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MORPHOLOGICAL ASPECT OF PYOGENIC SPINAL EPIDURAL ABSCESSES. PART I

ASPECTO MORFOLÓGICO DOS ABSCESSOS PERIDURAIS PIOGÊNICOS DA COLUNA. PARTE I

ASPECTO MORFOLÓGICO DE LOS ABSCESOS EPIDURALES ESPINALES PIÓGENOS. PARTE I

PEDRO LUIS BAZÁN[1,2,3], JOSÉ CARLOS SORIA ADARO[4], NICOLÁS MAXIMILIANO CICCIOLI[1,5], ALFREDO OSVALDO GODOY ADARO[6], RICHARD ALEJANDRO AVERO GONZALEZ[7]

1. HIGA San Martín de La Plata, Buenos Aires – Argentina.
2. Hospital Italiano de La Plata, Buenos Aires – Argentina.
3. Instituto de Diagnóstico La Plata, Buenos Aires – Argentina.
4. Clínica Francesa. Mendoza, Mendoza – Argentina.
5. Clínica Pueyrredón de Mar del Plata - Argentina.
6. Clinica Modelo S.A. Paraná, Entre Rios - Argentina.
7. Clínica Modelo Quilmes – Argentina.

ABSTRACT

Background: Pyogenic Spinal Epidural Abscess (PSEA) is difficult to diagnose and can have devastating consequences. Magnetic Resonance Imaging (MRI) has high sensitivity and specificity, which are further increased with the use of contrast. There are several classifications of vertebral infectious processes, with emphasis on spondylodiscitis. Objective: To analyze the morphological parameters and their reproducibility; and to analyze different resonance imaging sequences. Methods: Using an image database, a morphological classification of PSEA was planned, with five parameters: Region (R), indicating the upper and lower limits of the abscess; Location (U), indicating whether the abscess is anterior or posterior within the canal; Compromise (C), meningeal or content of the structures; Association (A), discitis, osteomyelitis or both; and Perivertebral (P), anterior, lateral or posterior extravertebral abscess. The first three parameters give an idea of the volume of the PSEA, while the last two give the related infectious foci. Thirty-five cases were analyzed using Kappa's coefficient. Results: The global intra- and interobserver reproducibility was Kappa 0.81. The results for each parameter were as follows: R=0.95, U=0.92, C=0.66, A=0.70 and P=0.80. The first three give a notion of volume and the last two relate to the presence of vertebral infectious foci outside the canal. T2 weighted MRI with contrast was found to be the most effective imaging sequence. Conclusion: The morphological classification is simple to use, with excellent reproducibility. The parameters with the highest reproducibility were region and location, with values >0.92. The addition of gadolinium contrast increased the sensitivity of the diagnosis; the use of sagittal and axial images in T2-MRI was the most sensitive imaging sequence. **Evidence Level III; Original.**

Keyword: Spine; Abscess; Classification; Spondylodiscitis; Osteomyelitis.

RESUMO

Introdução: O abscesso peridural piogênico da coluna (PSEA) é de difícil diagnóstico e pode ter consequências devastadoras. A ressonância magnética (RM) tem alta sensibilidade e especificidade, que são aumentadas ainda mais com contraste. Existem várias classificações dos processos infecciosos vertebrais, com ênfase em espondilodiscite. Objetivo: Analisar os parâmetros morfológicos e sua reprodutibilidade; e analisar as diferentes sequências de imagens de ressonância. Métodos: A partir de um banco de imagens, foi planejada uma classificação morfológica do PSEA, com cinco parâmetros: Região (R) que indica os limites superior e inferior do abscesso; Localização (U), indicando se o abscesso é anterior ou posterior dentro do canal; Comprometimento (C), meníngeo ou de conteúdo das estruturas; Associação (A), discite, osteomielite ou ambas e Perivertebral (P), abscesso extravertebral anterior, lateral ou posterior. Os três primeiros parâmetros dão uma ideia do volume da PSEA, enquanto os dois últimos mostram os focos infecciosos relacionados. Trinta e cinco casos foram analisados usando o coeficiente de Kappa. Resultados: A reprodutibilidade global intra e interobservador foi Kappa 0,81. Os resultados para cada parâmetro foram os seguintes: R = 0,95, U = 0,92, C = 0,66, A = 0,70 e P = 0,80. Os três primeiros dão uma noção de volume e os dois últimos se relacionam com a presença de focos infecciosos vertebrais fora do canal. A RM ponderada em T2 com contraste foi considerada a sequência de imagens mais eficaz. Conclusões: A classificação morfológica é simples de usar e tem excelente reprodutibilidade. Os parâmetros com maior reprodutibilidade foram região e localização com valores > 0,92. A adição do contraste de gadolínio aumentou a sensibilidade do diagnóstico; o uso de imagens sagitais e axiais em RM T2 foi a sequência de imagens mais sensível. ***Nível de Evidência III; Original.***

Descritores: *Coluna Vertebral; Abscesso; Classificação; Espondilodiscite; Osteomielite.*

RESUMEN

Introducción: El absceso epidural espinal piógeno (PSEA) es difícil de diagnosticar y puede tener consecuencias devastadoras. La resonancia magnética (RM) tiene una alta sensibilidad y especificidad, que aumentan aún más con el contraste. Existen varias clasificaciones

Study conducted at the HIGA San Martín de La Plata, Provincia de Buenos Aires, Argentina.
Correspondence: Pedro Luis Bazán, Calle 51 – 1715 (1900) La Plata, Provincia de Buenos Aires, Argentina. pedroluisbazan@gmail.com

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de los procesos infecciosos vertebrales, con énfasis en la espondilodiscitis. Objetivo: Analizar los parámetros morfológicos y su reproducibilidad; y analizar las diferentes secuencias de imágenes de resonancia. Métodos: Utilizando un banco de imágenes, se planificó una clasificación morfológica del PSEA, con 5 parámetros: Región (R), que indica los límites superior e inferior del absceso; Ubicación (U), que indica si el absceso es anterior o posterior dentro del canal; Compromiso (C), meníngeo o contenido de las estructuras; Asociación (A), discitis, osteomielitis o ambas; y absceso perivertebral (P), anterior, lateral o posterior extravertebral. Los tres primeros parámetros dan una idea del volumen del PSEA y los dos últimos los focos infecciosos relacionados. Se analizaron 35 casos mediante el coeficiente Kappa. Resultados: La reproducibilidad general intra e interobservador fue Kappa 0,81. Los resultados de cada parámetro fueron los siguientes:: R=0,95, U=0,92, C=0,66, A=0,70 y P=0,80. Los tres primeros dan una noción de volumen y los dos últimos se relacionan con la presencia de focos infecciosos vertebrales fuera del canal. La resonancia magnética ponderada en T2 con contraste se consideró la secuencia de imágenes más eficaz. Conclusiones: La clasificación morfológica es sencilla de utilizar y tiene una excelente reproductividad. Los parámetros con mayor reproducibilidad fueron la región y ubicación con valores > 0,92. La adición de contraste de gadolinio aumentó la sensibilidad del diagnóstico; el uso de imágenes sagitales y axiales en RM T2 fue la secuencia de imágenes más sensible. ***Nivel de Evidencia III; Original.***

Descriptores: *Columna Vertebral; Absceso; Clasificación; Espondilodiscitis; Osteomielitis.*

INTRODUCTION

Pyogenic Spinal Epidural Abscess (PSEA) is an infection caused by a collection of pus[1] within the spinal canal, between the dura mater and osseoligamentous structures. Depending on its extent and location, it can cause various symptoms related to the compression of neural structures, directly affecting the contents of the spinal canal and posing a major challenge for the spinal surgeon.

PSEA is a rare pathology, though nine times more frequent than its intracranial variant.[1] From a neurological perspective, it is potentially devastating[2-4] or even fatal. Although usually considered a consequence of a spondylodiscitis, osteomyelitis or abscess of the psoas muscle, PSEA may sometimes be the primary expression of an infectious process. Its spatial location can vary, depending on its origin.[5] The most feared consequences are neurological deficit by the mass effect[2,3,6,7] and vascular complications such as thrombosis or heart attack.[2,8]

Magnetic Resonance Imaging (MRI) is the most sensitive and specific diagnostic imaging test of any spinal infectious process,[2,3,7,9-11] particularly the T2 sequence, and the use of gadolinium as a contrast agent further increases this sensitivity.[4,9,12-14]

The international literature classifies PSEA as a variant or accessory of an infection located in the disc and/or body, based on the extent of tumoral compression[15] and the evaluation of images and neurological compromise.[16,17] But none of these classifications is able to specify the PSEA taking into account its length, location and size.

It is clear that to ensure a correct approach to this pathology, there must first be a high level of suspicion, in order to improve or even facilitate the diagnosis.[5,9,11] In this article, we propose an algorithm for the morphological classification of PSEA.

The objectives of this study were to analyze the morphological parameters and their inter- and intra-observer reproducibility; and to analyze the results using different resonance imaging sequences.

METHODS

After obtaining the approval of The Research Department of the Hospital (HSMLP2021/0054), the first phase was to create a classification of Pyogenic Epidural Abscess; next, the intra- and extra- independent observer reproductivity were analyzed; and finally, therapeutic suggestions are given, based on the images and clinical findings.

Based on an image database of different epidural abscesses, a morphological classification was created, recording, wherever possible, the length of the abscess, its location within the spinal canal, its volume, the compromise of surrounding structures, and any associations with intra- or extra- vertebral foci.

Classification criteria: Five parameters were used: Region (R) Location (L), Compromise (C), Association (A), and Perivertebral (P). Hence, the mnemonic RUCAP was created (based on these words in Spanish).

Region: this parameter is determined based on the upper and lower limits of the epidural abscess shown on the image, discarding the supernatant inflammatory process. If one of the limits coincides with the vertebral body, it takes the name of that vertebral body; if one of the limits coincides with a disc, it takes the name of the upper or lower vertebra adjacent to it. Thus, the first parameter shows the length of the abscess and gives partial information about its location.

Location: the abscess may be anterior or posterior within the canal (Figure 1) and as such, may affect the anterior or posterior cordon of the medulla at the cervical or thoracic levels.

Compromise: the compromise of surrounding structures is classified as follows: M if the abscess extends to the meningeal space but without moving or compressing the intradural content, whether medullar or radicular, depending on its location; CI if it causes the meningeal content to move without compressing it; and C2 if it causes deformation of 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). Only one option must be selected.

Perivertebral: this determines any association of the perivertebral abscess with the anterior space (prevertebral), the lateral space (including the psoas) or the posterior space (vertebral groove) (Figure 3). If any of these associations are present, it is marked with a + symbol.

Thirty-five cases were selected for inclusion in a Power Point presentation, with videos recorded in mp4 format and automatic slide transition to the next case every thirty seconds.

In the second evaluation, the positions of all the cases was changed, with each being attributed a random number. Considering the position of the case in the second evaluation, the same procedure was carried out for the third evaluation. A matrix was designed for recording the responses to the different evaluations. This was sent out by email, together with the video. A few days after responding to the first evaluation, the same procedure was conducted for the second and third evaluations (Figure 4-10).

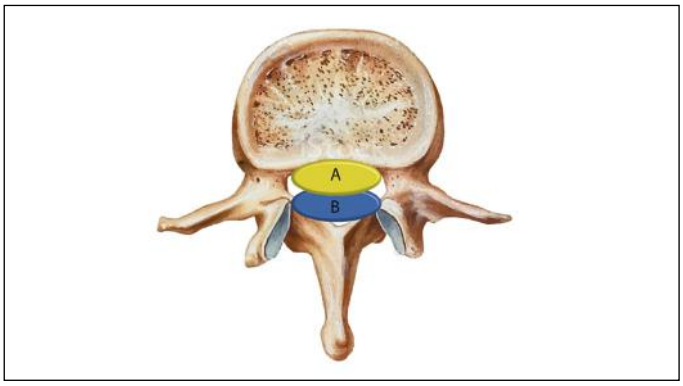


Figure 1. Diagram showing the location of the Epidural Abscess within the canal, taking into consideration the largest area occupied. A = Anterior, from the posterior wall, occupying up to 50% of the canal diameter. B = Posterior, from the posterior osteoligamentous margin forward, occupying up to 50% of the canal diameter.

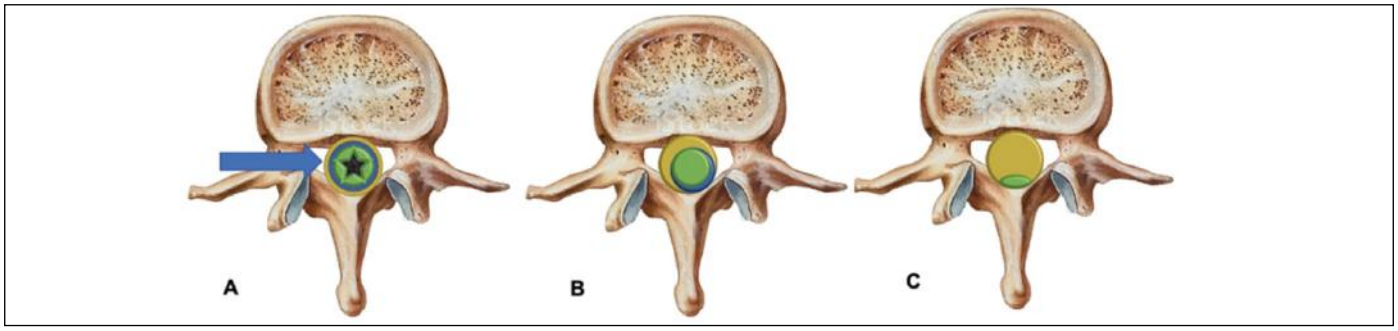


Figure 2. Diagram showing compromise of the spinal canal. The canal is marked with three circumferential rings; the central one shown in green, with a star, shows the content (marrow or roots), with its envelope in blue. A. The superficial ring, shown in orange with an arrow, represents the epidural space occupied by the PSEA (classified as M). B. The PSEA scrolls the content (C1). C. The PSEA compresses the content (C2).

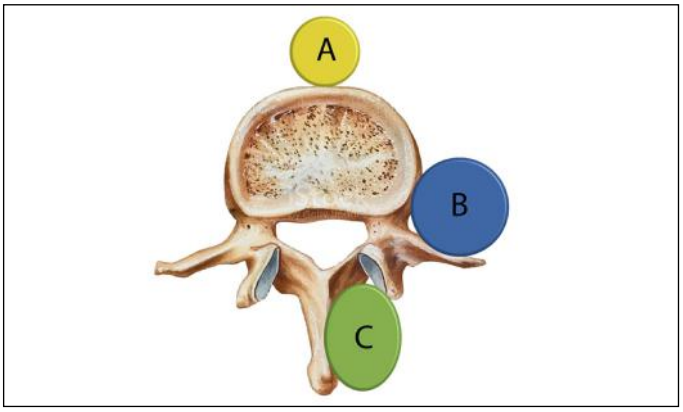


Figure 3. Diagram showing the presence of perivertebral abscesses. A. Anterior, B. Lateral and C. Posterior.

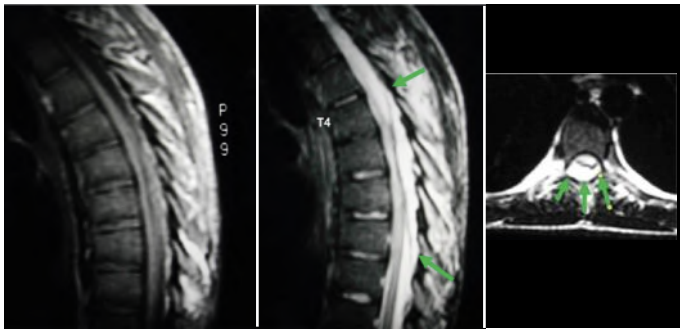


Figure 4. Case 10. MRI sagittal sections T1 and T2 and Axial T2. Defined as T4-T8, P, C2 (Region T4-T8, Posterior Location, the PSEA compresses the canal content). Some cases of posterior PSEA may not have any vertebral association; these are classified as negative Perivertebral.

The results were transferred to an Excel spreadsheet, and each case was analyzed for intra- and inter-observer reproducibility according to Kappa's coefficient, divided by each parameter and globally.

RESULTS

Kappa's coefficient for global intra- and inter- observer reproducibility was 0.81, which is considered very high.

Focusing on each of the parameters, the scores were: R=0.95, U=0.92, C=0.66 (depending on the MRI window and the use of contrast agent), A=0.70 and P=0.80. The first three parameters give a notion of volume, which is useful in the treatment selection. The last two relate to the presence of vertebral infectious foci outside the canal (Figures 4 to 8).

MRI in T2 with contrast was the most effective imaging sequence (with Kappa >0.87) on every cut, followed by T2 without contrast agent, STIR and finally, T1 without contrast.

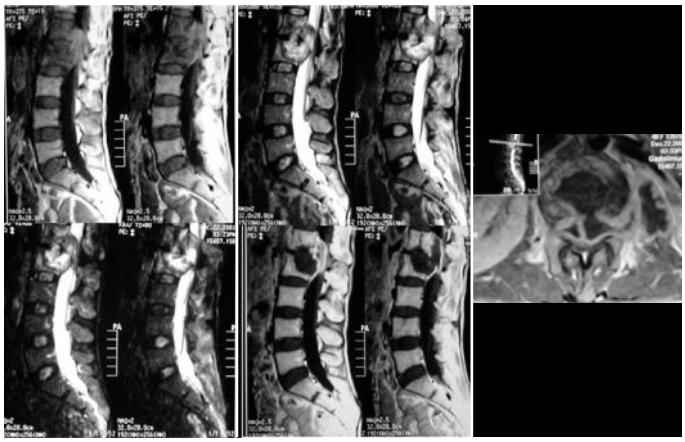


Figure 5. Case 13. MRI sagittal sections T1, T2, Stir, T1 with contrast and Axial T1 with contrast. Defined as L1-L2, A, C2, O2, + (L1-L2 Region, Anterior Location, the PSEA compresses the canal content, Association with disc and bone involvement, Perivertebral positive - lateral/Psoas).

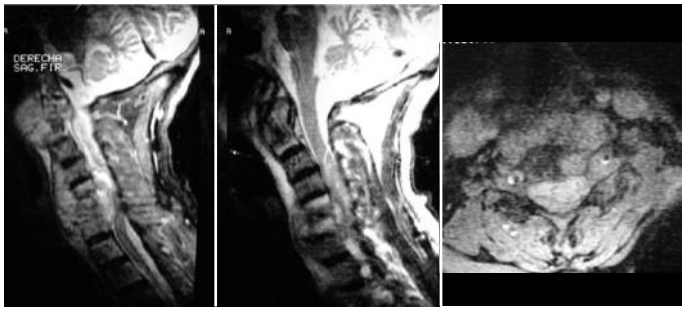


Figure 6. Case 17. MRI sagittal sections T2 without and with contrast and Axial T2 with contrast. Defined as C5-C7, A, C2, O2, + (Region C5-C7, Anterior Location, the PSEA compresses the canal content, Association with disc and bone involvement, Perivertebral positive - anterior).

DISCUSSION

The existing literature presents studies focusing on abscesses that compromise the osseous and discal areas, but these do not describe the epidural abscess in sufficient detail, such as the region where it is located (cervical, dorsal, lumbosacral), the length of the abscess, compromise of intercanal structures, or the presence of extraosseous or remote injuries.

Almansour and Col[14] attempted to design a clinical and radiological classification that includes, as one of its aspects, the epidural abscess together with neurological deficiency, instability, lab, pain and MRI injuries. They describe the main treatment indications in cases where one of them, following a surgical approach, is deficiency caused by epidural abscess.



Figure 7. Case 18. MRI Coronal sagittal sections, T1 with contrast, T2 without contrast and Axial T2 and T1 with contrast. Defined as T10-T12, A, C1, O2, + (Region T10-T12, Anterior Location, The PSEA moves the content, Association with disc and bone involvement, Perivertebral positive - lateral).

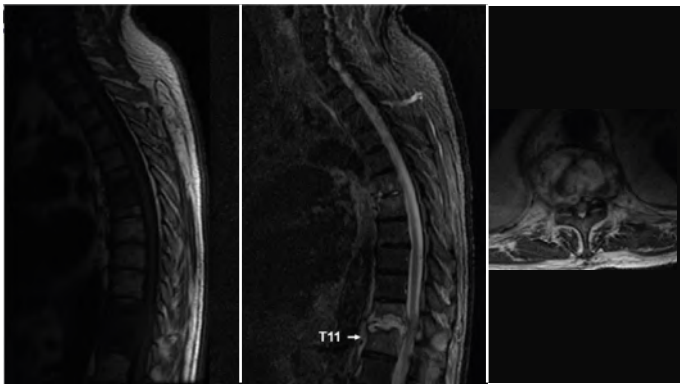


Figure 8. Case 21. MRI sagittal sections T1 and T2 and Axial T2. Defined as T10-T11, A, C1, O2, +. (Region T10-T11, Anterior Location, the PSEA moves the content, Association of disc and bone infection, Perivertebral Lateral/Psoas).

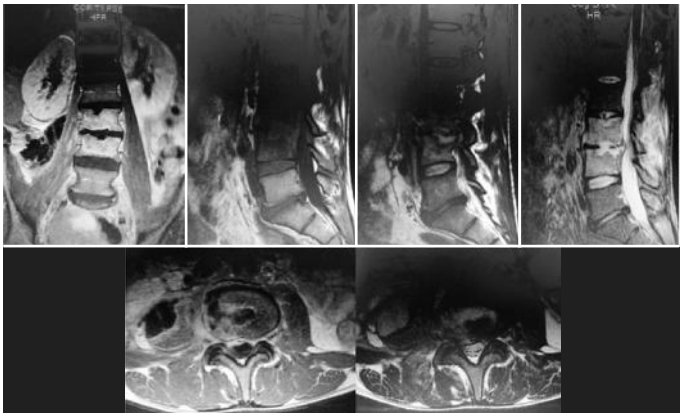


Figure 9. Case 34. MRI coronal, sagittal T1, T2 and T2 with contrast and Axial T1 with contrast and T2 without contrast. Defined as L3-L4, A, C1, O2, +. (Region L3-L4, Anterior Location, the PSEA moves the content, Association with disc and bone infection, Lateral Perivertebral/Psoas).

In the classification of Pola and Cole,[13] which is one most widespread currently in use, cases are classified according to whether the infection has caused bone destruction or instability, and the presence of epidural abscess, neurological signs, or damage to the paravertebral space. The three main types described are: A- discitis, B- osteomyelitis and C- epidural abscess, but the treatment indications given by the authors are over-generalized and lack valid specific justification. Type A is subdivided into 4 types, depending on the presence of damage in the paravertebral space; type B has 4 subtypes, depending on the relationship between instability and paravertebral space; and type C, the type described in this work, also has 4 subtypes,



Figure 10. Case 35. MRI sagittal sections T1, T2 and T2 with contrast and Axial T2. Defined as L2-L3, A, C2, O2, +. (Region L2-L3, Anterior Location, the PSEA compresses the content, Association with disc and bone infection, Lateral Perivertebral/Psoas).

depending on the combination of bone destruction, instability and neurological compromise. The length of the abscess is not identified; therefore, this classification cannot be used for epidural abscess with more than one level. Recently, Camino Willhuber and Col[18] analyzed the reproducibility of this classification, and suggested that it has a moderate rate of intra- and inter- observer reproducibility.

Other classifications and scores developed for other purposes are currently used for the management of epidural abscess, such as that of Bilsky and Col's.[15] But these classifications are thought to have some weaknesses; for example they do not divide abscesses by area, and they do not analyze the length of the abscess or its relation with other infectious foci.

Shah and Col,[16] Uchida K and Col[17] hypothesized the possibility of epidural treatment based on the use of contrast magnetic resonance correlated with the Frankel grade of neurological injury. However this study was based only on lumbar spine cases, and its applicability to the cervical and dorsal spine is not known for certain.

Our proposed morphologic classification describes and incorporates aspects of length, location, type of compression, relationship with the vertebral body, intervertebral disc, paravertebral location, and distant infections, with excellent intra- and inter- observer reproducibility.

This, we believe, is the strength of this work, as no other studies were found, in the global literature, that describe the morphological characteristics, covering different areas, the pathology and the extension.

CONCLUSIONS

The proposed morphological classification is simple to use and has excellent intra- and interobserver reproducibility. The parameters with the highest reproducibility are: region and location with values >0.92 and the remaining values between 0.66 and 0.80.

The addition of gadolinium contrast enhances the sensitivity of the diagnosis, and the use of sagittal and axial images in T2 is more sensitive for classification. In the immediate future, it is necessary to expand the number of cases and to re-evaluate the reproducibility of the classification and associate it with clinical parameters, in order to produce a scale that can be used as a basis for accurate therapeutic indications.

Abbreviations

PSEA: Pyogenic Spinal Epidural Abscess
MRI: Magnetic Resonance Imaging
R: Region
U: Location
C: Compromise
A: Association
P: Perivertebral

Declarations

Ethics approval and consent to participate

The project of this article was evaluated by the Research Ethics Committee of the Teaching and Research Service of our Hospital. As it used a database of anonymous images as a research instrument, informed consent was not required.

Availability of data and materials

The data reported in this article can be requested from the corresponding author, at the email address: pedroluisbazan@gmail.com or pedroluisbazan@med.unlp.edu.ar

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