

Minimally Invasive Methods for the Diagnosis of Destructive Lesions of the Spine

Zulfiya Makhmudova

Republican Specialized Scientific and Practical Medical Center of Tuberculosis and Pulmonology, Tashkent, Uzbekistan

Abstract *Objectives:* To evaluate the usefulness of diagnostic trepan-biopsy in the differential diagnosis of spine patients with confined destructive lesions of various ages. *Material and Methods:* 55 patients were treated for destructive lesions restricted to a single spinal motion segment with percutaneous vertebral body trepan biopsy, followed by cytological and histological examinations of biopates. These patients were brought with a suspicion of tuberculous spondylitis. The pathology's structure and potential complications were established. *Results:* In 75% of patients, the results of cytological and histological examination of biopates supported the diagnosis. *Conclusions:* If manipulation is carried out earlier, before indication of antibacterial or tuberculostatic therapy, the informative value of cytological and histological study of trepan biopsy sample may be higher. If there is a paravertebral soft-tissue component, an aspiration biopsy should be added to the trepan biopsy along with extra bacteriologic and cytological examination.

Keywords Extrapulmonary tuberculosis, Spondylitis, Spinal tumor, Biopsy

1. Introduction

Identification of a destructive process in the spine and its nosological verification in case of limited vertebral fractures present specific difficulties due to polymorphism and non-specificity of radiation manifestations of destruction with the low information content of unique methods used in the diagnosis of specific inflammatory processes, such as chest radiography and skin tuberculin tests [1]. Such signs as a pathological fracture and destruction of the vertebral body, as well as paravertebral formations, are found in spondylitis (tuberculous and nonspecific) and tumors of the vertebrae. In this case, accurate disease diagnosis is critical for timely appointment of appropriate treatment. Refusing morphological verification of the diagnosis with a seemingly typical radiation picture in oncological diseases and compression fractures in osteoporosis results in a high (up to 84%) detection of diagnostic and therapeutic errors, which in some cases are critical to the patient's life [2,3]. Dissatisfaction with the results of non-invasive diagnostics of inflammatory diseases of the spine requires a wider introduction of interventional methods with further analysis of their results. The positive data obtained by the authors of this article during a blinded prospective study of a limited group of children have already been published previously [4]. Despite the minimal number of complications of vertebral trepanobiopsy

[5,6], the number of publications on its use in the differential diagnosis of spondylitis is extremely small [7-10].

Surgical excision and anterior column reconstruction have traditionally been the recommended treatments, but they are occasionally not advised for patients who have serious medical issues. For pyogenic spondylodiscitis, recent papers have detailed posterior fixation methods using an open approach [11,12]. Additionally, for patients with many comorbidities, minimally invasive spine stabilization (MIS) with a percutaneous pedicle screw (PPS) may be a less invasive option.

With the description of tubular retractors for access to the lumbar spine and the report of the first lumbar microendoscopic discectomy, modern minimally invasive spine surgery (MIS) was first performed in the 1990s. Since then, improvements in medical technology and surgical instruments have caused MIS to become a significant and quickly expanding area of spine surgery. Today, a range of spinal pathologies, including degenerative disc disease, disc herniation, instability, deformity, fracture, infection, and malignancies, are treated using MIS techniques and methods [13,14]. MIS was pursued as a way to lessen iatrogenic tissue injuries during surgery as opposed to the standard open spine surgery [15,16]. Smaller incisions, less soft tissue damage, decreased estimated blood loss (EBL), decreased postoperative pain and narcotic use, shorter hospital length of stay (LOS), quicker recovery, and quicker return to work and normal activity are some of the theoretical advantages of MIS over traditional open surgery [17]. Traditional open

* Corresponding author:

nazirova.zulfiya@mail.ru (Zulfiya Makhmudova)

Received: Jan. 2, 2024; Accepted: Jan. 29, 2024; Published: Feb. 4, 2024

Published online at <http://journal.sapub.org/ajmms>

spine surgery techniques frequently necessitate significant muscle and ligamentous disturbance during the surgical approach to the spine, decreasing spinal stability and causing eventual morbidities [18]. By using self-retaining retractor devices to prevent muscle crush injury, known anatomic neurovascular and muscle planes, avoiding disruption of the tendon attachment sites of critical muscles at the spinous processes, and limiting the surgical corridor's width, MIS reduces approach-related morbidity. Important benefits of MIS over open spine surgery include the reduction in approach-related morbidity and indirect iatrogenic instability of the spine [19-21].

This study aims to evaluate the accuracy of diagnostic puncture-trepanation biopsies for the differential diagnosis of limited destructive lesions of the spine in patients of different age groups.

2. Materials and Methods

In 2018–2021 55 patients aged 20 to 77 years old, hospitalized in the osteoarticular department of the RSSPMC F and P with suspected tuberculous spondylitis, underwent closed percutaneous trepanobiopsies of the vertebral bodies at the stage of preoperative examination using a unified technique. Inclusion in the study was determined by the presence of the destruction of the vertebral bodies, detected by radiation methods, limited to one spinal motion segment. The leading complaint in all patients was pain at the level of the affected vertebrae and also the majority of them suffered from neurological disorders of varying severity. In most patients, the duration of the disease by the time of admission to the clinics exceeded from 3 months to 5 years. At the stages of examination in the general medical network, patients underwent a complex of radiological studies: X-ray spondylography, MRI, CT of the spine, and 15 patients underwent PET diagnostics. In addition to the general clinical examination, all of them underwent chest radiography in order to possibly identify a pulmonary process;

Additionally, skin tuberculin and Diaskin tests were performed. The pathological process was localized in the cervical region in 5 patients, in the thoracic region in 17 cases, in the thoracolumbar region in 11 patients, in the lumbar region in 13 patients, and in the lumbosacral spine in 9 patients.

Patients were administered sedative and analgesic drugs 30 minutes before the study, and infiltration anesthesia was used directly during the manipulation while maintaining consciousness and speech contacts. Biopsies were performed under aseptic operating room conditions, using special bone biopsy needles (so-called Yamshidi needles, 9G and 11G), with radiation control on a C-arm X-ray unit. Manipulations were performed in the patient's prone position, with the

exception of cervical localization (done in the supine position with finger control of the median structures of the neck and blood vessels). The position of the needle was controlled by fluoroscopy. In 3 adults in the thoracic region, a biopsy was performed from a transpedicular approach by marking the projection of the root of the arch and inserting a needle closer to the lateral bone wall; in other cases, a posterolateral extrapedicular approach was used (the disadvantage of the transpedicular approach is the difficulty of changing if it is necessary to angulate the needle for targeted sampling in the area of interest, which is possible with a more mobile extrapedicular approach. The obtained column of bone tissue was sent for histological examination, additionally, a cytological examination of smears was analyzed (a cytological examination was examined in the case of obtaining a soft tissue substrate); the liquid contents were sent for bacteriological examination.

3. Results

Biopsy data made it possible to determine the diagnosis in 47 of 55 cases in adults (Table 1). Biopsy data made it possible to determine the diagnosis in 47 of 55 cases in adults. Only eight materials of biopsies gave non-informative data. Out of 55 patients with suspected tuberculous spondylitis, only 21 had the disease confirmed (in these acid-resistant bacteria were present in analysis during bacterioscopy of the punctate), and non-specific inflammation was found in 10. The tumor process was histological and immunohistochemical verified in the remaining 16 cases.

Table 1. Biopsy data of 47 patients

Number of patients	Referral misdiagnosis	Diagnosis identified by biopsy examination
21	Tuberculous spondylitis	Tuberculosis
10	Tuberculous spondylitis	Non-specific spondylitis
5	Tuberculous spondylitis	Metastatic Adenocarcinoma
2	Tuberculous spondylitis	Primitive neuroectodermal tumor (PNET)
1	Tuberculous spondylitis	osteosarcoma
2	Tuberculous spondylitis	Non-Hodgkin's lymphoma
1	Tuberculous spondylitis	A space-occupying lesion with the unknown primary site, metastasized the brain, VC 4
2	Tuberculous spondylitis	Cancer of the upper lobe of the right lung with metastasis to the lumbar VL4 vertebra. Prostate cancer;
1	Tuberculous spondylitis	plasmacytoma
1	Tuberculous spondylitis	MTS Undifferentiated cancer
1	Tuberculous spondylitis	Chondrosarcoma G -3

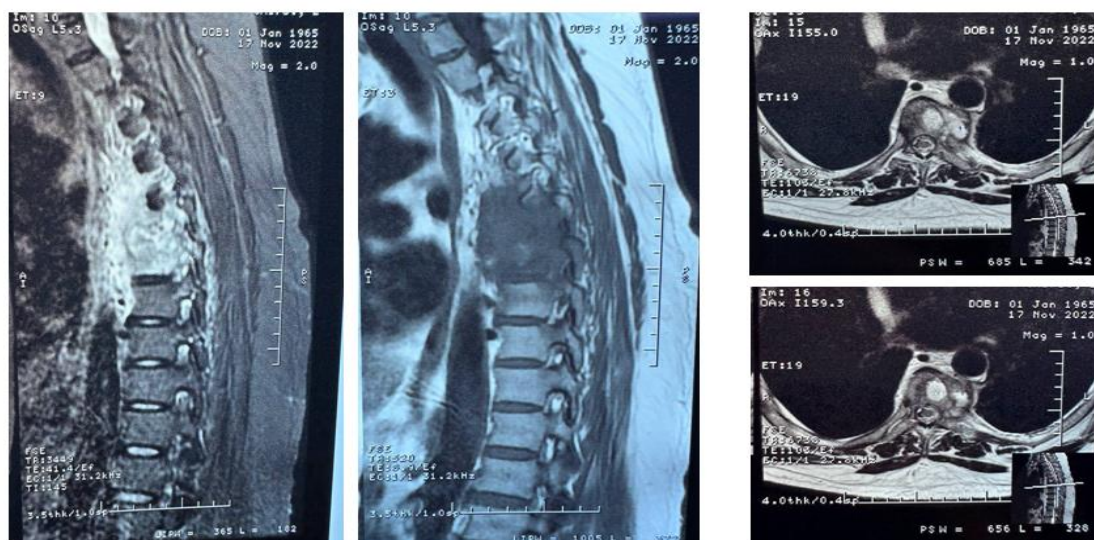


Figure 1. MRI images of the thoracic vertebrae

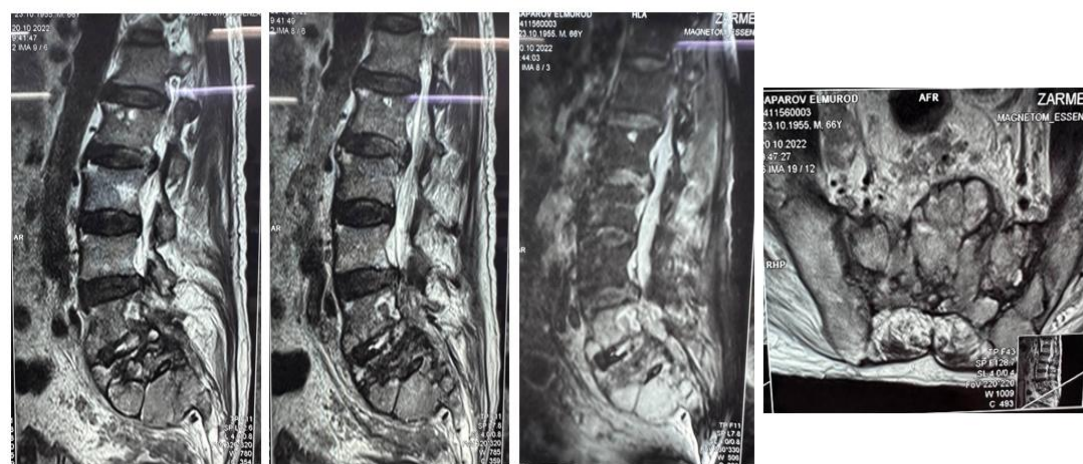


Figure 2. MRI images of the lumbosacral vertebrae

The discrepancy between the cytological and histological conclusions concerned 1 case of a tumor lesion (according to the cytological data, it was regarded as benign, histological, it was malignant). Complications of manipulation were noted in 3 cases: in 2 cases, transient radiculopathy occurred after extrapedicular biopsy, which was stopped conservatively within two weeks; in 1 - technical pneumothorax due to early removal of the mandrel (the complication was diagnosed and stopped immediately during manipulations without any consequences).

In 2 patients, within a few days after the biopsy, there was a worsening of the initially existing pathological neurological symptoms; during the subsequent operation, no signs of compression or traumatic injury of the spinal cord were not detected, and movement disorders were caused by current epiduritis against the background of vertebral osteomyelitis. Following the results of the biopsy performed in adult patients, conservative treatment was corrected; in all cases, the inflammatory process in the vertebrae subsided. Patients with a verified tumor lesion are referred to cancer centers for chemotherapy. All patients with specific inflammatory,

non-specific inflammatory, and tumor processes of the vertebral bodies underwent reconstructive and stabilizing operations, which allowed them to be rehabilitated as soon as possible. When a malignant tumor process is detected, patients are referred to an oncological hospital. As an illustration, we present three clinical observations, two of which confirm the information content of biopsies, and one of which confirms the situation when a seemingly typical radiation pattern becomes the cause of a tactical and therapeutic error.

The 57-year-old patient. Back pain for several months. According to MRI and CT (Figure 1), the destruction of the anterior and lateral parts of the Th5-6-7 vertebral body, with epidural and paraspinal formation, which could be either a fragment of the extruded body or an abscess. The patient was admitted to the hospital with constant back pain for several months with a typical X-ray picture of Calve's disease (not shown due to the typical image). According to MRI and CT, the destruction of the anterior and lateral parts of the Th10 vertebral body with a paravertebral formation could be either a fragment of an extruded body or an abscess. Admitted with competitive diagnoses: MTC Th10, pathological fracture,

tuberculous spondylitis. Consulted by oncologists. Histological verification of the diagnosis is recommended. Puncture trepanobiopsy was performed, and acid-resistant bacteria were found in the material, histologically - tuberculosis. The diagnosis was confirmed during surgery bacteriologically and histologically.

The patient is 67 years old. MRI picture of spondylitis of the lumbar VL4-5 and sacral VS1-2 vertebrae with transition to the sacroiliac joints (the process progresses in dynamics), complications: paravertebral abscesses (Figure 2). Operated without previous biopsy, granulation tissue was found in the abscess, however, adenocarcinoma metastasis was histologically verified, which was confirmed immunohistochemically. Radioisotope scanning revealed a second bone lesion (destruction of the thoracic VTH 3), after which the patient was referred for treatment to an oncological hospital.

4. Conclusions

Percutaneous Trepan Biops of the vertebrae is one of the informative and relatively safe methods of interventional diagnosis of spinal lesions. This method should be applying for preoperative differentiation of inflammatory (tuberculous and nonspecific spondylitis), traumatic and neoplastic diseases accompanied by the destruction of one spinal motion segment. The method's diagnostic accuracy in the case of limited destructive processes is quite high, and according to our data, it is 75.0 percent in adults. In the structure of mono-segmental degradation of the spine with suspected tuberculous spondylitis, nonspecific spondylitis in adults and tumor lesions, including malignant ones, predominate. The severest complications of percutaneous trepanobiopsy of the vertebrae that we observed were due not to technical reasons, but the progression of a nonspecific inflammatory process (epiduritis) against the background of osteomyelitis of the spine. Transient complications in the form of radiculopathy and pneumothorax, with their timely recognition and adequate treatment, were not accompanied by clinical consequences. Perhaps, the information content of cytological and histological studies of punctate obtained during trephine biopsy may be higher if this manipulation is performed as early as possible, before the appointment of antibacterial or tuberculostatic therapy to the patient, combined with aspiration biopsy of the material with additional bacteriological and cytological studies in the presence of soft tissue paravertebral component.

REFERENCES

- [1] Malamashin DB. Possibilities of minimally invasive methods in the differential diagnosis of limited destructive lesions of the spine in children, International Conference on New Technologies in Epidemiology, Diagnosis and Treatment of Tuberculosis in Adults and Children, Moscow, 2011.
- [2] Rimondi E, Staals EL, Errani C, et al. Percutaneous CT-guided biopsy of the spine: results of 430 biopsies. *Eur Spine J* 2008; 17: 975–981.
- [3] Yang YJ, Damron TA. Comparison of needle core biopsy and fine needle aspiration for diagnostic accuracy in musculoskeletal lesions. *Arch Pathol Lab Med*. 2004; 128: 759–764.
- [4] Mushkin AYU, Malamashin DB, Krasilnikova LA. Percutaneous puncture trepanobiopsy for limited destructive lesions of the spine in children. *Spinal Surgery* 2009; 2: 62–67.
- [5] Stevens KJ, Gregson RH, Kerslake RW. False aneurysm of a lumbar artery following vertebral biopsy. *Euro Spine J* 1997; 6: 205–207.
- [6] Welker JA, Henshaw RM, Jelinek J, et al. The percutaneous needle biopsy is safe and recommended in the diagnosis of musculoskeletal masses. Outcomes analysis of 155 patients at a sarcoma referral center. *Cancer* 2000; 89: 2677–2686.
- [7] Colmenero JD, Jimenez-Mejias ME, Reguera JM, et al. Tuberculous vertebral osteomyelitis in the new millennium: still a diagnostic and therapeutic challenge. *Eur J Clin Microbiol Infect Dis*. 2004; 23: 477–483.
- [8] De Lucas EM, Gonzalez Mandly A, Gutierrez A, et al. CT-guided fine-needle aspiration in vertebral osteomyelitis: true usefulness of a common practice. *Clin Rheumatol*. 2009; 28: 315–320.
- [9] Michel SC, Pfirrmann CW, Boos N, et al. CT-guided core biopsy of subchondral bone and intervertebral space in suspected spondylodiskitis. *AJR Am J Roentgenol*. 2006; 186: 977–980.
- [10] Ousehal A, Gharbi A, Zamiaty W, et al. Imaging findings in 122 cases of Pott's disease. *Neurochirurgie*. 2002; 48: 409–418.
- [11] Pee YH, Park JD, Choi YG, Lee SH. Anterior debridement and fusion followed by posterior pedicle screw fixation in pyogenic spondylodiscitis: Autologous iliac bone strut versus cage. *J Neurosurg*. 2008; 8: 405–412.
- [12] Gonzalvo A, Abdulla I, Riaz A, De La Harpe D. Single-level/single-stage debridement and posterior instrumented fusion in the treatment of spontaneous pyogenic osteomyelitis/discitis: Long-term functional outcome and health-related quality of life. *J Spinal Disord Tech* 2011; 24: 110–115.
- [13] Mobbs RJ, Phan K, Malham G, Seex K, Rao PJ. Lumbar interbody fusion: techniques, indications and comparison of interbody fusion options including PLIF, TLIF, MI-TLIF, OLIF/ATP, LLIF and ALIF. *Journal of Spine Surgery* 2015; 1(1): 2–18.
- [14] Wu PH, Kim HS, Jang I-T. Intervertebral Disc Diseases PART 2: A Review of the Current Diagnostic and Treatment Strategies for Intervertebral Disc Disease. *International Journal of Molecular Sciences* 2020; 21(6): 2135.
- [15] Hong SH, Suh SP, Yeom J, Kim JY, Lee SG, Han JW. Minimally Invasive Spine Surgery versus Open Posterior Instrumentation Surgery for Unstable Thoracolumbar Burst Fracture. *Asian Spine Journal* 2021; 15(6): 761–768.
- [16] Snyder LA, O'Toole J, Eichholz KM, Perez-Cruet MJ, Fessler R. The Technological Development of Minimally Invasive Spine Surgery. *BioMed Research International* 2014; 293582.

- [17] Adogwa Owoicho, Parker Scott L, Bydon Ali, Cheng Joseph, McGirt Matthew J. Comparative Effectiveness of Minimally Invasive Versus Open Transforaminal Lumbar Interbody Fusion: 2-year Assessment of Narcotic Use, Return to Work, Disability, and Quality of Life. *Journal of Spinal Disorders & Techniques* 2011; 24(8): 479-484.
- [18] Camacho JE, Usmani MF, Strickland AR, Banagan KE, Ludwig SC. The use of minimally invasive surgery in spine trauma: a review of concepts. *Journal of Spine Surgery* 2019; 5: S91-S100.
- [19] Carazzo CA, Yurac R, Guiroy A, Zamorano JJ, Cabrera JP, Joaquim AF. Minimally Invasive Versus Open Surgery for the Treatment of Types B and C Thoracolumbar Injuries: A PRISMA Systematic Review. *International Journal of Spine Surgery* 2021; 15(4): 803-810.
- [20] Kohler FC, Schenk P, Bechstedt-Schimske M. et al. Open versus minimally invasive fixation of thoracic and lumbar spine fractures in patients with ankylosing spinal diseases. *Eur J Trauma Emerg Surg* 2022; 48: 2297-2307.
- [21] Castillo-Calcáneo JD, Navarro-Ramirez R, Gimenez-Gigon M, Adjei J, Damolla A, Nakhla J, Hernandez RN, Hartl R. Principles and Fundamentals of Minimally Invasive Spine Surgery. *World Neurosurgery* 2018; 119: 465-471.