hospitalization he presented fever which was managed with intravenous antibiotics for four weeks. Four months postoperatively he was admitted to our hospital due to kyphosis deformity and decreased strength in the lower extremities. The patient has coronary revascularization surgery as an important background.

In our institution he was initially classified neurologically as ASIA C, an MRI was taken showing vertebral collapse of 70% at T2-T3 level with spinal cord compression in 40%. Postoperative changes of laminectomy from C7 to T4 levels with a high risk of instability were also observed (*Figure 2*). It was decided to perform a posterior fixation of C5-T6 and an anterior corpectomy by sternotomy. Once taken to the operating room under general anesthesia, posterior fixation is performed followed by an anterior approach by sternotomy. It was observed a coronary bypass at the level of the bilateral internal mammary artery as well as abundant fibrous tissue, so it was decided not to continue with this approach due to the high risk of massive cardiac infarction

during the procedure. The wound was closed with wire cerclage. For this reason, the surgical plan was changed to a right infraclavicular thoracic approach.

Surgical technique

The patient is placed in ventral decubitus position with selective left pulmonary intubation and the thoracic approach is initiated.

1. Second anterior intercostal space was located, making an incision from the anterior axillary line to the sternocostal junction,
2. Carrying out dissection by planes, the pectoralis major is located. With blunt dissection, the pectoralis minor is located on its medial border, which is retracted laterally without the need to section. Intercostal muscles are dissected on the upper edge of the third rib, by placing an automatic Finochietto retractor (*Figure 3*).
3. The intrathoracic space is widely exposed additionally by placing malleable retractors on the lung in order to expose the anterior aspect of the upper thoracic spine from T1 to T4, affected levels are corroborated with fluoroscopic imaging and prepared for corpectomy.
4. Prior cauterization of segmental vessels, dissection of the parietal pleura from the anterior face of the vertebral bodies to the rib joint is executed, respecting the sympathetic chain path.
5. Afterwards, corpectomy of T2 and T3 (level affected by the infection) were performed, to obtain decompression of the spinal cord, until finding a healthy vertebral inferior platform of T1 and superior platform of T4.
6. Once confirmed the integrity of the anterior dura, a two-level expandable cylinder is placed restoring stability, as



Figure 1:

Panoramic sagittal view of CT scan. Yellow arrow indicates extensive laminectomy without instrumentation.

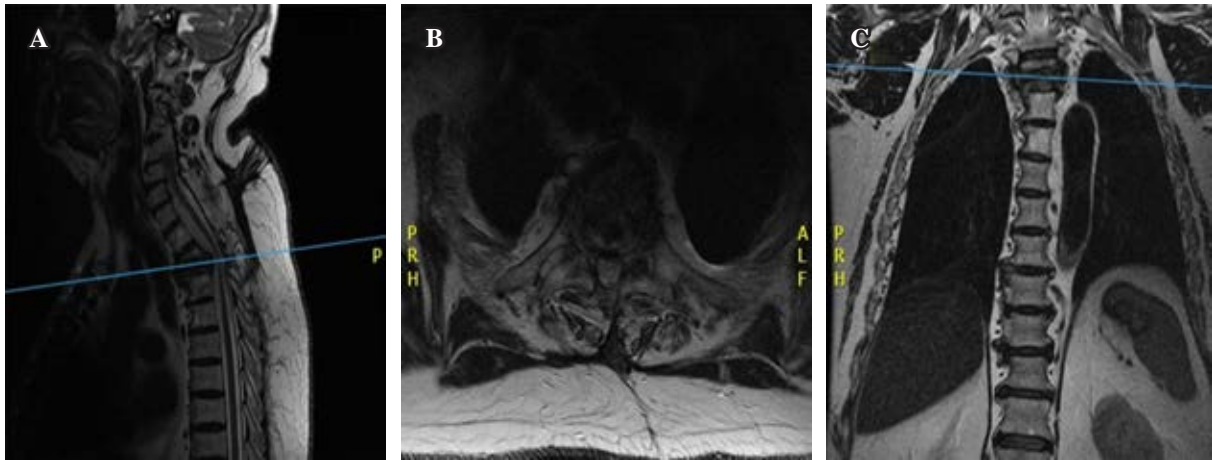


Figure 2: MRI T2 sequence. **A)** Sagittal view showing T2-T3 vertebral collapse with secondary kyphosis. **B)** Axial view at T2-T3 showing severe spinal cord compression. **C)** Coronal view showing vertebral collapse at T2-T3.

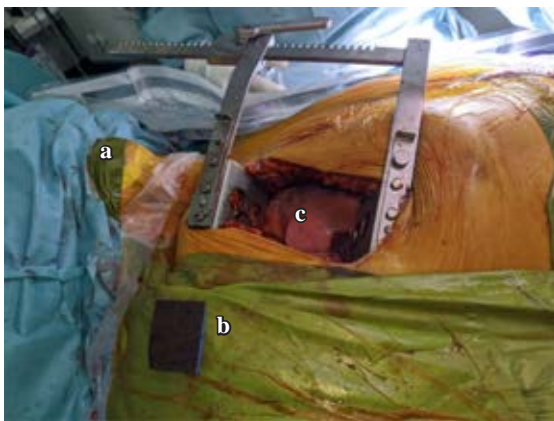


Figure 3: Patient in ventral decubitus position. **a)** Patient's chin. **b)** Right shoulder. **c)** Right anterior thoracic approach showing wide exposure in ventral decubitus.

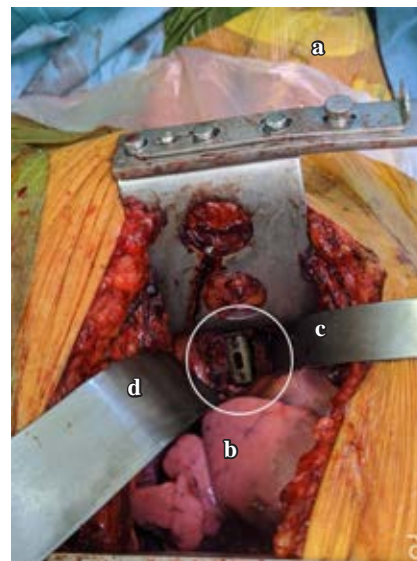


Figure 4:

Wide exposure of vertebral bodies.
a) Patient's chin.
b) Right lung parenchyma retracted inferiorly.
c) Malleable retractor protecting mediastinal structures.
d) Malleable retractor protecting lung parenchyma. White circle indicates corpectomy area and placement of expandable cylinder.

well as placement of broad-spectrum antibiotic granules (*Figure 4*). Stability of the osteosynthesis system besides the integrity of the cardiopulmonary elements are corroborated (*Figure 5*), a deep thoracic drainage tube is placed and the incision was closed in layers as usual (*Figure 6*).

Follow-up

The patient was transferred to the intensive care unit and continued antibiotic treatment. Two weeks later he presented improvement of the neurological scale to ASIA D, four weeks later he progressed to ASIA E. No clinical or paraclinical signs of infection were observed (*Figure 7*).

Hospital discharge was decided in the sixth postoperative week with home physiotherapy indicated. At the assessment visit four months post-surgery, the patient continued with ASIA E without clinical signs of infection.

Discussion

The anterior approach helps to avoid injury to the spinal dura mater, surgical site infection, pulmonary infection, anterior cord syndrome and many others possible lesions.^{7,12} There are reports of uncommon injuries to consider, such as the chain of sympathetic ganglia that are most frequently found anterior and at the level of the costal heads, with special attention to the Kuntz nerves at the level of T2 and T3,¹³ even more rarely, massive cerebral ischemia due to carotid artery traction has been reported during the placement of retractors in an anterior mediastinal approach.¹⁴ For this, surgical planning methods have been implemented to help deciding which approach is sufficient in the visualization of the anterior levels, as well as to assess the need to perform a posterior combined approach to achieve adequate stability and a lower rate of failures in the instrumentation and minimize risk.^{15,16}

To reduce the complications associated with mediastinal approaches, in 2010 some authors describe a left infraclavicular approach which involved resection of the first anterior costal arch as well as the disinsertion of the pectoral and scalene muscles, visualizing a space that is superior to the lung parietal pleura, inferior to the subclavian plexus and lateral to the mediastinum. In this space there is a path to access to the anterior bodies of T1-T2-T3 vertebrae.¹⁷ Similar ideas were reported for resection and diagnosis of tumor pathology.¹⁸ Less invasive approaches were reported in 2019, two important and innovative transaxillary approaches focused on upper thoracic reach. The first surgical technique consists in a right axillary approach that goes from the posterior axillary line to the nipple at the level of the 4th costal arch, with a length of 12 cm. At that level a resection of the 4th

arch is performed, therefore the anterior face is exposed to the vertebral bodies from T2-T6.¹⁹ The second surgical technique consists in a left axillary approach at the level of the second costal arch with an incision of 4 cm of length, creating a safe access route to the anterior and lateral face of T2-T4 vertebrae, allowing the vision of all the structures surrounding the vertebral body,²⁰ it is important to mention that both approaches avoid the high complexity and comorbidities of a sternotomy, which confirms by means of adequate familiarization with the approach or the help of a thoracic surgeon, it can be performed either right or left depending on the pathology of each patient. Based on the above, it is likely that a high right infraclavicular anterior thoracic route such as the one described in our case is less complex for the thoracic surgeon or spinal surgeon since we avoid dissection of the mediastinum.

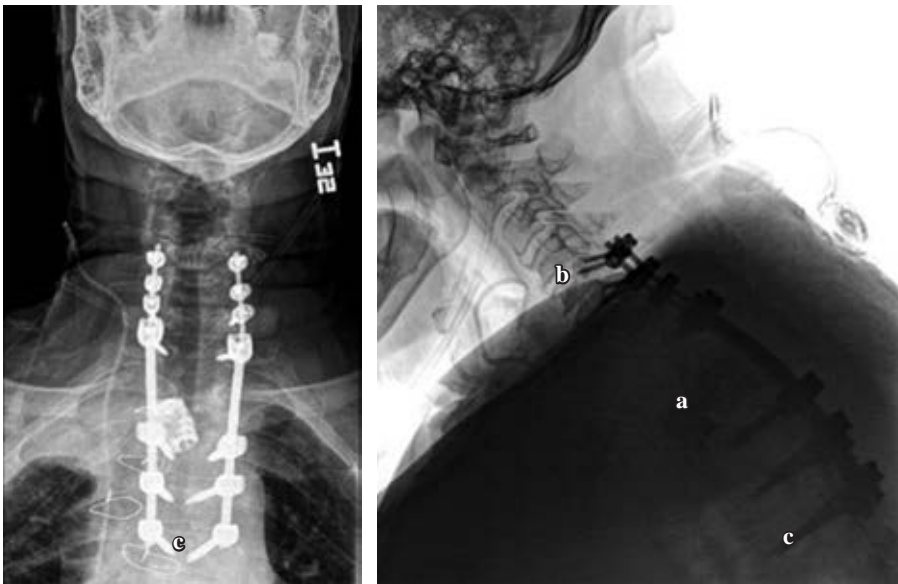


Figure 5:
Intraoperative X-rays.
a) Expandable cylinder in T2-T3.
b) C5 vertebra. c) T6 vertebra.

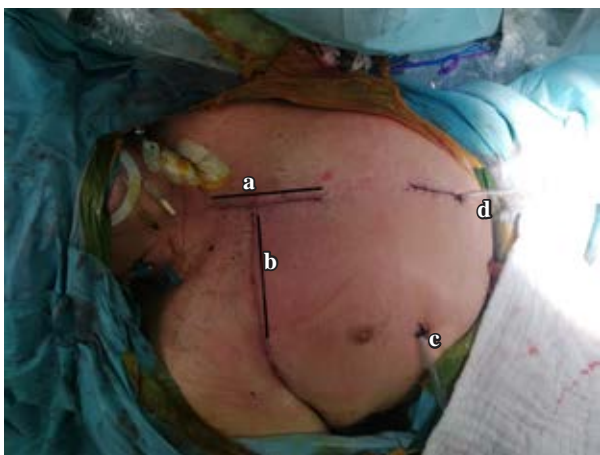


Figure 6: Patient lying in ventral decubitus. a) Sternotomy. b) Right infraclavicular approach from anterior axillary line to sternum. c) Thoracic drainage tube. d) Mediastinal drainage tube.



Figure 7: Frontal view of patient 4 weeks after surgery. a) Lateral approach limit. b) Medial approach limit.

Conclusion

Right infraclavicular anterior thoracic approach described, is a safe technique that has the benefits of avoiding a complex access through the mediastinum, being useful at the same time if there is a need for an anterior cervical approach because the patient is in a supine position.

However, it should be noted that, like the approaches described, it is an unconventional approach that in our review of the literature is described for the first time for treatment purposes of the upper thoracic spine, from T1 to T4. Therefore, it must be managed in a multidisciplinary way with the help of thoracic surgeon.

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