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Classifications of Non-Specific Hematogenous Vertebral Osteomyelitis. Critical Review and Suggestions for Clinical Use

A.Yu. Bazarov

Regional Clinical Hospital No. 2, Tyumen, Russian Federation
Tyumen State Medical University, Tyumen, Russian Federation

Abstract

For a long time classification of V.Y.Fischenko published in 1983 and being solely descriptive was the main classification of vertebral osteomyelitis in the former USSR. In recent years some versions of tactical classifications appeared in the literature which were dedicated to standardization of tactics and methods of treatment. However, those classifications did not reflect distribution according to injury type, destruction degree, biomechanical instability and presence of neurological deficit and did not embrace all scenarios of disease progress. ***Purpose of the study*** — to compare existing classifications and to offer an adapted Russian language version of tactical classification for hematogenous vertebral osteomyelitis. ***Material and Methods.*** The study included 209 patients with non-specific vertebral osteomyelitis treated in the period from 2006 till 2017. All cases of vertebral osteomyelitis were distributed in accordance with known classifications. The authors conducted the analysis of treatment tactics used in the clinic and by the authors of given classifications. The authors revealed a group of patients which is not classified in known literature. ***Results.*** 209 patients with hematogenous vertebral osteomyelitis were treated in the period from 2000 till 2017. Patients were distributed according to known classification. Full match of treatment tactics with standardized approaches suggested by authors of new classifications was 61.5% (n = 126), partial match (applied treatment tactics does not contradict to suggested) — 20.0% (n = 41), which overall was 81.5% (n = 167). The authors refer to patients who underwent ventral sanation or reconstructive procedures. The majority of patients had the septic form of disease. Four out of 209 patients were not classified while three patients features isolated injury of vertebral processes and one patient — injury of C_I–C_{II}. ***Conclusion.*** Modern suggested classifications of hematogenous vertebral osteomyelitis are applicable in clinical practice and allow to standardize treatment algorithms. Tactics is determined not only by degree of destruction, involvement of paravertebral tissues, biomechanical instability of affected spine segment and neurological deficit, but by a presence of systemic inflammation response syndrome (SIRS). Considering the above it would be useful to introduce some additional subtypes which would characterize septic process of disease and determine the indications for sanation and reconstructive ventral procedures, which can be supplemented by instrumental fixation after stabilization of the patient.

Keywords: hematogenous vertebral osteomyelitis, classifications.

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Alexsander Yu. Bazarov; e-mail: tyumen_trauma@mail.ru

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For a long time classification of V.Y. Fischenko, published in 1983, was the main classification of vertebral osteomyelitis in the former USSR [1]. However, evolution of diagnostics and treatment methods inevitably leads to evolution of tactics for treatment of various diseases. At time when the main treatment option for this pathology was drainage of vertebral lesions focus the descriptive classification fully met the requirements. The majority of current classifications stipulate not only distribution of pathology per subtypes but also a certain algorithm of manipulations, thus standardizing the treatment process and in some cases allowing to control the outcomes.

Hematogenous vertebral osteomyelitis is among such diseases which absolutely demand multidisciplinary approach for treatment [2]. A close cooperation of spine surgeons, radiologists, contamination surgeons, neurosurgeons, trauma and orthopaedic surgeons and anesthesiologists must be ensured. This pathology features late diagnostics what is reflected in literature of the majority of researchers from various countries irrespectively of the level of medicine development. Diagnosis term varies from three weeks to 2–6 months [3, 4]. Considering late diagnostics and varying pathology severity it's difficult to find a single treatment approach [5, 6]. Due to this a concept was suggested based on pathology status named „severity oriented surgery" [7]. It should be noted that presently there is no universal classification of vertebral osteomyelitis that would be accepted by the majority of spine surgeons. However, we see the increasing number of publications where authors suggest some algorithms for treatment of such patients.

Purpose of the study — to compare existing classifications and to offer adapted Russian language version of tactical classification for hematogenous vertebral osteomyelitis.

Materials and Methods

Comparison of hematogenous spondylodiscitis classifications

V. Fischenko classification (1983):

• Site: cervical, thoracic, lumbar, sacral, coccygeal, multiple lesions;

• Vertebral site: body, pedicle, processes (with or without deformity);

• Morphological manifestation: focal, diffuse-focal, diffuse;

• Clinical manifestation: acute (toxico-adynamic or septico-pyemic), recurrent chronic, primary chronic;

• Stages of pathology: acute, sub-acute, chronic, late effects, secondary compensatory effects;

• Complications: with or without complications;

• Purulent presentations: phlegmones and abscesses of the neck, phlegmones and abscesses of mediastinum, perirenal phlegmones and abscesses, pelvic phlegmones and abscesses, fistulas, indurative mediastinitis, purulent psoitis;

• Neurological manifestation: spinal compression syndrome, secondary radiculitis, indurative periduritis;

• Mixed manifestation: purulent meningitis, purulent meningomyelitis.

The author suggests to identify the site, form and stage of pathological process, to reflect presence of complications and doesn't offer any tactical solutions or algorithms, noting that in some cases conservative treatment allows to gain pathology subsiding which though can be not persistent [1].

L. Homagk in this article „Spondylodiscitis severity code: scoring system for the classification and treatment of non-specific spondylodiscitis" [7] presents conventional classification according to etiology to non-specific (bacterial, mycotic, parasitic (which is casuistic)) and specific (tuberculosis, brucellosis, syphilis), according to infection (exogenous or endogenous), according to duration of disease (acute and chronic) with

mandatory identification of location in the spine. Besides L. Homagk suggests to evaluate the severity of the pathology and answer three questions:

- Is there an instability of spine motion segment formed due to the bone destruction?
- Is there any neurological deficit?
- Are the structures adjacent to spine are involved into the pathological process?

Basing on answers L. Homagk et al identified next three severity degrees of spine inflammatory process (Table 1).

I severity grade A/B. All cases of spondylodiscitis without neurological deficit, instability and destruction of vertebral boies. Kyphosis and narrowing of spinal canal can be present. Conservative treatment is the method of choice, however, internal fixation can be attempted. Antibacterial therapy is prescribed for 3 months. X-ray control is made in 2 and 6 weeks postoperatively.

Severity grade II A/B — all cases of spondylodiscitis with destruction of vertebral bodies leading to instability but without neurological deficit. Surgical treatment consists of internal fixation of thoracic and lumbar spine with attempt of kyphosis correction. Antibacterial therapy is prescribed depending on sensitivity for 3 months postoperatively. CT control is made in three months to evaluate formation of bone block in case of lesion focus resection and spine fusion.

Severity grade III A/B — all cases with neurological deficit, degree of bone destruction is secondary. Surgical treatment was made immediately after establishing the diagnosis and includes fixation of thoracic and lumbar spine. Decompression of spinal canal was made by laminotomy or laminectomy. Mandatory harvesting of material for biopsy, inflammatory focus was resected from costotransverse or postero-lateral approach, materials with staged release of antibiotics were implanted. Some patients underwent ventral stabilization. Antibiotics were administered for 3 months, X-ray control in 2 and 6 weeks after the procedure. Apart from presented classification the researchers suggest to develop the evaluation system „SponDT" (Spondylodiscitis Diagnosis and Treatment). Clinical material of authors includes 296 cases. This system is based on evaluation of biochemical inflammation marker CRP mg/dl, pain syndrome severity by VAS, MRI data [8] (Tables 2, 3).

Table 1

SSC classification of vertebral osteomyelitis 2004–2009 [7]

Severity (grade)	Bony destruction and instability	Acute neurological deficit	Involvement of paraverterbral tissues (A = no, B = yes)
I	No	No	A/B
II	Yes	No	A/B
III	Yes/No	Yes	B

Table 2

Severity of inflammation process according to SponDT [8]

Criteria	0	1	2	3
CRP, mg/dl	<10	<50	51–150	>150
Pain by VAS	<3	<5	<8	>8
MRI	No	Spondylodiscitis without destruction	Spondylodiscitis with destruction	Spondylodiscitis with abscess

Table 3

Severity of inflammation process according to SponDT

Criteria	Points
Severe	>6
Moderate	3–5
Mild	<3

By elaborating on the present approach, the authors modified the scale „Clinical and roentgenographic classification of spondylodiscitis severity" („spondylodiscitis severity code") [7] (Table 4). They offered the following recommendations for tactics selection depending on pathology severity [7] (Table 5).

E. Pola et al in their work „New classification for the treatment of pyogenic spondylodiscitis: validation study on a population of 250 patients with follow-up of 2 years" described a new classification based on clinical picture and X-ray data which determines a simple and reproducible algorithm for spine surgeons [9]. Authors distinguish three major lesion types (A, B, C) based on the following primary criteria: bone destruction or segmental instability, epidural abscess and neurological deficit, as well as on secondary criteria: involvement of paravertebral tissues and presence of intramuscular abscesses. Biomechanical instability was identified in 25% of patients with segmental kyphysis formation at the lesion level. Authors also evaluated the data of precise physical examination including assessment of deep tendon reflexes, sensitivity, muscular strength, central pathological signs necessary to exclude neurological deficit. MRI with contrast allowed to clarify involvement of neural structures, presence of abscesses and involvement of paravertebral soft tissues. Considering above criteria the following distribution for types was suggested:

Table 4

Clinical and roentgenographic classification of spondylodiscitis severity (SSC) 2010 [7]

SSC	SponDT	Neurological deficit	Bone destruction
I grade	<3	No	No
II grade	3–6	No	Yes
III grade	>6	Yes	

Table 5

Recommendations for tactics depending on pathology severity [7]

I grade	II grade	III grade
Conservative treatment or posterior stabilization. Biopsy.	Posterior stabilization, biopsy, reduction, sanation of paravertebral tissues, ventral stabilization in the second stage	Posterior stabilization with laminectomy, discectomy from posterior approach with histological examination, local antibiotic therapy, sanation of involved paravertebral tissues, early ventral stabilization
Antibacterial therapy for 12 weeks	Antibacterial therapy for 12 weeks	Antibacterial therapy for 12 weeks

Type A

All types without biomechanical instability and acute neurological deficit or epidural abscess.

Subtypes distribution depends on secondary criteria:

A.1 — ordinary discitis without involvement of vertebral bodies;

A.2 — spondylodiscitis with involvement of intervertebral disc and adjacent vertebral bodies;

A.3 — spondylodiscitis with limited involvement of paravertebral soft tissues;

A.4 — spondylodiscitis with uni- or bilateral intramuscular abscesses.

Treatment principles: antibacterial therapy, all day constant wearing of rigid corset until full eradication of infection. Patients with high demands in respect of life quality can undergo minimally invasive transpedicular fixation (TPF).

Type B

All patients with X-ray confirmed substantial bone destruction or biomechanical instability without acute neurological deficit or epidural abscess. Patients were divided into subgroups:

B.1 — destructive spondylodiscitis without segmental instability;

B.2 — destructive spondylodiscitis with involvement of paravertebral soft tissues without segmental instability;

B.3 — destructive spondylodiscitis with biomechanical instability and segmental kyphosis (B.3.1<25°, B.3.2 >25°).

Treatment principles: conservative treatment or percutaneous TPF. The latter aims at preservation of stability of affected spine segment (B.1, B.2). Spine stabilization is mandatory in cases of segmental instability or kyphosis. Minimally invasive TPF is an option for treatment of patients with not severe kyphotic deformities.

Type C

All patients with epidural abscess or acute neurological symptoms.

C.1 — epidural abscess without neurological symptoms and segmental instability,

C.2 — epidural abscess with segmental instability without neurological deficit,

C.3 — epidural abscess with acute neurological deficit without segmental instability,

C.4 — epidural abscess with acute neurological deficit and segmental instability.

Treatment principles: patients without acute neurological deficit and segmental instability (C.1) undergo conservative treatment with careful monitoring of neurological status. Patients of C.2 subtype are treated by surgical stabilization and sanation of abscess to exclude potential risk of neurological deficit development. In cases of C.3 and C.4 surgical decompression of neural structure was always performed in combination with segmental stabilization if biomechanical stability was at risk.

Table 6 presents key aspects of classification and suggested tactical solutions according to ICD 10, „New classification pyogenic spondylodiscitis“ (NCPS) by E. Pola and „Spondylodiscitis severity code“ (SSC) by L. Homagk [7, 9].

Principles differences are reported only in paragraph C.2/IIB which are related to the fact that E.Pola classification considers all clinical types of epidural abscesses, and L. Homagk reports only neurological deficit which requires immediate surgical treatment, while bone destruction is secondary. Other paragraphs of both classifications suggest similar tactical solutions, however, surgeons give preference to conservative treatment or to instrumental stabilization with medicinal therapy. Options of ventral procedures are not considered by authors.

Table 6

Matching of classifications of E.Pola, L. Homagk and suggested options of tactical solutions

ICD 10	Pola et al. NCPS	Homagk SSC	Treatment tactics	
			NCPS (Pola et al.)	SSC (Homagk et al.)
M46.2 M86.0 M86.2 M86.5 M86.6	A.1	IA	Conservative treatment, transpedicular fixation can be done to improve life quality	
	A.2	IA		
	A.3	IB		
	A.4	IB		
	B.1	IIA	Conservative treatment or transpedicular fixation	Transpedicular fixation, attempt to correct kyphosis
	B.2	IIB		
	B.3.1	IIA	Always transpedicular fixation, minimally invasive procedure in cases of not sever kyphosis	
		IIB		
	B.3.2	IIB		
G06	C.1	IB	Conservative treatment with careful control of neurological symptoms	Conservative treatment or transpedicular fixation
M46.2 M86	C.2	IIB	Transpedicular fixation, abscess sanation	Transpedicular fixation, attempt to correct kyphosis
	C.3	IIIB	Decompression or stabilization	Stabilization and decompression, ventral stabilization is possible
	C.4	IIIB		

Material of the author's clinical study

The study included 209 patients with non-specific vertebral osteomyelitis treated in the period from 2006 till 2017. All cases of vertebral osteomyelitis were distributed in accordance with classifications described below. The authors conducted the analysis of treatment tactics used in their hospital and by the authors of given classifications.

Mean age of the patients was 48.68±14.8 years. Male patients were three times more than female: 153 (73.2%) and 56 (26.8%) respectively. Signs of inflammation manifested by fever and of leukocytosis at admission were reported for 109 (52.1%) patients. Neurological deficit was observed in 37 (17.7%) patients.

Results

All patients were classified by ICD 10 and divided by types according to „New classification pyigenic spondylodiscitis" (NCPS) by E. Pola and „Spondylodiscitis severity code" (SSC) by L. Homagk et al. (Table 7).

Four out of 209 patients were not classified while three of those featured isolated lesion of vertebral processes (1.4% of total number of patients) and one patient — lesion of C_I–C_{II}.

Patients were distributed according to classification of E. Pola [9] and treatment tactics developed in the clinic of the authors (Table 8).

In vertebral osteomyelitis (C.3, C.4) draining of epidural abscess was performed in all patients at sanation or reconstructive stage of surgery.

Full matching of treatment tactics with standardized approaches was observed in 61.5% (n = 126) of cases. However, if we consider options like sanation+transpedicular fixation, anterior spine fusion, circular spine reconstruction as not contradicting to suggested concept for patients with destructive and complicated forms of osteomyelitis, then matching rate increases up to 81.5% (n = 167).

Table 7

Patients' distribution according to NCPS and SSC

ICD 10	NCPS (Pola et al.)	Number of patients	SponDT	Number of patients
M46.2 M86.0 M86.2 M86.5 M86.6	A.1	0	IA	0
	A.2	42	IA	42
	A.3	16	IB	16
	A.4	4	IB	4
	B.1	56	IIA	56
	B.2	31	IIB	31
	B.3.1	16	IIA	4
			IIB	12
	B.3.2	1	IIB	1
G06	C.1	1	IB	1
M46.2 M86	C.2	9	IIB	9
	C.3	10	IIIB	10
	C.4	19	IIIB	19
Total		205		205

Table 8

Patients' distribution according to NCPS and SSC

Type	Conservative treatment	TPF	Sanation	Sanation + TPF	Anterior spine fusion	360° reconstruction	Total
A.2	28	10	3**	–	1**	–	42
A.3	6	–	6**	1**	3**	–	16
A.4	2	–	2**	–	–	–	4
B.1	22	13	2**	3*	4*	12*	56
B.2	3	7	7**	2*	4*	8*	31
B.3.1	3**	4	–	–	7	2	16
B.3.2	–	–	–	1*	–	–	1
C.1	1	–	–	–	–	–	1
C.2	1**	1	4**	–	2	1	9
C.3	–	–	3**	1*	6*	–	10
C.4	–	–	2**	3	8	6	19
Total	66	35	29	11	35	29	205

Note. Figures without index represent cases of complete match of treatment tactics; * — no contradiction to selected treatment tactics; ** — treatment tactics significantly differs from suggested by E. Pola.

Discussion

In the process of comparing tactical solutions with analogous described by L. Homagk the authors obtained similar results. Full match of tactics was in 59.0% (n = 121) cases, tactics not contradicting the suggested — in 23.9% (n = 49) cases, tactics significantly differs from suggested — in 17.1% (n = 35) cases. Major differences are related to absence of stabilization for affected segments after sanation procedure which was characteristic for the early stage of the present research.

Development and verification of classification for hematogenous vertebral osteomyelitis is the essential task. Biomechanical instability of spinal motion segment is the one of the key criteria determining treatment tactics. At the same time criteria used in surgical treatment of degenerative spine lesions [10] due to no destruction of bone are not quite applicable for evaluation of septic instability. C. Herren et al in their systematic review presented clear signs of instability in cases of hematogenous osteomyelitis: segmental kyphosis >15°, vertebral body destruction >50% of its height, translation >5 mm [11].

It should be noted that in all publications known to the authors there is a common opinion that acutely developed neurological deficit is the indication for urgent surgery and predicts treatment outcome [12]. However, many authors exclude from their consideration the patients who experienced neurological abnormalities for a certain period of time, meaning those signs are not acute.

Another important factor influencing treatment tactics and disease prognosis is the systemic inflammatory response syndrome where draining of lesion focus is often a life-saving procedure. Sanation is mainly performed from ventral approach especially in cervical and more rarely in lumbar spine. Absence of indications for ventral procedures [9] which after stabilization of general status of the patient can be supplemented by implants demonstrates that above mentioned publications give insufficient attention to septic osteomyelitis. Procalcitonin test did not prove its efficiency for diagnostics and monitoring of septic vertebral osteomyelitis, however, authors studied only 17 patients with hematogenous vertebral osteomyelitis and 18 patients in control group [13].

SSC classification features a strict methodology approach, however it suggests that all patients with severity grade III should undergo anterior reconstruction. In this respect authors of the two key works (E. Pola and L. Homagk) offer quite opposite approaches. We need a compromise option of decision making while ventral procedure often is technically challenging and late outcomes after isolated instrumental fixation can be comparable.

Spontaneous formation of bone block was observed in major part of patients who underwent posterior fixation along with antibacterial therapy. Decision on the need to perform the second stage of surgery, anterior reconstruction in case of positive dynamics should be delayed.

Dynamic follow up of patient, control of inflammation markers, clinical remission (according to our observance) lead to formation of bone block within 6–18 months, according to data of A.G. Hadjipavlou bone healing can occur after 24 months but not in all patients [14]. Detailed analysis of described tactics of isolated instrumental fixation is in the process of preparing for publication.

Positive blood sterility tests were obtained in 10% (n = 21) out of 209 patients, 17 patients had acute and subacute disease form. 17 out of 21 patients with verified sepsis underwent ventral procedure, seven patients underwent anterior spine fusion after sanation, four patients were treated conservatively. Infection and inflammation complications at the surgical site were observed in five patients.

Sanation was performed in 29 patients (13.9%) which is only slightly different in numbers of septic osteomyelitis cases.

Suggested classifications are quite applicable in the clinical practice and correspond to the stated aim, however, the

authors consider necessary to introduce subtypes specific of SIRS when in some cases a sanation of lesion focus from ventral approach is required for hemodynamic stable patients.

Classification of E. Pola is basing on disease severity grades well known to the majority of trauma and orthopaedic and spinal surgeons with subdivision for A, B and C types. This classification is more extended and includes roentgenological versions, and only availability of neurological deficit is assessed out of clinical data.

Classification of L. Homagk is in a greater extent oriented at the clinical picture, at laboratory control of disease severity and gives much more consideration to patient's status.

In cases of complicated progress of vertebral osteomyelitis there are the following indications for surgery: neurological deficit and/or epidural abscess, sepsis, paravertebral abscesses >2.5 cm and unsatisfactory outcomes of conservative treatment [11], although the size of paravertebral abscess subject to mandatory sanation is disputable drainage is possible under navigation control [7].

When using classification of E. Pola [9] it's reasonable to supplement it with subtypes reflecting presence of sepsis in A and B types. C type requiring sanation of lesion focus doesn't need any subtypes.

Type A

A.5 — spondylodiscitis with SIRS;

A.5 — sanation of spondylodiscitis focus from ventral or postero-lateral approach; reconstruction of anterior spine structures according to indications; fixation of affected spine segment after stabilization of general status of the patient.

Type B

B.4 — destructive spondylodiscitis complicated by SIRS;

B.4 — sanation of lesions focus in the spine with reconstruction of anterior support complex and extrafocal stabilization of affected segment. Septic status is not considered when using SSC classification, only estimation of CRP and VAS evaluation.

Suggested modern classifications of hematogenous vertebral osteomyelitis are applicable in clinical practice defines the severity of pathological process and thus standardizing treatment algorithms and decrease the risk of tactical mistakes. Treatment tactics with above pathology is determined not only by destruction volume, involvement of paravertebral tissues, biomechanical instability of affected spine segment and neurological deficit, but also by systemic inflammatory response syndrome. Sepsis might demand sanation of lesions focus supplemented by delayed stabilization while the decision on ventral reconstruction should be made at a later stage only in cases of clinical and x-ray remission due to a high probability of spontaneous bone block formation.

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INFORMATION ABOUT AUTHOR:

Alexsander Yu. Bazarov — Associate Professor, Department of Traumatology and Orthopedics, Tyumen State Medical University; orthopedic surgeon, Trauma and Orthopedic Department, Regional Clinical Hospital No. 2, Tyumen, Russian Federation