Morphological Aspects of Pyogenic Spinal Epidural Abscess

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ABSTRACT

Introduction: A pyogenic spinal epidural abscess is an infectious collection inside the spinal canal, outside the dural sac. The diagnosis is difficult and the consequences are devastating due to compression or vascular compromise. MRI has a high diagnostic sensitivity and specificity, which improves when a contrast medium is used. **Objectives:** To determine the inter- and intra-observer reproducibility, and to discriminate the different parameters and differences between specialties. **Materials and Methods:** Twenty-seven independent observers evaluated 5 parameters: region, location, involvement, association, and perivertebral, anterior, lateral, or posterior extravertebral abscess. The kappa coefficient was used to analyze 35 cases on three occasions. **Results:** The overall intra- and inter-observer global agreement level is kappa 0.76, with the following values obtained: region 0.94; location 0.88; involvement 0.55; association 0.67 and perivertebral abscess 0.77. The first three parameters indicate volume, while the final two indicate the presence of vertebral infectious foci outside the canal. **Conclusions:** The proposed morphological classification is simple to use and has high intra- and inter-observer reproducibility. The most reproducible parameters are region and location (>0.87).

Keywords: Infection; epidural; abscess; osteomyelitis; spondylodiscitis; classification; magnetic resonance.

Level of Evidence: III

Aspectos morfológicos del absceso epidural espinal piógeno

RESUMEN

Introducción: El absceso epidural espinal piógeno es la localización de una colección infecciosa dentro del canal raquídeo, por fuera del saco dural. El diagnóstico es difícil y las consecuencias son devastadoras a causa de la compresión o el compromiso vascular. La resonancia magnética tiene una alta sensibilidad y especificidad diagnósticas que aumentan si se administra un medio de contraste. Los objetivos de este estudio fueron: determinar la reproducibilidad inter- e intraobservador, y discriminar los distintos parámetros y diferencias entre especialidades. **Materiales y Métodos:** Veintisiete observadores independientes evaluaron 5 parámetros: región, ubicación, compromiso, asociación y perivertebral, absceso extravertebral anterior, lateral o posterior. Se analizaron 35 casos en tres oportunidades, se utilizó el coeficiente kappa. **Resultados:** El nivel de acuerdo global intra- e interobservador global es kappa 0,76; los valores obtenidos fueron: región 0,94; ubicación 0,88; compromiso 0,55; asociación 0,67 y perivertebral 0,77. Los tres primeros parámetros dan noción de volumen y los dos últimos reflejan la presencia de focos infecciosos vertebrales por fuera del conducto. **Conclusiones:** La clasificación morfológica propuesta es de uso simple y tiene una muy buena tasa de reproducibilidad intra- e interobservador. Los parámetros con mayor reproducibilidad son: región y ubicación (>0,87).

Palabras clave: Infección; absceso epidural; osteomielitis; espondilodiscitis; clasificación; resonancia magnética.

Nivel de Evidencia: III

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INTRODUCTION

Infectious processes that affect the spine can appear in a variety of locations (disc, vertebral body, spinal canal, perivertebral space), either in isolation or in association. A pyogenic spinal epidural abscess is an infectious collection inside the spinal canal,[1] between the dura mater and the osteoligamentous structures. Depending on its dimensions and location, it causes a variety of symptoms that are closely related to the compression of neural structures and have a direct impact on the content of the canal. The therapeutic indication and surgery pose a great challenge for the spinal surgeon.[2]

Despite its low incidence,[3] it is nine times more frequent than its intracranial variant,[1] and it can be a devastating disease[2,4] from the neurological point of view, and even fatal. It is almost always considered a consequence of spondylodiscitis, osteomyelitis, or a psoas muscle abscess, but in other cases, it is detected as a primary expression of an infectious process, the location of which may vary depending on its origin.[5] Neurological deficit is the most feared complication, and it may be due to a mass effect[2,3,6,7] or to vascular disorders, such as thrombosis or infarction.[2,8]

The diagnostic imaging study of choice is magnetic resonance imaging (MRI) due to its high sensitivity and specificity, mainly in the T2-weighted sequence;[2,3,7,9-11] gadolinium administration increases sensitivity.[4,9,12]

In the international literature, it is classified as a variant or accessory of an infection located in the disc or the body;[13,14] using tumor compression classifications,[15] in addition to imaging and neurological compromise,[16,17] but none of these classifications are specific to pyogenic spinal epidural abscess, as they do not consider its length, location, or size.

In order to improve or even facilitate the diagnosis, it is necessary to have a high index of suspicion.[5,9,11]

Our research group presented these morphological parameters of pyogenic spinal epidural abscesses[18] as the first step in a research process that will end with a clinical classification using images.

The objectives of this study were: to determine the inter- and intra-observer reproducibility, discriminate the different parameters and differentiate between the specialties of the independent observers.

MATERIALS AND METHODS

After approval by the Hospital Research Service (HSMLP2021/0054), the second phase of a project was carried out to implement a classification of pyogenic epidural abscess, with the ultimate goal of providing therapeutic suggestions based on images and clinical manifestations, in a complementary and final future.

A morphological classification of different epidural abscesses was carried out in magnetic resonance images extracted from a database. The length, location within the spinal canal, and involvement of its content were recorded, which confers an idea of volume; and the association with intra- and extravertebral foci was analyzed.

The morphological parameters were: region (R), location (L), involvement (I), association (A) and perivertebral (P) (RLIAP).

Region: it is determined by taking the upper and lower limits of the image corresponding to the epidural abscess and excluding the supernatant inflammatory process. If one of the limits coincides with the vertebral body, it receives the name of the vertebral body; if it coincides with the disc, it receives the name of the upper or lower adjacent vertebra, depending on whether it is the upper or lower limit. Therefore, the first data is the location and spatial length of the process.

Location within the canal: it can be anterior or posterior to the dural content (Figure 1); in this way, we can evaluate if there is involvement of the anterior or posterior cord of the spinal cord at the cervical or thoracic level.

Involvement: M, affects the meningeal space without displacing or compressing intradural content, which can be medullary or radicular depending on the sector; C1, displaces the content without compressing it; and C2, deforms the meningeal content. (Figure 2).

Association: The abscess may or may not be associated with vertebral infections, such as disc (O0), body (O1), or both (O2). A single variant must be selected or (-) if there is no combination.

Perivertebral: the association with perivertebral abscesses in the anterior (prevertebral), lateral (includes the psoas) or posterior (vertebral gutter) space is taken into account (Figure 3). It is marked with (+) if there are any of them or with (-) if they are not observed.

There were 27 independent observers: three spinal orthopedists, one subspecialty trainee orthopedist, 20 orthopedic residents, one spinal neurosurgeon, and two imaging residents.

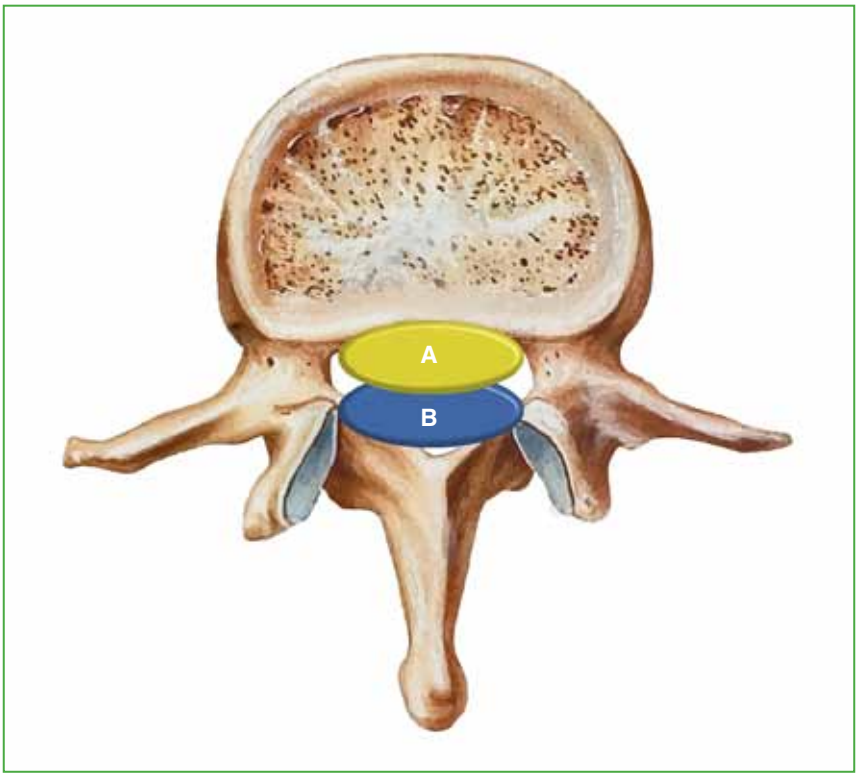

Figure 1. Diagram showing the location of the epidural abscess within the canal (considered the largest occupation). A = anterior, occupies from the posterior wall up to 50% of the diameter. B = posterior, occupies from the posterior osteoligamentous margin forwards to 50% of the diameter of the canal.

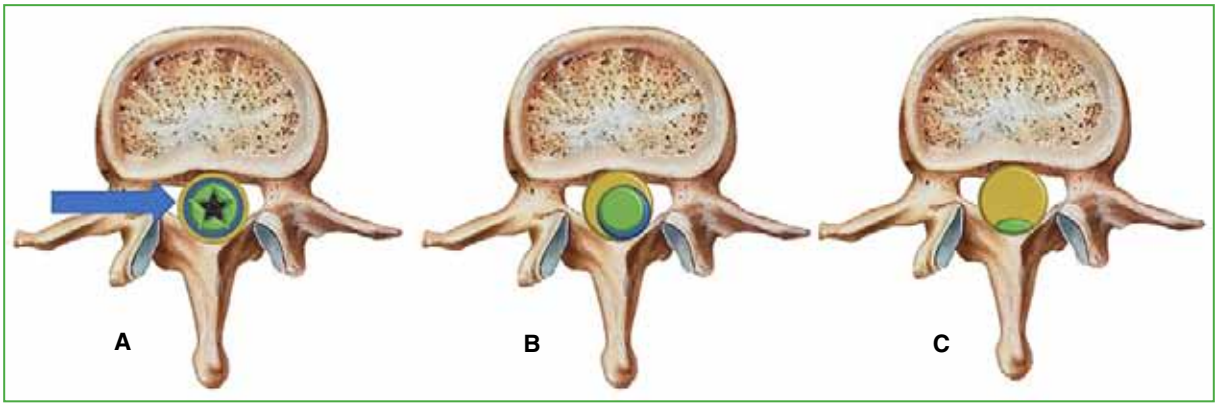

Figure 2. Diagram showing canal content involvement. The canal is depicted with three circumferential rings, the central one with a star and showing the content (medulla or roots) in green, with its enclosure in blue. **A.** The superficial ring marked with the arrow and colored orange represents the epidural space occupied by the pyogenic spinal epidural abscess (classified as M). **B.** The abscess displaces the contents (C1). **C.** The abscess compresses the content (C2).

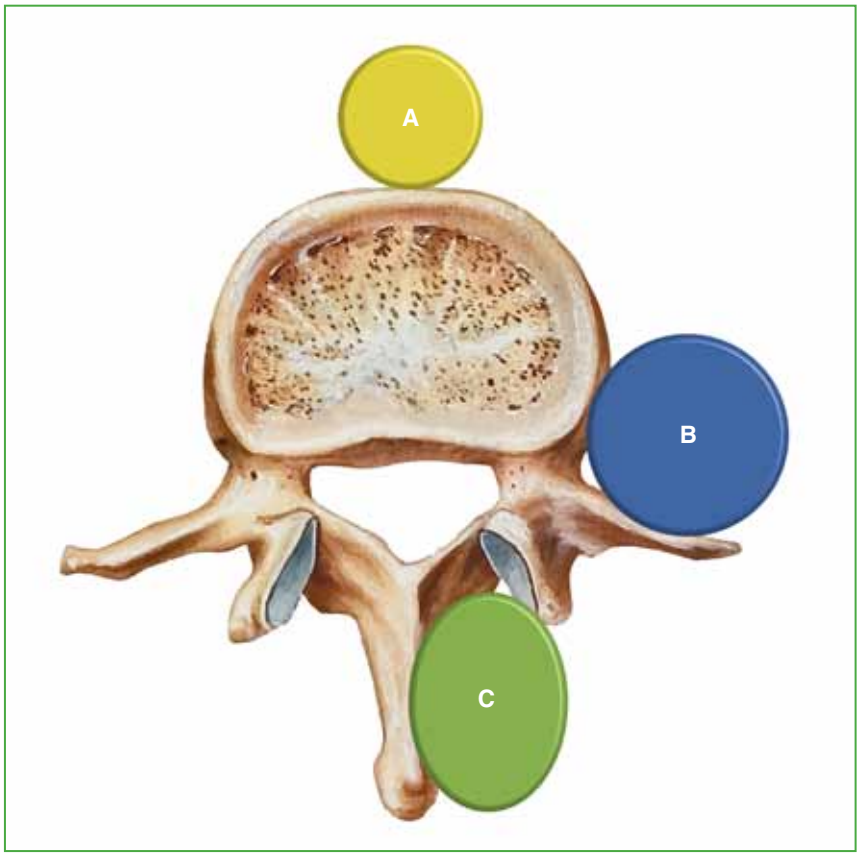

Figure 3. Diagram showing the location of perivertebral abscesses. A = anterior, B = lateral, C = posterior.

Evaluation methodology

Thirty-five cases with magnetic resonance imaging were included in different windows that were organized by the main author of the study who was not part of the evaluation. A PowerPoint presentation of each case was created, which was recorded in .mp4 video, with automatic replay every 30 seconds. Three rounds of evaluation were carried out separated by five weeks, the evaluator had to deliver them in 24 hours.

For the second evaluation, the position of the cases was modified, taking a random number and modifying the location of all of them. Based on the location of the second assessment, the same procedure was performed for the third assessment.

A response grid of the different evaluations was prepared and sent with the video by email. After answering the first evaluation and, after a few days, the same procedure was carried out for the second and third evaluation.

The results were entered into a spreadsheet of the IBM SPSS Static® 20.0 program and analyzed with Cohen's kappa coefficient separated by parameter and overall by case to determine intra- and inter-observer reproducibility.

RESULTS

Cohen's kappa coefficient on overall intra- and inter-observer agreement was 0.76, which is considered a very good reproducibility agreement. The values of each particular parameter were: R 0.94; L 0.88; I 0.55, depending on the resonance window and the use of contrast medium; A 0.67 and P 0.77. The first three parameters give a notion of volume that, in a future process, could be related to making a therapeutic decision and the last two indicate the presence of vertebral infectious foci outside the canal (Figures 4-6).

The gadolinium T2-weighted window was the image with the highest inter-rater agreement (kappa >0.87) in all sections, followed by T2 without contrast, STIR, and finally T1-weighted without contrast.

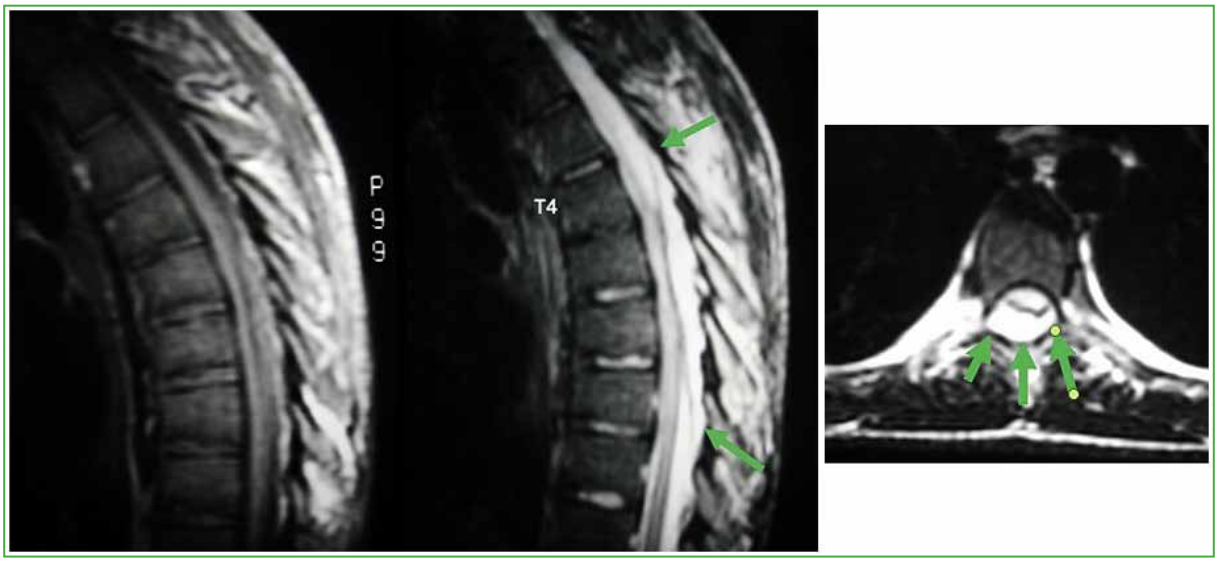

Figure 4. Case 10. MRI, T1- and T2-weighted sagittal sections, and T2-weighted axial section. Defined as T4-T8, P, C2 (Region: T4-T8, Location: posterior; Involvement: compresses the content). In cases of posterior pyogenic spinal epidural abscess, there may not have association; therefore, it is association and perivertebral negative.

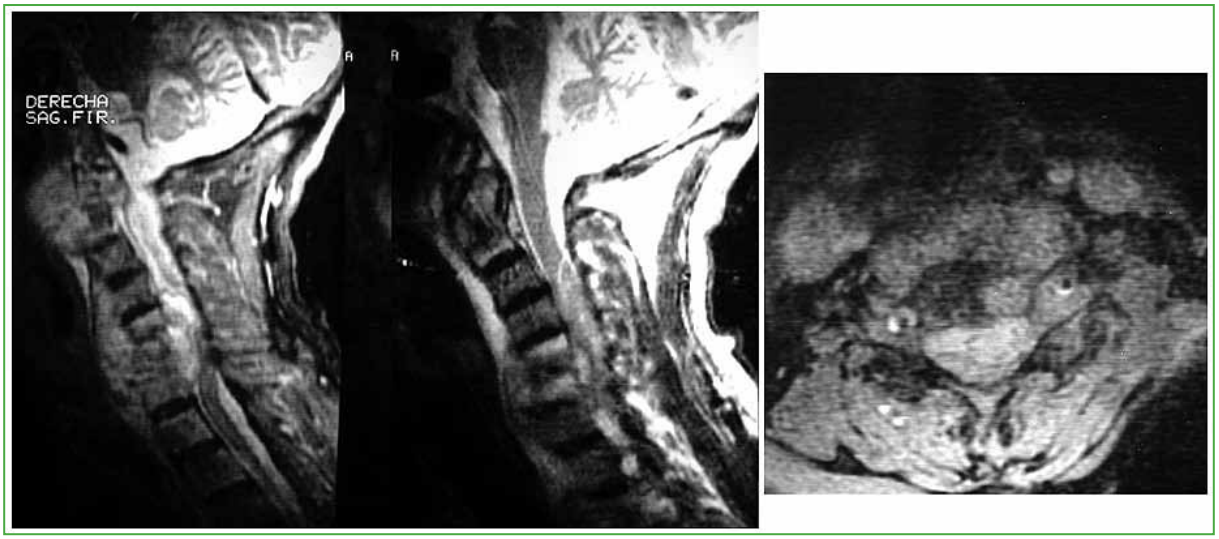

Figure 5. Case 17. MRI, T2-weighted sagittal sections without contrast and with contrast, and axial T2-weighted with contrast. Defined as C5-C7, A, C2, O2, + (Region: C5-C7, Location: anterior, Involvement: compresses the content, Association: disc and bone involvement, Perivertebral: positive - Anterior).

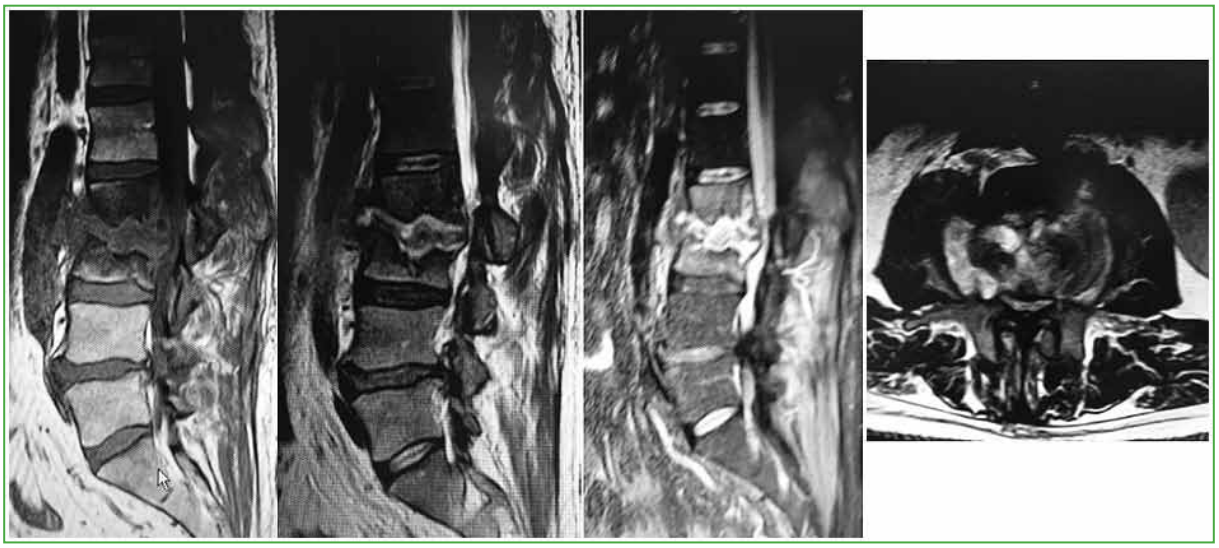

Figure 6. Case 35. MRI, T1- and T2-weighted sagittal sections, T2-weighted with contrast medium, and axial T2-weighted. Defined as L2-L3, A, C2, O2, + (Region: L2-L3, Location: anterior, Involvement: compresses the content, Association: disc and bone infection, Perivertebral: lateral/psoas).

DISCUSSION

There are studies in the current literature that emphasize lesions that compromise bone and disc indemnity without describing the epidural abscess, the region in which it is found (cervical, dorsal, lumbosacral), its extension, the involvement of intracanal structures, or the presence of extraosseous or distant lesions.

Pola et al.[13] proposed the most widespread and currently used classification, classifying their cases according to whether the infection causes bone destruction or instability, whether there is an epidural abscess, whether there is a neurological condition or involvement of the paravertebral space. In this way, three main types can be highlighted: A, discitis; B, osteomyelitis, and C, epidural abscess, and the authors provided global treatment guidelines without extensive rationale. Type A, depending on whether there is involvement of the paravertebral space, is divided into five subtypes; type B, into four subtypes, according to the combination of instability and paravertebral space, and type C, the subject matter of our work, is differentiated into four subtypes according to the combination of bone destruction, instability, and the neurological condition. The length is not identified, which is not applicable to epidural abscesses of more than one level. Recently, Camino Willlhuber et al.[19] analyzed the reproducibility of this classification, giving it a moderate inter- and intra-observer reproducibility index.

Almansour et al.[14] developed a clinical-radiological classification that includes, in one of its points, epidural abscess, together with neurological deficit, instability, laboratory analyses, pain, and magnetic resonance lesions. They described treatment guidelines and one of the main indications for a surgical approach is deficit due to epidural abscess.

At present, other classifications and scores for the management of epidural abscess developed for other purposes are used, such as the study by Bilsky et al.[15] We believe that they have weaknesses, because they lack a division by regions, they do not analyze the length of the pyogenic epidural abscess, nor the association with other infectious foci.

On the other hand, Shah et al.[16] and Uchida et al.[17] formulated a hypothesis for the treatment of lumbar epidural abscesses using magnetic resonance imaging with contrast medium and neurological correlation based on the Frankel score, and it was reproducible in the cervical and thoracic spine.

In the first part of this process,[18] Cohen's kappa coefficient on global intra- and inter-observer reproducibility was 0.81, an excellent reproducibility value; the remaining values were: R 0.95; L 0.92; I 0.66 according to the resonance window and the use of contrast medium; A 0.70 and P 0.80, significantly higher than the result of this evaluation, we believe that it is due to the fact that, in the first experience, the participating specialists were orthopedists dedicated exclusively to spinal pathology.

Our morphological classification proposal describes and incorporates aspects related to length, location, type of compression and its association with the vertebral body, intervertebral and paravertebral discs, and distant infections, with excellent inter- and intra-observer reproducibility.

The strength of our study is the lack of international studies that describe the morphological characteristics covering the different regions, their pathology, and their extension. The weakness is the display of images of few cases, because they correspond to the initial parts of the planned project. The sample will be increased in the final stage of the investigation, and clinical evaluation, laboratory studies, and treatment will be included to provide therapeutic projections. Finally, independent evaluators will be sought for validation.

CONCLUSIONS

The proposed morphological classification is simple to use and has an excellent intra- and interobserver reproducibility rate. The parameters with the highest reproducibility were: R and L (>0.87) and the rest yielded figures between 0.55 and 0.77.

On average, the difference between professionals specializing in spinal pathology and those who are not is 0.10 point. It is estimated that the two diagnostic imaging professionals in training are related to the first group.

Conflict of interest: The authors declare no conflicts of interest.

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