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ORIGINAL ARTICLE

Baastrup's disease prevalence across various age groups and its association with degenerative changes: insights from STIR sequence in MRI

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Abstract

Purpose Baastrup's disease is characterized by abnormal contact between adjacent spinous processes. Our study is the first to systematically incorporate the STIR sequence, recognized for its heightened sensitivity to fluid and edema, into the MRI protocol for diagnosing Baastrup's disease in symptomatic individuals. The objective is to determine its prevalence and association with lumbar spinal degenerative changes.

Materials and methods Lumbar spinal MRI examinations of 375 patients performed between January 2021 and 2022 were retrospectively reviewed by two radiologists. Baastrup's disease was diagnosed based on meeting any of the following criteria: lumbar interspinous bursitis, hyperintense signal changes in adjacent spinous processes, and ligaments on the STIR sequence. The study also investigated the presence of degenerative changes and interreader agreement among radiologists.

Results Baastrup's disease was found in 141 of 375 individuals (37.8%). It correlated significantly with degenerative lumbar changes such as bulging ($P=0.0012$), herniation ($P=0.0033$), disc degeneration ($P=0.0013$), Modic changes ($P=0.034$), facet osteoarthritis ($P=0.0041$), spinal stenosis ($P=0.005$), and anterolisthesis ($P=0.0049$). No significant associations were observed with gender ($P=0.468$) or retrolisthesis ($P=0.167$). Its occurrence increased gradually, peaking at 87.5% in individuals aged 80 and above. Radiologists showed complete agreement with Baastrup's diagnoses.

Conclusion Baastrup's disease is more commonly observed than being considered rare, displaying an incremental occurrence with increasing age in symptomatic individuals notably discernible on the STIR sequence. Using the STIR sequence seems to promote a consensus among radiologists, irrespective of their experience levels.

Keywords Baastrup's disease · Magnetic resonance imaging (MRI) · Short tai inversion recovery (STIR) · Lumbar degenerative changes · Bursitis · Age distribution

Introduction

Baastrup's disease, known as 'kissing spines', is characterized by the close approximation and contact of the adjacent spinous processes, leading to edema, cystic changes, sclerosis, flattening, and enlarged articulating bone surfaces. This condition also involves the formation of an adventitious bursa in the interspinous region and, occasionally, epidural cysts or midline fibrotic masses [1, 2]. It typically affects the lumbar spine, usually involving only one level and predominantly manifesting at the L4–L5 level with additional degenerative changes. It tends to occur more frequently in individuals over 70, with no specific gender predilection [3, 4]. Baastrup's disease is regarded as a pathological syndrome of clinical relevance related to an increased degree of lordosis and repetitive strain on the interspinous ligaments, involving the formation of

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nociceptors leading to pain or as a component in the spectrum of the anticipated degenerative changes of the spine associated with advancing age [5]. While the clinical significance of Baastrup's disease remains ambiguous, and controversy persists regarding its classification as a nociceptor, symptomatic patients report midline pain specifically at the level of the pathological interspinous ligament, which is aggravated during extension and relieved during flexion [6]. The treatment of symptomatic Baastrup's disease generally includes a conservative approach utilizing analgesics and non-steroidal anti-inflammatory drugs, as well as percutaneous infiltrations involving corticosteroids and local anesthetics as an alternative method [4, 7, 8]. Moreover, surgical interventions like bursa excision or osteotomy are also regarded as therapeutic measures [7, 9].

While X-rays provide essential clues in the diagnosis, computed tomography (CT) is highly effective in revealing the close approximation and contact of adjacent spinous processes, sclerosis, flattening and enlargement of the articulating surfaces, and accompanying degenerative changes. Magnetic Resonance Imaging (MRI), however, stands as the preferred and superior imaging method for identifying lumbar interspinous bursitis, which is characterized by a fluid signal between opposing spinous processes, as well as bone, soft tissue, and interspinous ligament edema at the affected level. Furthermore, MRI can depict contrast enhancement around the soft tissues, indicating active disease, inflammation, and associated findings such as epidural cysts and midline fibrotic masses.

In the literature, few studies have explored the prevalence of Baastrup's disease in diverse populations, including young athletes and heavy automotive vehicle drivers, and have reported varying values ranging between 6.3 and 81.3% for different age groups [3, 10, 11]. Notably, the singular study that employed MRI to investigate the prevalence and its association with degenerative changes lacked the inclusion of the short tau inversion recovery (STIR) sequence, which is highly sensitive to fluid and edema, in the standard protocol [6]. Our study aims to establish the precise prevalence of Baastrup's disease and its association with degenerative-related findings using MRI, making it the first to incorporate the STIR sequence into conventional pulse sequences. We also aimed to explore the impact of varying levels of expertise and the degree of inter-reader agreement among radiologists with different levels of experience in diagnosing Baastrup's disease using MRI. This aspect has yet to be studied in any previous literature.

Materials and methods

Study design and patient population

Local ethics committee approval was obtained for this retrospective study, and the requirement for informed consent was waived (Approval number: 60116787-020-415581). A search within the radiology information system was carried out to identify routine unenhanced lumbar spine MRI scans performed between January 2021 and January 2022, and the study included 375 patients (73% females, 27% males; age range 10–88 years old; mean, 48; median, 50) who had undergone these examinations due to back or leg pain (lumbago and sciatica). Patients with rheumatologic diseases (such as ankylosing spondylitis and rheumatoid arthritis), benign or malignant lesions (i.e., metastases, plasmacytoma, schwannoma), spondylodiscitis, recent trauma history with acute or chronic fractures, or prior spinal surgery were excluded. Contrast-enhanced MR examinations were also not included. Furthermore, MR images were assessed by a neuroradiologist with 28 years of experience, and inadequate examinations that included only some pulse sequences, including the STIR sequence, or met the minimum technical requirements for appropriate evaluation were excluded.

Image acquisition and MRI protocol

All MRI scans were conducted using a 1.5-T scanner (Ingenia; Philips Healthcare) equipped with a dStream Posterior coil. The scanner had a gradient power of 45 mT/m on each axis and a maximum slew rate of 200 mT/m/sec. All MRI scans comprised the following pulse sequences: T1-weighted sagittal fast spin echo (FSE) without fat suppression, T2-weighted sagittal FSE without fat suppression, T2-weighted axial FSE without fat suppression parallel to the disc, and sagittal short tau inversion recovery (STIR). The pulse sequence parameters are summarized in Table 1.

Image analysis

A fourth-year radiology resident who completed training in both neuroradiology and musculoskeletal radiology and a radiologist with 28 years of experience in neuroradiology independently reviewed spine MR images on a PACS (Picture Archiving and Communications System) workstation

Table 1 Spinal MRI sequence parameters

Parameter	Sagittal T1W	Sagittal T2W	Axial T2W	Sagittal STIR
TR (msec)	528	2500	2300	2500
TE (msec)	16	120	100	70
Flip angle	90	90	90	90
FOV (mm)	180×302	180×302	200×200	180×302
Voxel size (mm)	0.75×1.06	0.75×1.06	0.7×0.8	1.2×1.5
Section thickness (mm)	4	4	3	4
Matrix size	240×300	240×300	288×232	152×200
Gap (mm)	1	1	0.3	1
NEX	3	3	3	1
Sequence time (min:sec)	02:14	02:30	02:32	01:45
Total MR zmaging time (min:sec)	02:14	04:44	07:16	09:01

T2W, T2 weighted; TR, time of repetition; TE, time of echo; FOV, field of view; NEX, number of excitations; Min, minute; Sec, second; Msec, miliseconds; Mm, milimeter

using a structured report form. At every intervertebral lumbar disc level, the assessment of MR images included Baastrup's disease, abnormalities in disc contour (bulge and herniation), disc degeneration (spondylosis), alterations in endplate marrow signal (Modic changes), osteoarthritis of the facet joints, central canal stenosis, and sagittal displacement (anterolisthesis, retrolisthesis).

The diagnosis of Baastrup's disease was established when any of the following features, namely lumbar interspinous bursitis with fluid-like signals observed between consecutive spinous processes, hyperintense signal changes of spinous processes, or hyperintensity of interspinous ligaments on STIR images, were identified (Fig. 1).

Disc contour abnormalities were categorized as either bulge or herniation, following definitions outlined in the multidisciplinary standard nomenclature [12]. Bulges were characterized by diffuse contour abnormalities covering 50% or more (180°) of the disc circumference, while herniations were identified as focal contour irregularities encompassing less than 50% or 180° of the disc circumference. Detailed subtype designations were not employed for this context, including protrusion, extrusion, and sequestrated disc. In disc evaluation, no disc height loss was considered normal, and disc height decrease was considered grade 3 and 4 disc degeneration according to the Pfirrmann classification [13]. The endplate bone marrow signal abnormalities were assessed according to Modic's classification [14]. Subtype

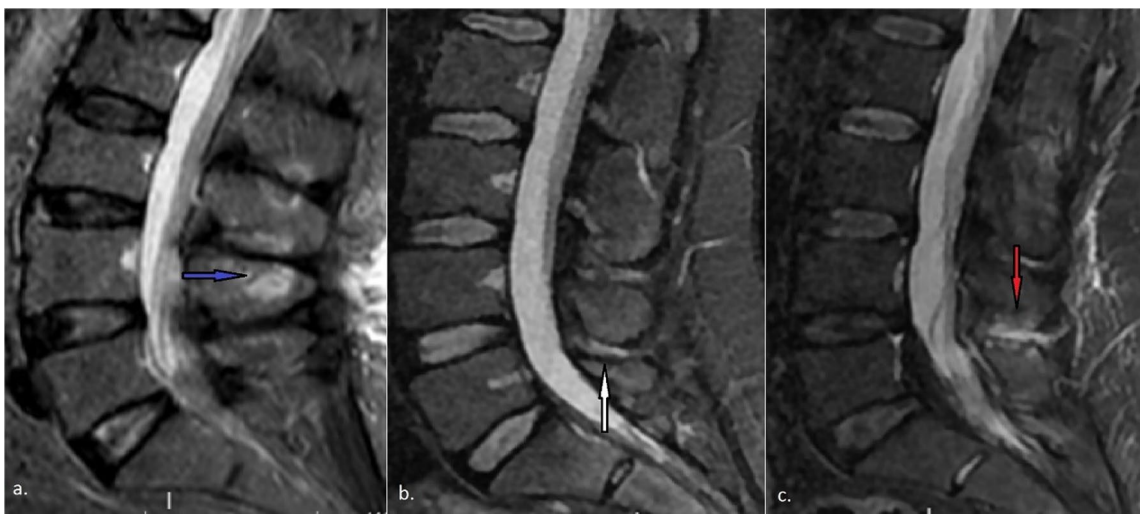

Fig. 1 Sagittal STIR sequence images of three distinct patients who underwent MRI examination for lumbago. In the leftmost image **a** flattening, enlargement, and bone marrow edema of spinous processes at L2–L5 levels, with the most pronounced changes observed at the L4 level (blue arrow), are evident. The middle image **b** shows hyperintense signals in the interspinous ligament of the L4–5 level (white arrow), indicating soft tissue edema. The STIR image of the third patient **c** reveals a fluid signal in the interspinous region at the L4–L5 level (red arrow), consistent with bursitis

designations were intentionally omitted in this assessment. Instead of categorizing endplate marrow signal alterations based on superior versus inferior endplate involvement, they were differentiated by disc level. Facet joints were evaluated and categorized as normal or degenerated [15]. The scoring of left and right facet joints was conducted collectively, with the rating primarily influenced by the more severe findings. Normal facet joints exhibited a uniform joint space ranging from 2 to 4 mm, devoid of osteophytosis or subchondral bone reaction. Facet osteoarthritis was documented if any of the following, or a combination thereof, were observed: osteophytes, narrowing of the joint space, hypertrophy of the articular process, subarticular bone edema, or subchondral cysts. Stenosis of the central canal was characterized by an anteroposterior dimension measuring less than 10 mm on axial images aligned parallel to the intervertebral disc. Sagittal images were utilized to detect anterolisthesis and retrolisthesis, and their presence or absence was recorded as a binary value.

Statistical analysis

Findings specific to each level (including Baastrup's disease, disc contour abnormalities, disc degeneration, endplate signal abnormalities, facet osteoarthritis, central canal stenosis, retrolisthesis, and anterolisthesis) were combined at the respective levels for comprehensive analysis. The analysis unit was based on each level for level-specific findings and on each patient for generalized features. Statistical analyses were performed using SPSS (Statistical Package for the Social Sciences) software version 25.0 (SPSS Inc). Kolmogorov–Smirnov and Shapiro–Wilk tests examined the suitability of data to normal distribution. The presence of Baastrup's disease was assessed with MRI findings through the use of X^2 analysis for dichotomous variables, including bulge, herniation, disc degeneration, endplate signal changes, facet osteoarthritis, central canal stenosis, anterolisthesis, and retrolisthesis. The Kappa coefficient was used to determine the interreader agreement. Kappa value ranges were accepted and interpreted: less than 0.20 as absent; 0.21–0.40 as minimal agreement; 0.41–0.60 as moderate agreement; 0.61–0.80 as substantial agreement; and 0.81–1 as perfect agreement. All statistical tests were calculated two-sided, and a P value lower than 0.05 was accepted as statistically significant.

Results

Table 2 presents the frequency distributions of MRI findings across 1875 intervertebral levels in the cohort of 375 patients. Baastrup's disease, evaluated with the STIR sequence, was identified in 296 levels, corresponding to 37.6% (141 out of 375) of the patients. In cases where Baastrup's disease was observed, it manifested at various levels in 71.6% (101 out of 141) instances. Among these, the majority (59.4% or 60 out of 101) exhibited involvement at two levels, while the minority (40.6% or 41 out of 101) showed Baastrup's disease across three or more levels. In the remaining 40 patients, Baastrup's disease was determined to be at a single level.

Disc bulge was observed at 717 levels in 65.3% (245 out of 375) of the patients. Disc herniation was noted in 174 levels, representing 41.9% (157 out of 375) of the patient cohort. Disc degeneration manifested in 143 levels, accounting for 25.6% (96 out of 375) of the patients. Endplate signal changes (Modic alterations) in the endplate were identified at 565 levels, encompassing 54.9% (206 out of 375) of the patient cohort. Facet osteoarthritis manifested in 402 levels, accounting for 41.6% (156 out of 375) of the patients. Central canal stenosis was observed in 188 levels, affecting 25.1% (94 out of 375) of the patients. Anterolisthesis was present in 56 levels, accounting for 13.9% (52 out of 375) of

Table 2 Distribution of lumbar spinal MRI findings

	Baastrup	Bulge	Herniation	Disc degeneration	Endplate signal alterations (modic)	Facet osteoarthritis	Spinal stenosis	Anterolisthezis	Retrolisthezis
Patients (n = 375)	141 (37.6%)	245 (65.3%)	157 (41.9%)	96 (25.6%)	206 (54.9%)	156 (41.6%)	94 (25.1%)	52 (13.9%)	34 (9.1%)
Levels (n = 1875)									
L1–L2	5	79	7	12	81	9	9	0	3
L2–L3	26	110	11	19	96	27	26	2	6
L3–L4	73	145	32	26	115	82	62	10	8
L4–L5	105	188	53	39	131	141	76	28	14
L5–S1	87	195	71	47	142	143	15	16	11
Total	296	717	174	143	565	402	188	56	42

the patient cohort. Similarly, retrolisthesis was identified in 42 levels, representing 9.1% (34 out of 375) of the patients.

Baastrup's disease was predominantly observed at the L4–L5 level (35.5% or 105 out of 296), followed by occurrences at the L5–S1 (29.4% or 87 out of 296) and L3–L4 levels (24.7% or 73 out of 296). The remaining 31 levels of Baastrup's disease consist of 26 out of 296 (8.8%) and 5 out of 296 (1.7%) involvements at the L2–L3 and L1–L2 levels, respectively. Additionally, spinal stenosis, anterolisthesis, and retrolisthesis were most frequently identified at the L4–L5 level, while bulging, herniation, disc degeneration, endplate signal intensity changes (Modic), and facet osteoarthritis exhibited a higher prevalence at the L5–S1 level.

Out of the 141 patients assessed, representing 37.8% of the total, manifestations of Baastrup disease were observed, affecting at least one spinal level. The prevalence of kissing spines exhibited a noticeable rise with advancing age, escalating decade by decade and reaching its peak at 87.5% in individuals aged 80 years and above. For a detailed breakdown of Baastrup's disease frequency for each decade, please refer to Fig. 2

Baastrup's disease demonstrated a statistically significant correlation with disc bulging ($P=0.0012$), disc herniation ($P=0.0033$), disc degeneration ($P=0.0013$), endplate signal intensity changes ($P=0.034$), facet osteoarthritis ($P=0.0041$), central canal stenosis ($P=0.005$), and anterolisthesis ($P=0.0049$). However, no statistically significant associations were observed between Baastrup's disease and gender ($P=0.468$) and retrolisthesis ($P=0.167$).

In the conclusive Baastrup diagnoses, relying on the STIR sequence, there was complete agreement between the radiology resident and the neuroradiologist, boasting 28 years of experience. The Kappa value was determined to be 0.87.

Discussion

Our study showed that Baastrup's disease, diagnosed on the STIR sequence, was present in 37.8% of the 375 MRI examinations. Associations with degenerative changes, such as bulging, herniation, disc degeneration, Modic changes, facet osteoarthritis, spinal stenosis, and anterolisthesis, were also noticed, while no correlation with gender or retrolisthesis was found. Furthermore, an increase in frequency associated with age was observed, reaching 87.5% among patients aged 80 years and older. The L4–L5 level exhibited the highest prevalence of involvement. In instances where Baastrup's disease was evident, it was more commonly distributed across multiple levels rather than confined to a single level, in contrast to the patterns observed in some published studies in the literature [3, 6]. Finally, in diagnosing Baastrup's disease, complete agreement was observed among radiologists, regardless of their experience level.

As mentioned earlier, apart from some case reports, only a few studies have addressed the prevalence of Baastrup's disease, with varying percentages ranging from 6.3 to 81.3% in different age groups and populations [3, 6, 10, 11]. In the literature, Maes and colleagues stand as the sole group to utilize MRI exclusively for diagnosing Baastrup's disease, reporting a prevalence of 8.2%, a figure notably lower compared to the present study, which also examines the association of degenerative changes with Baastrup's disease [6]. In our study, an association with degenerative changes was similarly observed; however, it is believed that the utilization of the STIR sequence, known for its heightened sensitivity to fluid compared to conventional MRI sequences,

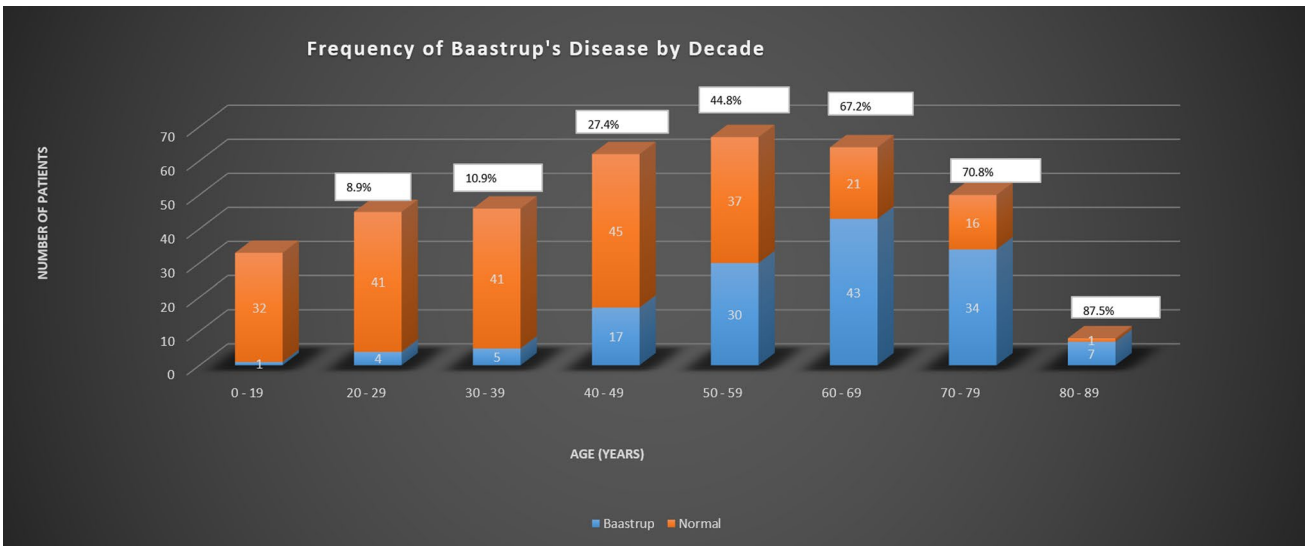

Fig. 2 Frequency of Baastrup's disease by decade

has significantly enhanced diagnostic sensitivity in detecting Baastrup's disease. Furthermore, our study employed a more inclusive criterion for diagnosing Baastrup's disease, including the assessment of interspinous bursitis. In contrast, Maes et al. [6] focused on visualizing the bursa for disease identification. Finally, Maes et al. [6] did not include information on the age distribution of the patients, making a direct comparison of figures difficult.

Baastrup's disease is believed to emerge due to repetitive strain on the interspinous ligaments, leading to their degeneration and collapse, ultimately permitting contact between opposing spinous processes. As observed in our study, a higher incidence of Baastrup's disease in older age group and a strong association with other degenerative changes, such as loss of disc height and spondylolisthesis, which can contribute to the approximation of spinous processes and absence of characteristic midline pain specifically at the level of the pathological interspinous ligament in most of patients may suggest Baastrup's disease as a part of degenerative changes related to aging rather than a distinct clinical entity [5]. Furthermore, MRI is often considered oversensitive to detect findings related to Baastrup's disease. As a result, patient's pain symptoms may not consistently align with a diagnosis of Baastrup's, nor does a Baastrup's diagnosis always explain patient's pain symptoms [6]. For all these reasons, including the poor surgical outcomes published in a few previous studies, Kwong et al. and some other authors propose renaming this entity as the Baastrup phenomenon instead of referring to it as Baastrup's disease. [3, 16–18]. However, the utilization of CT in the study of Kwong et al. which has limited soft tissue resolution leading to impaired assessment of some degenerative changes like disc degeneration and an inability to visualize interspinous bursitis, makes this suggestion questionable. Furthermore, despite its low incidence, the presence of Baastrup's disease in patients without degenerative changes, as also discussed in the same study, and some case reports showing surgical decompression as a beneficial therapeutic option, suggest that this proposition warrants additional studies [7, 19, 20]. All in all, we believe that although the results of our study suggest Baastrup's disease as a clinical entity in the spectrum of degenerative processes, further research is needed to elucidate the clinical significance and exact role of Baastrup's disease as an independent nociceptor.

To our knowledge, this is the first and only study examining interobserver agreement in diagnosing Baastrup's disease, and we observed complete agreement between readers, regardless of their experience. The STIR sequence, which enables even less experienced readers to identify Baastrup's disease-related changes, may have significantly contributed to this high level of agreement.

Lastly, it is noteworthy that radiologists often emphasize anterior and middle column pathologies while overlooking diseases in the posterior column, including Baastrup's disease. An inexperienced radiologist unfamiliar with this condition might mistakenly diagnose interspinous bursitis as infection or neoplasm or misinterpret ligament and bone edema as manifestations of rheumatologic diseases. Furthermore, someone who is unaware of the strong association of Baastrup's disease with degenerative processes may excessively mention related findings, potentially leading to misguided clinical management of the patients. Therefore, awareness of imaging findings of Baastrup's disease in all imaging modalities is essential for the correct diagnosis of this disease.

There are some limitations to our study. First, this was a retrospective study, and it was performed in a single center using a single MRI scanner. Additionally, our study population consisted of a symptomatic patient group with lumbago and sciatica, needing a control group, making it unfeasible to pinpoint the exact prevalence of Baastrup's disease in the general population. Lordosis believed to be a potential factor or contributor to Baastrup's disease, was not intentionally assessed due to the supine and non-weight-bearing position during the MRI examination, which could result in a reduction of lordosis. Future studies should incorporate lumbar radiographs conducted in a standing position to evaluate lordosis's association with Baastrup's disease thoroughly. Lastly, the absence of a reference standard for confirming interspinous bursitis and the need for detailed characteristics regarding patient's low back pain complicate the evaluation and relation of MRI findings with the correct clinical context. The association between Baastrup's disease and clinical findings, particularly pain, remains unclear, warranting caution when considering it as the primary cause of back pain, especially in older patients with spinal degenerative changes.

Conclusion

In summary, among individuals experiencing symptoms of lumbago and sciatica, findings related to Baastrup's disease are prevalent rather than rare, exhibiting a gradual increase with advanced age on lumbar MRI, particularly noticeable on the STIR sequence. Additionally, Baastrup's disease, identified through MRI, is linked to the manifestation of degenerative changes. Finally, using the STIR sequence facilitates a consensus among radiologists, regardless of their experience level.

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Data availability The data supporting this study's findings are available on request from the corresponding author.

Declarations

Conflict of interest The authors have no relevant financial or non-financial interests to disclose.

Ethics approval This study was approved by the ethics committee of Pamukkale University [08.09.2023, E-60116787-020-415581]. All methods were carried out by relevant guidelines and regulations.

References

1. Chen CK, Yeh L, Resnick D et al (2004) Intraspinal posterior epidural cysts associated with Baastrup's disease: report of 10 patients. AJR Am J Roentgenol 182(1):191–194. https://doi.org/10.2214/ajr.182.1.1820191
2. Jang EC, Song KS, Lee HJ, Kim JY, Yang JJ (2010) Posterior epidural fibrotic mass associated with Baastrup's disease. Eur Spine J 19:165–168. https://doi.org/10.1007/s00586-009-1262-8
3. Kwong Y, Rao N, Latief K (2011) MDCT findings in Baastrup disease: disease or normal feature of the aging spine? AJR Am J Roentgenol 196(5):1156–1159. https://doi.org/10.2214/AJR.10.5719
4. Singla A, Shankar V, Mittal S, Agarwal A, Garg B (2014) Baastrup's disease: the kissing spine. World J Clin Cases 2(2):45–47. https://doi.org/10.12998/wjcc.v2.i2.45
5. Filippiadis DK, Mazioti A, Argentos S et al (2015) Baastrup's disease (kissing spines syndrome): a pictorial review. Insights Imaging 6(1):123–128. https://doi.org/10.1007/s13244-014-0376-7
6. Maes R, Morrison WB, Parker L, Schweitzer ME, Carrino JA (2008) Lumbar interspinous bursitis (Baastrup disease) in a symptomatic population: prevalence on magnetic resonance imaging. Spine 33(7):E211–E215
7. Lamer TJ, Tiede JM, Fenton DS (2008) Fluoroscopically-guided injections to treat "kissing spine" disease. Pain Physician 11(4):549–554
8. Okada K, Ohtori S, Inoue G et al (2014) Interspinous ligament lidocaine and steroid injections for the management of Baastrup's disease: a case series. Asian Spine J 8(3):260–266. https://doi.org/10.4184/asj.2014.8.3.260
9. Cohen SP, Argoff CE, Carragee EJ (2008) Management of low back pain. BMJ 337:a2718. https://doi.org/10.1136/bmj.a2718
10. Mann DC, Keene JS, Drummond DS (1991) Unusual causes of back pain in athletes. J Spinal Disord 4(3):337–343. https://doi.org/10.1097/00002517-199109000-00011
11. Hagner W (1988) Baastrup's disease of the lumbar segment of the spine among drivers of heavy motor vehicles. Med Pr 39(1):65–70
12. Fardon DF, Milette PC (2001) Nomenclature and classification of lumbar disc pathology recommendations of the combined task forces of the North American Spine society, American society of Spine radiology, and American society of neuroradiology. Spine 26(5):E93–E113
13. Pfirrmann CW, Metzdorf A, Zanetti M, Hodler J, Boos N (2001) Magnetic resonance classification of lumbar intervertebral disc degeneration. Spine 26(17):1873–1878
14. Modic MT, Steinberg PM, Ross JS, Masaryk TJ, Carter JR (1988) Degenerative disk disease: assessment of changes in vertebral body marrow with MR imaging. Radiology 166(1 Pt 1):193–199. https://doi.org/10.1148/radiology.166.1.3336678
15. Weishaupt D, Zanetti M, Boos N, Hodler J (1999) MR imaging and CT in osteoarthritis of the lumbar facet joints. Skelet Radiol 28(4):215–219. https://doi.org/10.1007/s002560050503
16. Alonso F, Bryant E, Iwanaga J, Chapman JR, Oskouian RJ, Tubbs RS (2017) Baastrup's disease: a comprehensive review of the extant literature. World Neurosurg 101:331–334. https://doi.org/10.1016/j.wneu.2017.02.004
17. Yang X, Liu Y, Chen J, Chen Y, Liu H (2021) 68Ga-FAPI PET/CT Imaging of baastrup disease in a patient with esophageal cancer. Clin Nucl Med 46(12):1024–1025. https://doi.org/10.1097/RLU.0000000000003902
18. Beks JW (1989) Kissing spines: fact or fancy? Acta Neurochir (Wien) 100(3–4):134–135. https://doi.org/10.1007/BF01403600
19. Corr F, Grimm D, Rothoerl RD (2023) Partial spinous process decompression in Baastrup's disease: a case report and literature review. Cureus 15(1):e34070. https://doi.org/10.7759/cureus.34070
20. DePalma MJ, Slipman CW, Siegelman E et al (2004) Interspinous bursitis in an athlete. J Bone Jt Surg Br 86(7):1062–1064. https://doi.org/10.1302/0301-620x.86b7.15154