Determination of Thoracic Spine Level by MRI

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Purpose: Since numbering thoracic spine by MRI is tedious, we sought to determine if anatomic landmarks are reliable for the numbering of thoracic spine on MRI.
Methods: In 52 thoracic MR-images the sternal apex, pulmonary artery, aortic arch and osseous or discal abnormalities were numbered on cervical localizer, and thoracic sagittal image.
Results: None of the anatomical landmarks were labeled at a consistent level.
Conclusion: The only reliable ways to determine thoracic spine level is to include C2 through T12, or have an abnormality seen on both cervical localizer and thoracic sagittal images. External landmarks are close to useless.

Introduction

Accurate numerical definition of thoracic levels on MR imaging is tedious. The commonly used reference levels are the second cervical vertebra (1) or L5 and S1(1). Occasionally, there is a transitional vertebrae (lumbar or thoracic) that makes numbering on the basis of L5 difficult (2). Suggested alternative methods proposed include utilizing the level of the sternal notch (3), using an external marker adhered to the skin (4), or noting the level of the great vessels.

Consequently, we sought to determine the accuracy of these suggested system of reference in accurately, reliably and reproducibly determining thoracic spine numerical level.

Materials and Methods

52 consecutive MR studies of the thoracic spine were evaluated (23 males, 29 females, age range 18-83 years. Most patients were imaged at 1.5T (GE medical systems, Milwaukee, WI).

On Gradient echo or T1 weighted localizers of the cervical and thoracic spine, which included C2 as a standard of reference, the level of the following landmarks was noted: the sternal apex and superior margin of the pulmonary artery on midsagittal images, superior margin of the aortic arch.

In order to try and compare the level of the landmarks in a given patient on different series, we looked for specific abnormalities in the vertebral bodies or discs that were visible on both cervical/thoracic localizer and thoracic sagittal images. In patients who had findings that were seen on only one or on neither of these sequences (abnormalities in the lower thoracic spine, out of the localizer field of view, or were not seen on the localizer due to insufficient quality) were excluded.

In order to check the accuracy of external markers on the skin, we took measurements in an additional 15 patients that had vitamin e markers placed on the skin over the spine. We tried to determine whether the markers were at a consistent level in the cervical/thoracic localizer and in the sagittal thoracic image; without knowing the absolute level. In a given patient we compared the location of the marker on different sequences in relation to visible anatomical landmarks (C2, sternal apex), vertebral body or disc abnormality.

Also when possible, we measured the "gap" between the 2 or 3 vitamin e markers. These measurements were taken on a Canon PACS workstation (Canon Medical Systems, Irvine, CA) by drawing a straight horizontal line, connecting the superior edge of the marker with the vertebral column. The intermarker gaps were measured by the total, plus fractional number of intervening vertebral bodies.

Results

The sternal notch was visualized in 51 cervical anatomic localizer images. It was located between T2-T5; at T3 in about a half (28/51). The aortic arch was visualized in 48 localizer images. It was located at T2-T4, specifically at T4 in about a third (18/48). The pulmonary artery was seen on 51 localizer images. It was located between T4-T7, at T5 in less than a half (20/52) (Fig 1).

Twelve patients had abnormal findings in the vertebral bodies or in the disc that were clearly visible on both the cervical localizer and one of the sagittal thoracic spine sequences. These included hemangiomas (8), schmorl's nodes (2), a compression fracture (1), bone marrow replacement (1) and degenerative end plate changes (1). In only nine of these cases, could the anatomic level be determined accurately without the localizer image.

In the additional 15 patients with vitamin e markers that were placed over upper thoracic spine, 7 patients had two vitamin e markers, 4 had three markers and 4 had one marker. Eleven of the 15 patients showed consistency in the level of the markers in relation to the reference points, or consistent intermarker gap between the sequences. In the 4 other patients, 2 showed a gap difference of half a vertebral body between the localizer and thoracic clinical sequences and one showed a difference of 1 vertebral body. In one patient with 3 markers, one gap differed in half of a vertebral body and the other gap was a whole vertebral body; between the diagnostic and localizer images.

Discussion

When C2 or L5 are not included in the any of the sequences of the thoracic spine MRI, there is a need to find alternative methods to number the vertebrae. We evaluated 66 patients and found large amounts of variability in these alternative methods. The variability in the level of the sternal apex between patients has been reported previously (3). Between patients, in our study there was a range of 3 vertebrae for the sternal apex level, 2.5 vertebrae for the pulmonary artery and 2 vertebrae for the aortic arch within the sets of series performed in a given patient. Variatility can be explained by differences in body habitus, positioning of the patient on the MR table, respiratory motion (sternum and pulmonary artery) and vascular pulsation (aorta). Regardless of the explanations, these landmarks are not consistent or reliable enough to be used clinically.

We found external markers (vitamin E capsules) not to be reliable either. Although in most of the cases they do not change in numerical level between sequences, in more than a quarter of the cases they did. We relate these differences to movements of the chest wall, in relation to the skin during respiration.

Consequently we believe there are only two reliable ways to accurately define the levels. The first is by including C2 in the thoracic sequence of a diagnostic quality, and the second is by using an abnormality in the discs or vertebral bodies as a point of reference. Accurate numbering is most important for those patients who go to surgery. However, if this cannot be done with absolute certainty, comparison with fluoroscopically visible variant or abnormality may be the best method to allow intervention at the appropriate level.

Reference

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