

When Common Becomes Uncommon: Baastrup's disease, Sacralization of L5, and Swayback Syndrome in an Early Medieval Skeleton from Northeastern Italy

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Abstract

Baastrup's disease, or kissing spine, is a degenerative spinal condition marked by abnormal contact between the spinous processes of adjacent vertebrae. Although frequently diagnosed in older clinical populations, where it is often found in association with other spinal diseases, it remains underreported in the palaeopathological record.

This study presents a case of co-occurring Baastrup's disease, L5 sacralization and swayback syndrome, in an adult male from a 6th–7th century CE burial at San Pietro al Natisone, northeastern Italy. The observed changes reflect the combined effects of age-related degeneration and biomechanical stress associated with the presence of a lumbosacral transitional vertebra (LSTV).

Our findings support the hypothesis that congenital anomalies such as LSTVs can predispose individuals to abnormal spinal mechanics and secondary degenerative changes. This case also emphasizes the diagnostic value of examining posterior vertebral elements in archaeological samples and highlights the importance of interpreting Baastrup's disease within the broader context of spinal degeneration.

Introduction

Baastrup's disease, also known as 'kissing spine', is a condition characterized by the contact between the spinous processes of adjacent vertebrae with interposed fibrous or cartilaginous tissue and, in some cases, the formation of a neo-articulation. This can lead to wear, sclerosis, osteophytes and subsequent back pain (Baastrup, 1933; Mayer, 1825). It most commonly affects the lumbar spine, particularly the L4–L5 segment, though cervical involvement has also been reported (Capasso, 2001; Haeusler et al., 2019; Hu et al., 2024; Nava & Seda, 1955; Viallet, 1950).

While the precise aetiology of Baastrup's disease remains unclear (Haig et al., 2001), a growing body of clinical (Hu et al., 2024; Sağtaş et al., 2024) and

palaeopathological (Kacki et al., 2011) evidence indicates that Baastrup's is not a standalone disease, but an indicator of generalized spinal degeneration, and thus often found in association with other diseases. These include degenerative disc disease (such as bulging, herniation, and disc space narrowing) (Fig. 1), as well as conditions that may contribute to or result from disc degeneration (e.g., facet joint osteoarthritis, spinal stenosis, anterolisthesis, excessive lumbar lordosis, and vertebral trauma) (Alonso et al., 2017; Maes et al., 2008; Sağtaş et al., 2024). Other reported associations include bilateral congenital hip dislocation, obesity (which contributes to intervertebral disc degeneration through both mechanical stress, as it can lead to excessive lordosis causing the spinous processes to rub against each other, and biochemical factors due to the inflammation and the effects of adipokines from

fat tissue, which can degrade the disc's extracellular matrix with disc degeneration) (Baastrup, 1933; Resnick, 1985; Ruiz-Fernandez et al., 2025). In contrast, recent studies (Maes et al., 2008; Sağtaş et al., 2024) suggest that there is no significant association with retrolisthesis or scoliosis.

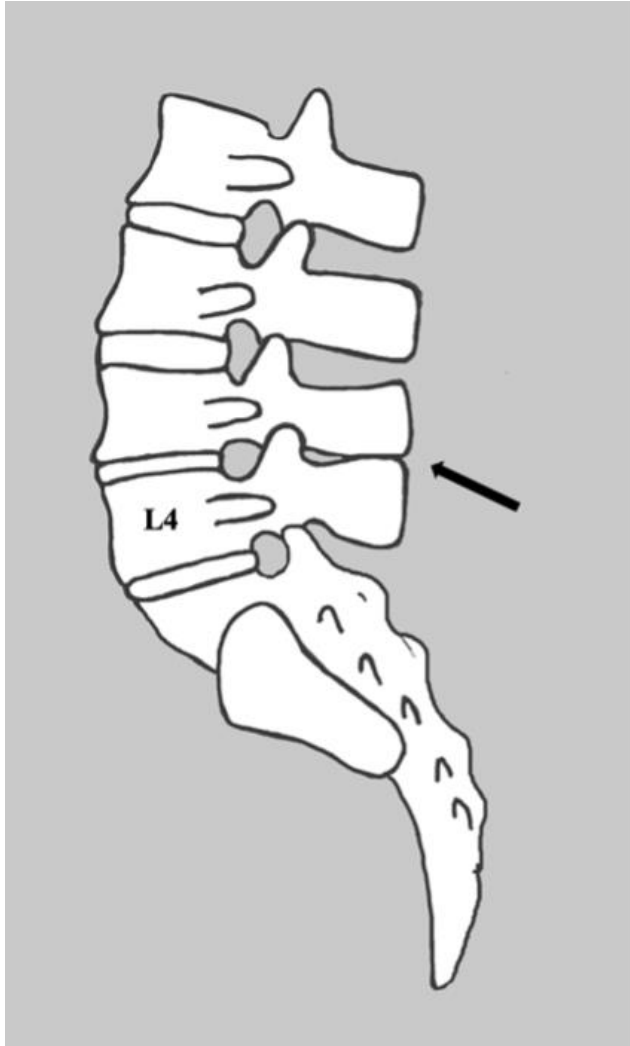


Figure 1: Schematic representation of Bastrup's disease in discal degeneration with sacralization of L5.

In some cases, beyond the contact between the spinous processes, an additional contact can occur between the superior and inferior articular processes of one vertebra and the vertebral arch of the adjacent vertebrae, a condition referred to as swayback syndrome (Freyschmidt et al., 2003; Jacobson et al., 1958).

Among congenital conditions, lumbosacral transitional vertebrae (LSTVs, i.e., the sacralization or lumbarization at the L5–S1 junction) are relatively common (Becker et al., 2022) and easily identifiable in skeletal remains

(Aufderheide et al., 1998). Castellvi and colleagues (1984) introduced a four-type classification system for LSTVs that remains in clinical use today, distinguishing between pseudoarticulation (type II), full fusion (type III), and mixed forms (type IV). Types III and IV are associated with altered load distribution in the lumbar spine and an increased incidence of degenerative joint disease and spondylolisthesis (Farshad-Amacker et al., 2015).

In this study, we describe a case of Baastrup's disease, swayback syndrome, and L5 sacralization (Castellvi type IIIb, with the transverse process fusing with the sacrum bilaterally) in a mature adult skeleton from a 6th–7th century CE burial at San Pietro al Natisone in northeastern Italy. Our findings contribute to the expanding palaeopathological literature on spinal degeneration and vertebral anomalies in past populations and further support the observation that Baastrup's disease more frequently co-occurs with other spinal pathologies (Baastrup, 1933; Mayer, 1825).

Material and methods

San Pietro al Natisone is located in the Natisone Valley in northeastern Italy (Fig. 2A). In 2003, construction work for a residential complex (Belvedere Residence) led to the discovery of a necropolis dated to the second half of the 6th to the early 7th century CE (Borzacconi, 2007). The burial practices and associated grave goods suggest a local population inhabiting the fertile Natisone Valley, an area favourable for agriculture and animal husbandry (Borzacconi, 2007).

While excavations uncovered a total of 27 graves (Fig. 2B), most of which only partially preserved, the overall extent of the cemetery remains unknown to date. The osteological sample comprises 29 individuals: six nonadults between approximately 6–9 months and 8–10 years, one adolescent female (16–18 years), and 22 adults (equally divided between males and females), 32% of whom were over 45 years old (Saccheri, 2025).

This study focuses on the remains of a single individual from this assemblage, designated as T17A. Archaeologically, this burial does not differ from others in terms of structure or associated grave goods, suggesting no particular distinction in social treatment.

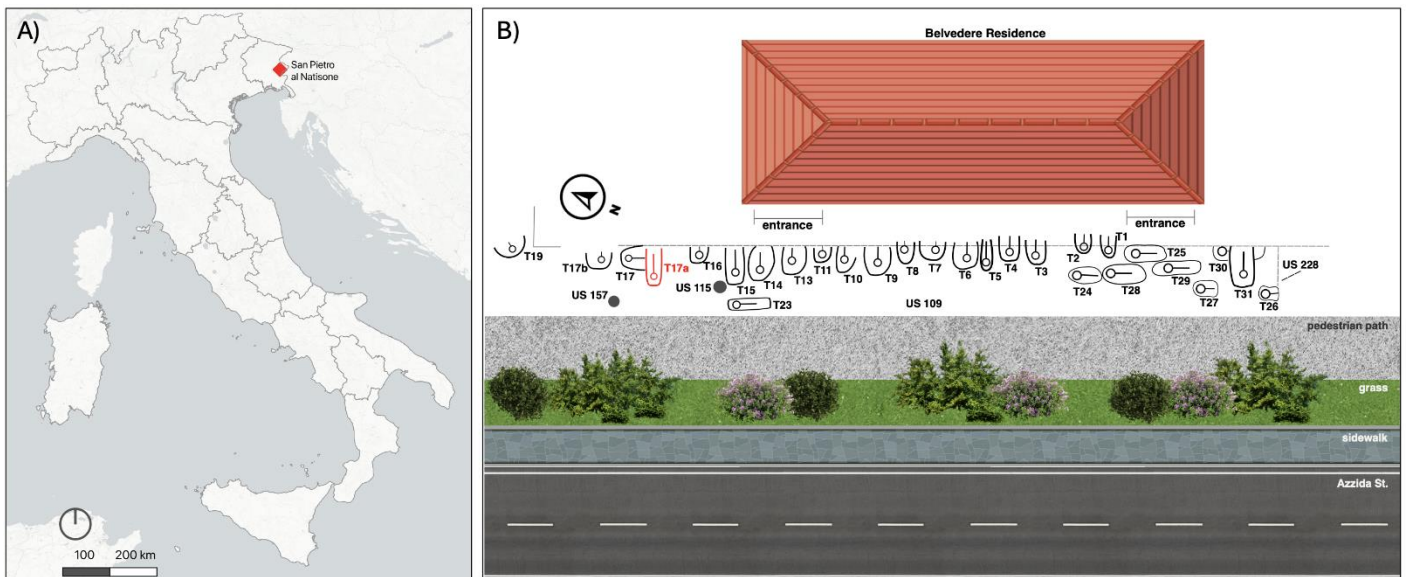


Figure 2: A) Location of San Pietro al Natisone; B) Digital plan of the excavated necropolis. Individual T17a, discussed in this paper, is highlighted in red.

Sex was estimated using standard pelvic and cranial morphological traits (Buikstra & Ubelaker, 1994), while age-at-death was estimated based on auricular surface morphology, dental wear, the degree of fusion of cranial sutures and tooth cementum annulation (Brothwell, 1981; Meindl & Lovejoy, 1985; Lovejoy et al., 1985; Travan et al., 2008). Morphological analysis was carried out to assess occupational markers, including the presence and development of entheses, Schmorl's nodes, and occupationally related osteoarthritis, as well as pathological alterations (Cardoso & Henderson, 2010; Milella et al., 2015). Degenerative joint disease was assessed by recording the severity of marginal lipping (ML), porosity (PO), surface osteophytes (SO), eburnation (EB), and loss of morphology (LM) using a 0–3 scale (0 = absent; 3 = severe), following the criteria outlined by Zampetti and colleagues (2016).

Results

The skeleton of individual T17A is poorly preserved and the lower half of the body is almost entirely absent, except for the right ilium; both hands are also absent. biological sex was found to be consistent with male variation, while the age at death has been estimated at 45–55 years based on the morphology of the auricular surface of the right ilium (Lovejoy et al., 1985), the extent of the dental wear (Brothwell, 1981), the degree

of fusion of cranial sutures of the calvaria (Meindl & Lovejoy, 1985), the presence of degenerative lesions and the counting of cemental annular rings (Travan et al., 2008).

Despite preservation limitations, entheses are notably developed at the deltoid insertion sites on both clavicles and humeri, and at the biceps insertion on the right radius. Schmorl's nodes were not observed, although only a limited number of vertebral bodies could be evaluated. The right sternoclavicular joint exhibits moderate to severe osteoarthritis (ML=2, PO=2, SO=3, EB=0), while the left shows only mild degenerative changes (ML=1, PO=1, SO=1, EB=0). The right hip exhibits moderate to severe coxarthrosis (ML=3, PO=2, SO=2, EB=0). Degenerative changes in the cervical spine are mild to moderate (bodies: ML=0/1, PO=0/1 in the upper vertebrae and 3 in the lower ones, SO=0, EB=0; zygapophyseal facets: ML=1, PO=0, SO=0, EB=0), while more advanced degeneration is observed in the lower thoracic and lumbar regions (thoracic bodies: ML=1/2, PO=1, SO=1, EB=0; thoracic zygapophyseal facets: ML=1, PO=0, SO=0, EB=0; lumbar bodies: ML=2/3, PO=1/2, SO=1/2, EB=0; lumbar zygapophyseal facets: ML=1, PO=0, SO=0, EB=0). These patterns primarily affect the vertebral bodies, indicating intervertebral disc degeneration, while the neural arches appear comparatively less affected.

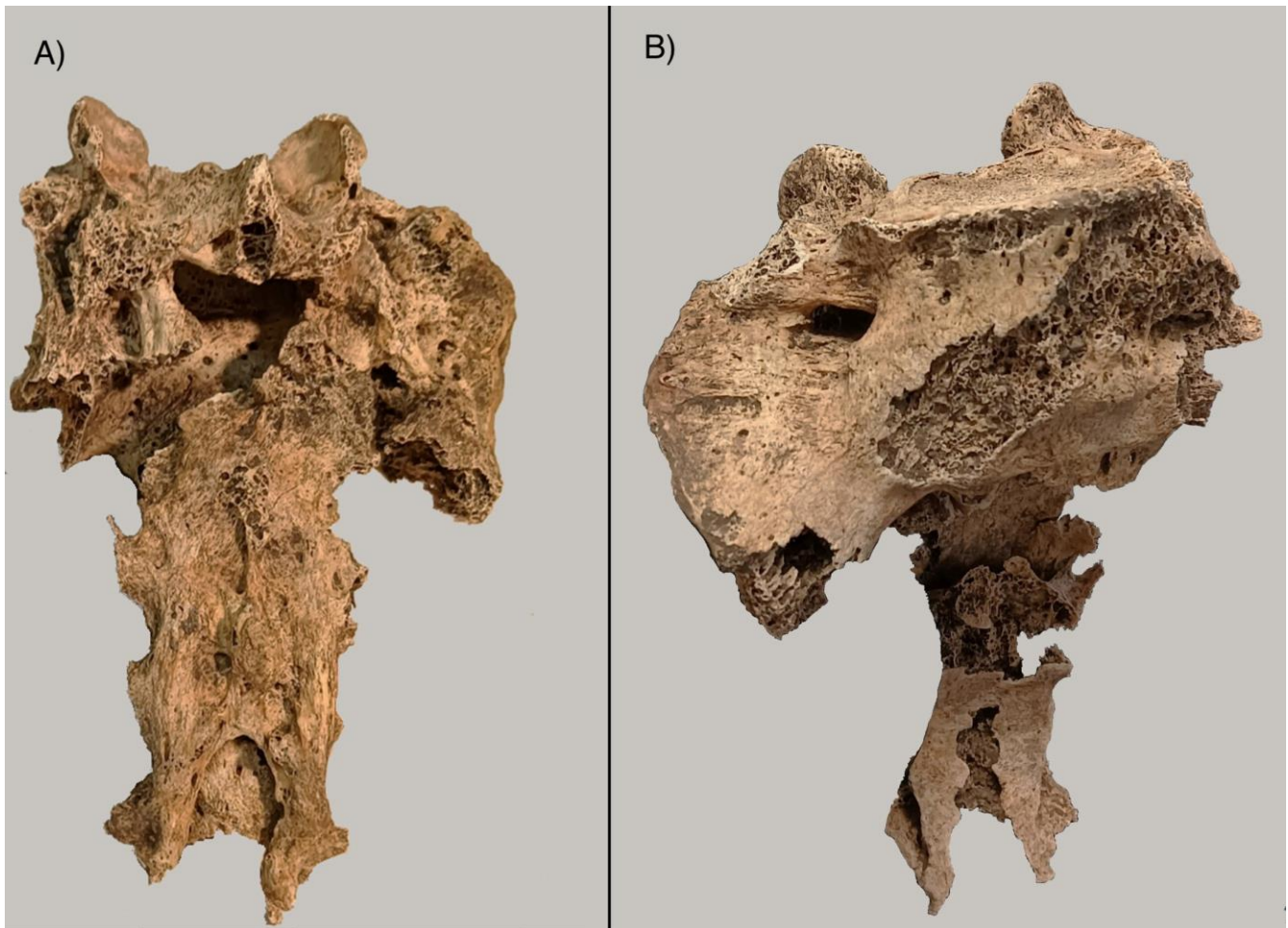


Figure 3: Individual T17A. Lumbosacral region showing complete bilateral fusion of the transverse processes of L5 with the sacrum

At the lumbosacral level, several pathological alterations are present. The sacrum is composed of six vertebrae, with the transverse processes of L5 completely fused with sacrum (Fig. 3). The superior endplate of L5 shows horizontal spinal osteophytes along the anterior margin, marginal lipping, fine porosity on the articular surface, and a deep erosion in the anterior portion of the annular epiphysis (Fig. 4). A prominent neo-articulation is also present between the spinous processes of L3 and L4 (Fig. 5A); both surfaces are flat and enlarged, showing erosive changes and the formation of small osteophytes. Marginal lipping and osteosclerosis are also evident on the endplates of L4 and L3. Additionally, a pathological area of contact is visible between the lower articular processes of L3 and the superior margin of the laminae of L4 (Fig. 5B). Taken together, the alterations observed in the sacrum, L3, and L4 are consistent with a diagnosis of complete sacralization of L5 (Castellvi type IIIb), Bastrup's



Figure 4: Individual T17A. Superior endplate of L5

disease (Supplementary Table 1), and swayback syndrome between L3 and L4.

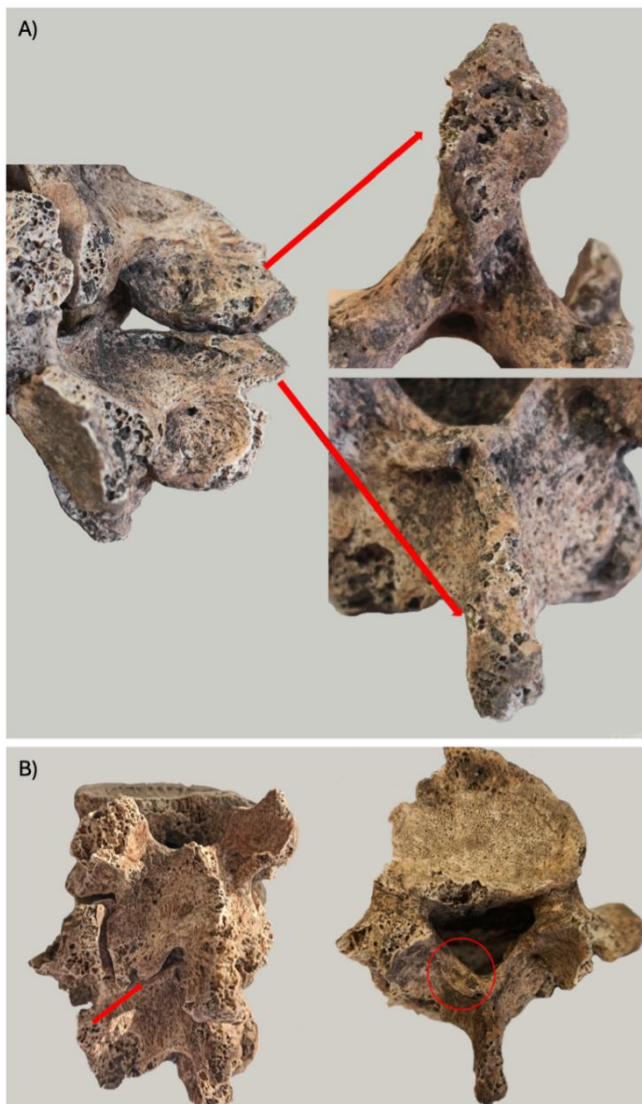


Figure 5: Individual T17A. A) Baastrup's disease involving the spinous processes of L3 and L4; B) Contact between the lower articular processes of L3 and the superior laminae of L4 (swayback syndrome).

Due to the poor preservation of the remaining vertebrae, it was not possible to assess the condition of other spinous processes.

Discussion

Complete sacralization of the L5 is often considered a normal anatomical variant, though it may be associated with lower back pain in clinical contexts. Its reported prevalence varies widely (from 1.5% to 14%) in both archaeological and modern populations, with a possible genetic component influencing its occurrence (Drew & Kjellström, 2021; Mahato, 2010; Matson et al., 2020).

Maintaining vertebral alignment and limiting displacement under normal loading conditions are essential for spinal stability and the prevention of early degenerative changes (Neumann, 2010). A recent radiographic study (Becker et al., 2022) has shown that L5 sacralization alters the distribution of mechanical loads within the lumbar spine, often resulting in compensatory hypermobility at the cranially adjacent segment during flexion and extension, increasing the risk of degenerative changes in the intervertebral discs and facet joints above the transitional vertebra (Becker et al., 2022; Elster, 1989). L5 sacralization is also considered to be a predisposing factor for degenerative spondylolisthesis at L4-L5 and the prevalence of sacralization of L5 is higher in patients with L4 anterolisthesis compared with the frequency in subjects without sacralization (Coskun Benlidayi & Tirasci, 2024; Kong et al., 2008; Mahmoodkhani et al., 2024). This is particularly evident in lumbosacral transitional vertebra type III and type IV (Farshad-Amacker et al., 2015).

The individual T17A does not show osteological signs of anterior of L4 slippage. Although damaged, the anterior margin of L5 appears to have a normal morphology and lacks the antero-posterior convexity appearance, characteristic in anterolisthesis, when viewed from the front (Mays, 2006). Therefore, in the case of individual T17A, the combination of advanced age and altered spinal mobility due to L5 sacralization likely contributed to intervertebral disc degeneration. This, in turn, may have led to a reduction in the interspinous space, resulting in abnormal contact between the spinous processes of L3 and L4 (Baastrup's disease) and the formation of a secondary articulation between the lower articular processes of L3 and the superior laminae of L4, consistent with swayback syndrome.

Baastrup's disease is typically an age-related condition associated with other degenerative changes such as height reduction of the intervertebral discs in the context of arthritis changes, lumbar hyperlordosis, and anterior slipping of the vertebral body relative to the underlying vertebra (anterolisthesis) (Baastrup, 1933; Farshad-Amacker et al., 2015; Hu et al., 2024; Kwong et al., 2011; Maes et al., 2008; Philipp et al., 2016).

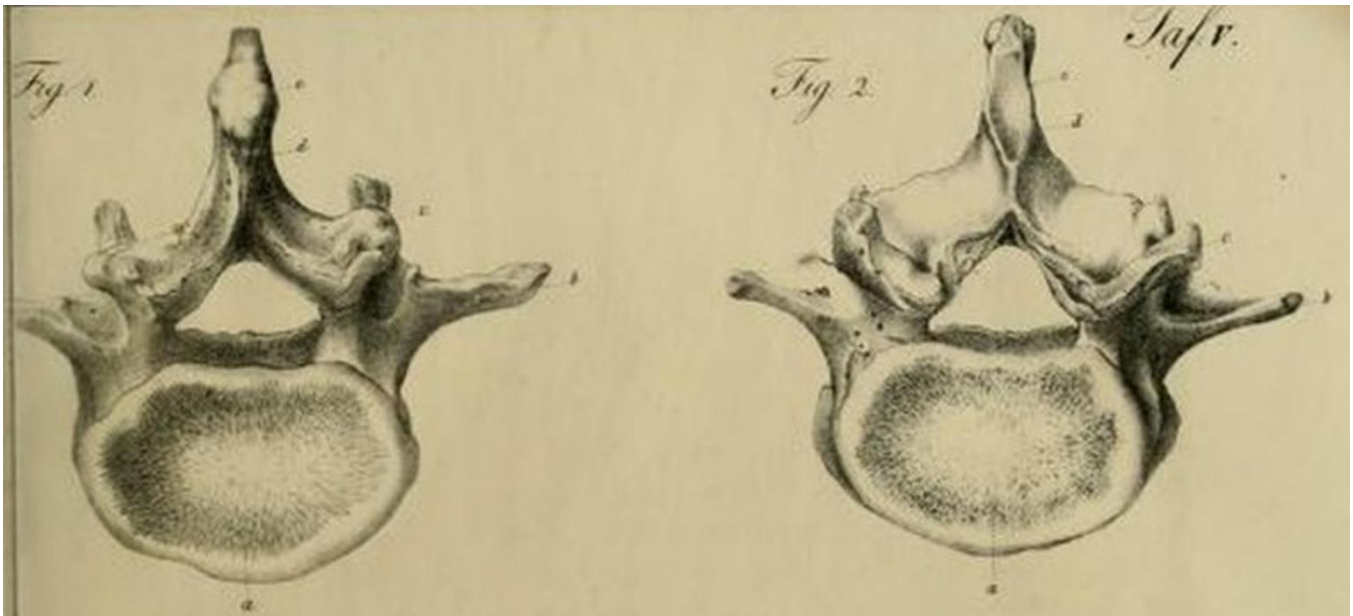


Figure 6: Early depiction of Baastrup's disease by von Sömmering (1839), illustrating contact between lumbar spinous processes

Other potential causes of Baastrup's disease include compression fractures of the vertebral bodies, spinous process fractures, spinal tuberculosis, kyphoscoliosis, poor posture and, in gymnasts, repetitive flexion and extension movements of the spine (Ali et al., 2022; Baastrup, 1933; Hu et al., 2024).

Although first systematically described by Baastrup in 1933, the condition had already been reported under various names: Mayer (1825) referred to it as "diarthrosis interspinosa vertebrarum lumborum" in soldiers with low back pain; Brailsford (1929) coined the still-used term "kissing spine"; and further contributions came from von Sömmering (1839) (Fig. 6), Poirier and Charpy (1899), and Le Double (1912).

Baastrup's disease is a very ancient condition, already observed in the lumbar spine of an adult male (*Homo heidelbergensis*) from the Middle Pleistocene site of Sima de los Huesos (Bonmatí et al., 2010), in a Neanderthal adult male from Shanidar Cave (Ogilvie et al., 1998), and in the cervical and lumbar spine of a Neanderthal adult male (Haeusler et al., 2019). An important contribution to the palaeopathological literature was made by Kacki and colleagues (2011), who published a review and three new cases of Baastrup's disease from a French post-medieval cemetery. In all three cases, additional neo-

articulations between the superior edges of the transverse processes of L4 (in two cases) and L5 (in one case) with the base of the transverse processes (in two cases) or with the inferior part of the pedicle (in one case), near the apophyseal joint, were present (Kacki et al., 2011). Notably, one of the individuals presented sacralization of L5, confirming that LSTVs are associated with altered spinal biomechanics and may contribute to the development of Baastrup's disease (Becker et al., 2022; Kacki et al., 2011).

In ancient skeletons, Waldron (2020) reports a prevalence of Baastrup's disease of up to 10%, depending on age-at-death. However, in the palaeopathological setting, this condition is often overlooked, with few published cases. It may go unnoticed when the posterior vertebral elements are damaged or missing, or when more apparent and commonly diagnosed pathologies (e.g., osteoarthritis or transitional anomalies) are present. As Waldron suggests, another contributing factor may be the fact that "few people take the trouble to articulate the spine." (Waldron, 2020: 143).

The true prevalence of Baastrup's disease in the general population remains uncertain, largely due to underdiagnosis and its frequent omission from clinical assessments. According to Sağtaş and colleagues

(2024), the overall prevalence in a symptomatic population was 37.8% (141 out of 375 individuals), with frequency increasing with age and reaching 87.5% in individuals aged 80 and above. In all cases, Baastrup's disease was associated with degenerative changes such as disc bulging, herniation, disc degeneration, facet osteoarthritis, spinal stenosis, and spondylolisthesis. Similarly, Kwong and colleagues (2011) reported a prevalence of up to 81.3% in symptomatic patients over 80 years old. In younger individuals, only a few cases have been described, particularly among gymnasts (Ali et al., 2022). In children, Baastrup's disease is exceedingly rare, with only isolated case reports available (Singh, 2016).

Although typically associated with degenerative spinal disorders, Baastrup's disease can itself be symptomatic, causing back pain and, in rare cases, leading to stress fractures of the spinous processes, neurological complications, spinal stenosis, or cauda equina syndrome (Farinha et al., 2015; Pinto, 2016; Shukla et al., 2019; Vaidya et al., 2025). In oncological settings, it may even mimic metastatic lesions, complicating diagnosis (Piracha et al., 2024). Therefore, accurate identification is essential for guiding appropriate treatment.

Pathological contact between the articular processes of adjacent vertebrae, such as in swayback syndrome, is even more rarely documented, and its true prevalence remains unknown (Freyschmidt et al., 2003; Jacobson et al., 1958). According to clinical evidence (Sağtaş et al., 2024), in adults, Baastrup's disease and associated neo-articulations between posterior spinal elements do not appear to correlate with specific occupational activities and thus have limited value as activity markers. However, in younger individuals, especially in the absence of other spinal pathologies, it may be linked to repetitive flexion-extension movements.

The case of individual T17A described in this paper presents the co-occurrence of Baastrup's disease, swayback syndrome, and L5 sacralization in an early medieval skeleton. While each condition has been documented separately, their combination here underscores how congenital anomalies like LSTV, often considered simple anatomical variants, can contribute

to altered spinal mechanics and to lead to degenerative changes (Becker et al., 2022; Kacki et al., 2011). Despite the fragmentary preservation of the skeletal remains, the pathological features of individual T17A suggest a complex interplay between age-related degeneration and biomechanical stress, supporting clinical evidence (Hu et al., 2024; Sağtaş et al., 2024) that Baastrup's disease often occurs alongside other spinal pathologies.

Conclusions

Although Baastrup's disease is relatively common in the living population, particularly among older individuals, it remains a rare finding in palaeopathological contexts. The case presented in this study adds valuable data to this limited body of evidence, documenting the co-occurrence of Baastrup's disease, swayback syndrome, and L5 sacralization. It highlights the importance of systematically examining the posterior spine in palaeopathological investigations, especially to identify modifications such as Baastrup's disease or neo-articulations between elements of the posterior arches. The striking discrepancy between the high frequency of Baastrup's disease in focused clinical studies and the scarcity of palaeopathological reports suggests that many cases likely go undetected.

Diagnosing spinal pathologies in archaeological remains is inherently challenging, often due to the absence of soft tissues and the poor preservation of skeletal material. For this reason, it is essential to document all observable alterations, even when preservation is limited. Vertebrae are frequently fragmented or incomplete in archaeological contexts, yet they may still offer important insights into spinal conditions such as osteoarthritis, spondylolysis, or scoliosis, which in turn can inform assessments of age and activity. Given the spine's segmental structure and the complexity of its articulations, multiple pathologies often coexist. Any anomaly identified should prompt a more thorough examination for additional, potentially overlooked conditions.

Furthermore, as Baastrup's disease can be asymptomatic (Kwong et al., 2011), its presence should not be assumed to reflect functional impairment or disability.



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Table 1: Differential diagnosis

Pathology	Epidemiology	Common pattern	Contact between spinous processes	Interposed fibrous or cartilaginous tissue between the spinous processes	Formation of a neo-articulation with adjacent processes	Association with generalized spinal degeneration	Association with Disc disease	Association with Bilateral congenital hip dislocation	Association with Obesity	Association with Swayback syndrome	Association with Altered spinal mobility	Correlation with Mature age
Baastrup disease	Probably common	Usually in the lumbar spine	Possible and diagnostic	Possible and diagnostic	Possible and diagnostic	Possible and diagnostic	Possible and diagnostic	Possible and diagnostic	Possible and diagnostic	Possible and diagnostic	Possible and diagnostic	Yes
Isolated fracture of the spinous process	Extremely rare (usually reported at cervical and thoracic level)	Fracture line at the base of the spinous process	No	No	No	No	No	No	No	No	No	No
Apophyseal injury/non-union	Rare	Smooth-appearing non-united ossicle at the tip of the spinous process	No	No	No	No	No	No	No	No	No	No
Neoplasms (osteoid osteoma)	10–14% of primary vertebral tumours	More frequent in the lumbar spine, Involvement of the spinous process not uncommon	No	No	No	No	No	No	No	No	No	No
Neoplasms (osteochondroma)	20-50% of all the benign bone tumors	More frequent in the cervical spine	No	Yes	No	No	No	No	No	No	No	No
Neoplasms (aneurysmal bone cyst)	Approximately 1% of all bone tumors	Predilection for the posterior spinal elements,	No	No	No	No	No	No	No	No	No	No

		The lesions tend to be lytic and expansile										
Neoplasms (multiple myeloma)	Spinal involvement in over 80% of patients	Multiple lesions, usually lytic	No	No	No	No	No	No	No	No	No	Yes
Neoplasms (metastasis)	The commonest malignant tumours of the spine	Lesions can be osteolytic or osteoblastic or mixed	No	No	No	No	No	No	No	No	No	Yes
Congenital lesions (hyperplasia)	Rare (usually reported at cervical level)	Abnormally enlarged spinous process	No	No	No	No	No	No	No	No	No	No
Infective lesions (aspecific)	Common	Endplate involvement is Most Common, Osseous irregularity and erosion	No	No	No	No	No	No	No	No	No	No
Infective lesions (tuberculosis)	Common	Body involvement is Most Common, lytic lesions	No	No	No	No	No	No	No	No	No	No
Degenerative diseases (osteoarthritis)	Very common	Marginal lipping, porosity, osteophytes	No	No	No	Yes	Yes	Yes	Yes	No	Yes	No

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