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ORIGINAL ARTICLE

# The low anterior cervical approach to the upper thoracic vertebrae: a decision by preoperative MR imaging

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PURPOSE
Surgical approaches to the upper thoracic spine are fraught with many problems as they involve thoracotomy or sternotomy. We analyzed 102 midsagittal MRI scans to evaluate the level of the sternal notch in relation to the upper thoracic spine, so that if the tangential line through the upper part of the sternal notch passed below the level of the involved vertebra, we could surgically access the involved vertebra by the low anterior cervical approach, which is familiar to most spinal surgeons.

MATERIALS AND METHODS
Between January and June 2002, 102 consecutive mid-sagittal T2 weighted MRI scans were evaluated. The line as described above was then drawn on each MRI to assess the level of the involved vertebra.

RESULTS
In 68.7% of the cases, the level of the sternal notch corresponded to T2 and T3. This method of assessing accessibility was used in a patient with a fractured T3 that yielded excellent surgical exposure. It was found that routine use of saturation bands is not needed in upper thoracic spine pathology as it obscured the visualization of the sternal notch in 20% of the cases.

CONCLUSION
In patients with high thoracic fractures who require surgical decompression and stabilization, pre-operative MR scan and assessing the level of the vertebra in relation to the sternal notch can allow a low anterior cervical approach to be used thus decreasing the patient morbidity related to the surgical approach.

*Key words:* • *thoracic vertebrae* • *surgical approach* • *magnetic resonance imaging*

Surgical access to the upper thoracic vertebrae (T1–T4) has always been difficult (1–6). Various procedures that provide access to the upper thoracic vertebrae are described in the literature (1–3, 7–9, 10); however, they involve a major step, such as thoracotomy or sternotomy, which are associated with high morbidity. Furthermore, this may require the assistance of a thoracic surgeon in some instances. Complications and difficulties can be avoided if a low anterior cervical approach can be employed. This exposure is simpler than the other procedures requiring sternotomy, and is routinely practiced by spinal surgeons to access the lower cervical vertebrae. The thoracic vertebrae can be exposed without sternotomy with this approach, although it depends on the relationship of the vertebrae to the level of sternal notch.

We aimed to assess the level of the sternal notch in relation to the thoracic vertebrae using magnetic resonance imaging (MRI) scans to estimate which thoracic vertebrae were approachable anteriorly and without sternotomy. This method was utilized in a patient to highlight the importance of MRI scans in preoperatively planning the approach.

## Materials and methods

Between January and June 2002, 102 consecutive mid-sagittal T2-weighted MRI scans were evaluated. A line tangential to the upper border of the manubrium (sternal notch) and perpendicular to the z-axis of the magnet was extended posteriorly to intersect the spine, and the level of intersection was recorded. This represented the level of the inferiormost upper thoracic vertebra that was accessible with the low anterior cervical approach, without sternotomy or thoracotomy.

This method was evaluated in a patient with a fractured T3 vertebral body. The T2-weighted mid-sagittal MRI scan performed preoperatively showed that the tangential line was below the fractured vertebra, and actually intersected the upper half of the T5 vertebral body (Fig. 1). Therefore, a low anterior cervical approach was performed to access the fractured T3 vertebral body.

## Results

The level of the sternal notch corresponded to the level of T2 and T3 in 68.7% of the cases (T2, 15.7%; T2–3, 25.5%; T3, 27.5%). In 3 cases, the body of T4 could be seen cranial to the tangential line to the sternal notch. In all the cases, the C7 vertebral body lay cranial to the supra-sternal level, while in 3 cases, only the T1 vertebral body could be visualized suprasternally. Table shows the frequency of visualization of the individual vertebral bodies above the level of the sternal notch in the 102 cases.

In 20 cases, the sternal notch could not be visualized clearly because the saturation bands routinely used in mid-sagittal MRI scans obscured proper visualization of the sternum.

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**Figure 1.** Preoperative T2-weighted midsagittal MRI scan showing the tangential line to the sternal notch intersecting the upper part of the T5 vertebral body. It also shows the fractured T3 vertebral body.

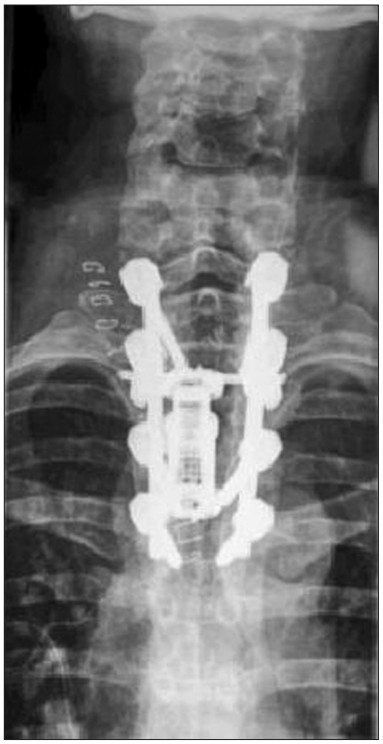

**Figure 2.** Postoperative anteroposterior radiograph showing interbody fusion cage and pedicle screw implants in situ.

In the patient in whom the fractured vertebra was preoperatively shown to lie cranial to the sternal notch in MRI scans, the low anterior cervical approach yielded good exposure up to the lower body of T4, allowing us to carry out the planned procedure with stabilization from T2–T4 using interbody fusion cage anteriorly and pedicle screw fixation posteriorly (Fig. 2).

## Discussion

With the advent of improved imaging techniques in the last two decades, visualization of various pathological entities pertaining to the upper thoracic spine has been made possible. The preferred approach to most of these lesions is anteriorly, as it is directed against the pathological lesion, which is usually found in the vertebral body. Technically, exposing the upper thoracic spine remains a challenging problem.

Hodgson et al. reported reported in 1960 a 40% mortality rate in their 10 patients who had surgical treatment via the anterior approach by median sternotomy for tuberculosis of the upper thoracic spine (11). However, using the transsternal approach with the addition of resection of the medial third of the clavicle, Sundaresan et al. reported no deaths among their 7 patients (5). Later, variations were reported in the literature, like biclavicular resection (10), resection of clavicle and manubrium (2), and resection of the midportion of the clavicle alone (9). These additional procedures were associated with high morbidity (12). For extensive radical resections at T1–T3 levels, the sternal splitting approach was also described (8).

Access to the upper thoracic vertebrae by thoracotomy is impaired by the presence of the aortic arch and great vessels. Furthermore, there are anatomical constraints, like the presence of the sternum anteriorly and the physiological transition of the cervical lordosis to the thoracic kyphosis (1).

Turner and Webb described a surgical exposure to the upper thoracic vertebra using posterior thoracotomy, especially in the elderly (6). A lateral extra cavitary approach was also described (5), but the scapula limited the exposure. Lazennec et al. advocated partial cervicosternotomy, which had the advantage of providing direct access to the upper thoracic vertebrae without the associated reconstruction problems caused by uni- or bilateral sternoclaviculotomies (4).

Gieger et al. proposed the simple anterior cervical approach to the upper thoracic vertebrae, which is a familiar approach to the lower cervical spine (3). However, the level of the upper thoracic vertebrae that can be exposed suprasternally varies by individual.

As the frequency of visualizing T2 and T3 suprasternally is high, a low cervical approach can be contemplated in most patients with upper thoracic spine pathology; however, the level of the vertebral body in the upper thoracic spine in relation to the sternal notch should be preoperatively ascertained in each patient.

Sharan et al. evaluated 106 MRI scans to visualize the upper thoracic spine and find its relationship to the sternal notch (13). They concluded that midsagittal MRI scans were useful for ascertaining the feasibility of approaching the upper thoracic spine without sternotomy or thoracotomy. Saturation bands are routinely used in T2-weighted mid-sagittal MRI scans to decrease movement artifacts, but they obscure the visualization of the ster-

Level of the sternal notch in relation to the upper thoracic vertebral bodies in 102 consecutive cases, as determined by T2-weighted midsagittal MRI scans

| Level of the sternal notch | Number of cases (%) |
|---|---|
| T1 | 3 (2.9) |
| T1–2 | 2 (2) |
| T2 | 16 (15.7) |
| T2–3 | 26 (25.5) |
| T3 | 28 (27.5) |
| T3–4 | 4 (3.9) |
| T4 and below | 3 (2.9) |
| Not visible | 20 (19.6) |

num in a significant number of cases (approximately 20% of patients in our series). Normally this does not matter if an MRI scan is performed only to assess a lesion in the upper thoracic spine; however, as our study revealed, visualization of the sternal notch in an MRI scan is important in these cases for deciding which surgical approach to use. To overcome this problem, either using saturation bands when performing T2-weighted mid-sagittal MRI scans in patients with suspected upper thoracic vertebral pathology may be avoided or a narrow saturation band can be used. Movement artifacts do not interfere with visualization of the sternal notch, nor do they distort the appearance of upper thoracic spine pathology.

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