

Results of surgical treatment in patients with tuberculous osteitis and progressing spondylitis

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Background Surgical treatment is essential for patients with tuberculous spondylitis, abscess and compression of the spinal cord. Conservative treatment is practical for patients with tuberculous osteitis uncomplicated with compression of the spinal cord. **Objective.** Make a comparative analysis of surgical treatment produced for pre-spondylitis and post-spondylitis patients with spinal tuberculosis. **Material and methods** Surgical treatment was performed for 17 (28.8 %) patients with tuberculous osteitis and 42 (71.2 %) patients with progressing spondylitis. Debriding resection of tuberculous focus, decompression of the spinal cord, abscess drainage were followed by anterior spine fusion with mesh cages or porous constructs of memory metal nitinol, posterior spondylodesis with self-locking shape memory clamps or transpedicular system. **Results** Static and dynamic spine function, ability to work were restored in 16 (94.8 %) patients with tuberculous osteitis and 29 (69.1 %) patients with progressing spondylitis. Complications developed in 30.9 % of the patients with progressing spondylitis. **Conclusions** Application of combined spondylodesis allowed for restoration of static and dynamic function of the spine in 17 cases at 6-month follow-up. Early ambulation of patients with tuberculous osteitis and spondylitis was shown to provide regression of neurological deficit after stabilization of anterior and posterior supporting vertebral column. Surgical treatment combined with chemical therapy at early stages of spine tuberculosis appeared to prevent infection and neurological complications, and considerably reduce rehabilitation period.

Keywords: spine, tuberculosis, phase, surgical treatment, методы, spondylodesis, mesh cage, transpedicular system

INTRODUCTION

Tuberculous spondylitis and spondylodiscitis adequately treated with antibiotics does not prevent kyphosis developed at the level of the involved vertebrae, neurological deficiency with a high risk of secondary compression fracture [1–5].

Surgical treatment of spondylolytic phase of tuberculosis accompanied by destruction of vertebral bodies, abscesses, compression of the spinal cord and kyphosis is universally recognized while making a treatment option decision [6–8].

Surgical correction of anatomical and topographical relationships is more aggressive for patients at postspondylolytic phase with secondary changes and involved vertebral articular facets, the dislocation due to rigid deformity [1, 5, 7, 9, 10].

Advantages of operative treatment for patients with limited types of spine tuberculosis (spondylitis) are a subject of discussion [1, 7].

Bone autologous grafts mostly harvested from a rib of a patient are used to repair postresection defects of involved vertebral bodies [5, 8, 11]. Economic body resection of adjacent vertebrae followed

by defects repaired with costal grafts is not enough radical and extensive resection require more substantial autografts for spondylodesis. The graft used to repair bone defect of a vertebral body is unable to produce stabilizing function immediately after the surgery. Normal static and dynamic function of the vertebral column can be provided with a bone block formed within at least 10 to 14 months due to poorer regenerative potential of tuberculous bone as compared to the good quality bone [2, 8, 10].

The results of the researches produced during the last 10 to 15 years have shown reliable application of inert and biocompatible implants of titanium alloys for spondylodesis in patients with spinal tuberculosis with no signs of infection. They were found effective to repair extensive postresection vertebral defects [8, 12].

Objective Make a comparative analysis of surgical treatment produced for pre-spondylitis and post-spondylitis patients with spinal tuberculosis.

MATERIAL AND METHODS

Debriding resection of tuberculous focus, decompression of the spinal cord, abscess drainage were followed by anterior spine fusion with mesh cages or porous constructs of memory metal nitinol, posterior spondylodesis with self-locking shape memory clamps or transpedicular system.

Medical records of 59 patients with tuberculous osteitis, progressing spondylitis who received treatment from 2014 to 2016 were reviewed using randomization method. There were 17 (28.8 %) patients with primary tuberculous osteitis and 42 (71.2 %) patients with progressing spondylitis. Destruction of two vertebral bodies and adjacent intervertebral disks was diagnosed in 21 (50.0 %) patients and 21 (50.0 %) patients with progressing spondylitis had involved body of two to three vertebrae and two to three intervertebral disks.

The primary diagnosis of complicated compression fracture was established in 6 (35.3 %)

out of 17 patients with osteitis and 3 (7.9 % – out of 42 patients with spondylitis. The patients were admitted at neurosurgery department to receive emergency assistance. Nine casualties underwent posterior decompression of the spinal cord and with adequate diagnosis osteitis, spondylitis) established were referred to TB dispensary. Low vertebral body height involved with tuberculosis and kyphosis were observed in all 59 patients (**Table 1**).

Prevertebral (n = 8; 38.1 %) and paravertebral (n = 5; 23.8 %) abscesses were observed in patients with tuberculosis involving 1 to 2 vertebrae and an adjacent disc. No infection was diagnosed in 8 (38.1 %) patients. Only one patient with spondylitis of Th₉-Th₁₂ showed no inflammation of the adjacent soft tissues. Paravertebral abscesses were observed in 20 (95.2 %) patients with disseminated spondylitis (see **Table 1**).

Table 1

Localization, phase, complications of spinal tuberculosis in 59 patients

Phase of tuberculosis	Localization	Complications							Total
		pathological fracture (compression)	neurological deficit		Abscess		kyphosis		
			grade	abs.	prevertebral	paravertebral	angle	abs.	
Tuberculous osteitis 17 (28.8 %)	C ₅	1	D E	1 2	–	–	10°	1	3
	Th ₉	–	–	–	–	–	10°	2	2
	Th ₁₂	3	D C E	1 2 1	–	–	25° 20° –	1 1 2	4
	L ₄	1	E D	2 1	–	–	10° –	1 2	3
	L ₅	1	D E	1 3	–	–	7° –	1 3	4
	Th ₁₂ –L ₁ , L ₃ –L ₄	–	E	1	–	–	–	–	1
Progressing spondylitis 42 (71.2 %)	Th ₅ –Th ₆	–	D	2	1	–	25° 18°	1 1	2
	Th ₄ –Th ₅	1	E D	1 2	2	–	30° 20°	1 2	3
	Th ₁₂ –L ₁	–	D C	3 2	2	–	18° 25°	2 3	5
	L ₁ –L ₂	1	D C E	3 2 3	1	4	18° 20° 25°	2 3 1	6
	L ₃ –L ₄	1	D E	1 3	2	1	20° 10°	2 3	5
	Th ₉ –Th ₁₂	–	D C E	2 1 3	–	5	28° 30° 35°	3 2 1	6
	Th ₁₁ –L ₁	–	D C E	3 2 3	–	7	18° 27° 20°	1 1 5	7
	Th ₁₀ –Th ₁₂	–	D C E	4 1 3	–	6	20° 25° 30°	3 4 1	6
	L ₃ –L ₅	–	D C	2 1		2	15° 20°	1 2	2

In addition to standard biochemical, clinical blood and urine tests comprehensive workup included standard chest radiograph, CT or MRI of the spine. PCR assay was used to detect *Mycobacterium tuberculosis* complex and R-forms. Clinical specimens (cerebrospinal fluid, sputum, or urine) were examined and cultured in a laboratory with Ziehl-Neelsen staining technique. Immunograms, B- and T-lymphocyte and EIA, HIV tests were performed to evaluate the immune system. Spinal cord injury was scored and classified using the ASIA/ISNCSCI (2015) guidelines [6, 12].

Preoperative preparation timing, methods of medication and surgical treatment were correlated with the results of patients' examination.

Surgical interventions were performed shortly, in 1 to 3 days of admission. Anterior spondylodesis was produced for 11 (64.7 %) out of 17 patients with osteitis after removal of caseous necrosis in the involved vertebra (and an adjacent intervertebral disc in 5 cases) followed by posterior spondylodesis after 12 to 14 days. Six patients (35.3 %) with laminectomy earlier performed at TB dispensary underwent posterior spondylodesis at the first stage and anterior compression and spondylodesis after wound healing and removal of stitches. Mech implants (Medtronic, U.S.A., registration № RZN 2013/333), porous nitinol implant (OOO «MITs SPF», Russia, registration № FSR 2009/04558) were used for anterior spondylodesis.

Transpedicular system (Medtronic, CIHA, registration № RZN 2013/333), self-locking thermomechanical shape memory clamp (OOO «MITs SPF», Russia, registration № FSR 2009/04558) were employed for posterior spondylodesis (**Table 2**).

Abscessotomy, necrectomy, anterior decompression of the spinal cord and anterior spondylodesis were performed for 39 (92.9 %) patients with tuberculous spondylitis at the first stage of surgical treatment. Posterior spondylodesis was produced for three patients with spondylitis complicated with compression fracture and compressed spinal cord following laminectomy at the first stage. There was an interval of 14 to 17 days between anterior and posterior spondylodesis in 9 (21.4 %) from 42 patients with spondylitis without abscesses. At least 3 to 4 week interval was needed for 8 (19.1 %) patients with prevertebral abscess. The second stage of surgical intervention was produced for 25 (59.5 %) patients with paravertebral abscesses with convincing evidence of absent intoxication and inflammation. An average of 90-to-96-day interval was required between the two surgical procedures. Reconstructive procedures were performed with Mech lyophilized bone implanting system (**Fig. 1**). Through porous nitinol implants were used for most of the cases. Either transpedicular system or self-locking shape memory clamps were used for posterior interbody fusion (see **Table 2**).

Table 2

Methods of surgical treatment in patients with tuberculous osteitis and progressing spondylitis

Indication	Localization	Mech + shape memory tightening clamp	Porous implant + shape memory tightening clamp	Reinforced porous implant + shape memory tightening clamp	Mech + transpedicular system	Porous implant + transpedicular system	Porous cage	Mech h	Total
Osteitis complicated with neurologic deficiency	C ₅	1	—	—	—	—	—	—	1
	Th ₁₂	2	1	—	—	—	—	—	3
	L ₄	1	—	—	—	—	—	—	1
	L ₅	1	—	—	—	—	—	—	1
Osteitis without neurologic deficiency	C ₅	—	2	—	—	—	—	—	2
	Th ₉	1	1	—	—	—	—	—	1
	Th ₁₂	—	1	—	—	—	—	—	—
	L ₄	—	2	—	—	—	—	—	2
	L ₅	—	—	—	—	—	2	1	3
Spondylitis, abscess, destruction of 2 bodies and an intervertebral disc	Th ₁₂ -L ₁ , L ₃ -L ₄	—	—	—	1	—	—	—	1
	Th ₄ -Th ₅	2	—	1	—	—	—	—	3
	Th ₅ -Th ₆	—	2	—	—	—	—	—	2
	Th ₁₂ -L ₁	—	—	5	—	—	—	—	5
	L ₁ -L ₂	1	3	2	—	—	—	—	6
Spondylitis, abscess, destruction of 2 and more bodies and 2 and more intervertebral discs	L ₄ -L ₅	1	2	2	—	—	—	—	5
	Th ₉ -Th ₁₁	—	1	3	2	—	—	—	6
	Th ₁₁ -L ₁	—	1	3	1	2	—	—	7
	Th ₁₀ -Th ₁₂	—	—	4	1	1	—	—	6
Total	L ₃ -L ₅	—	—	1	1	—	—	—	2
		10	16	21	6	3	2	1	59

Short- and long-term outcomes (maximum follow-up of 2 years) were scored in an integrated manner taking into consideration rehabilitation period with findings of clinical examination and workup. Dynamics in a patient's functional condition, immunological status was correlated with common blood test, urine and fluid tests including PCR and bacteriological examination. Dynamics in neurological deficit, restored static and dynamic function of the spine, quality of life was also evaluated [6]. Standard radiography, CT and MRI scans were helpful for control of implant position, intraoperatively achieved kyphosis correction, timing and quality of bone block formed, presence or absence of inflammation (abscess). Spirometry, functional lung ventilation test were produced to

detect latent (obvious) respiratory insufficiency. With absent deviations (or presence of mild changes) from normal study values outcomes were recognized as good (0 to 5 points), poor (17 to 27 points) and fair (6 to 16 баллов) (**Table 3**).

Statistical analysis was performed with statistical software package *Biostatistica 6.0* (S.A. Glantz, McGraw Hill, translated into Russian by *Praktika*, 1998). Nonparametric criterion χ^2 was used to compare absolute values of attributes in independent samples. Yates' correction for continuity was applied for less frequency (less than 10) of the criterion. Fischer's fourfold contingency table was employed for frequency less than 5. We set our significance level α at 0.05 when testing the null hypothesis.

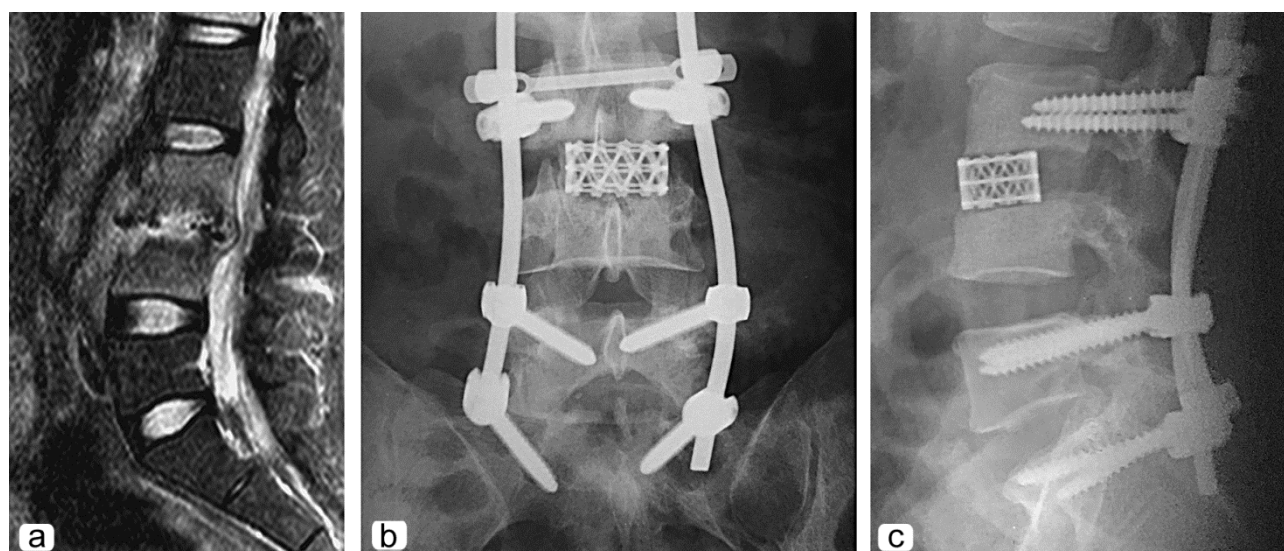


Fig. 1 A 28-year-old patient Kh. with tuberculous spondylitis of L₃ - L₄ vertebrae: (a) preoperative CT scan of lumbar spine showing destruction of L₃ and L₄ vertebral bodies with lower height of L₄ vertebra, caseously compressed spinal cord, paravertebral abscess; (b, c) AP and lateral views of spondylograms 2 weeks after combined spondylodesis

Table 3

Results of 49 patients at 12 months of a complex treatment with surgical intervention

Type of tuberculosis	Evaluation of outcomes						Total	
	0-5 points		6-16 points		17-27 points			
	good		fair		poor			
	abs.	%	abs.	%	abs.	%	abs.	%
Primary osteitis	16	94.1	1	5.9	–	–	17	100.0
Progressing spondylitis, destruction of 2 vertebral bodies and intervertebral disc	18	85.7	2	9.5	1	4.8	21	100.0
Progressing spondylitis, destruction of 2 and more vertebral bodies and 2 and more intervertebral discs	11	52.4	7	33.3	3	14.3	21	100.0
Total	45	76.3	10	16.9	4	6.8	59	100.0

RESULTS

In-patient length of treatment of 17 (28.8 %) patients with tuberculous spondylitis was 25 to 28 days. The patients were discharged from the hospital with normalized functional condition and regression of neurological deficit and recommended to use flexible immobilizing corset (neck brace).

Axial loading and vigorous activity were advised to be limited for the patients until bone block between the implant and vertebral bone was evident.

Radiological assessment (CT, MRI scans) at 5-to-6 follow-up confirmed persisted kyphosis correction achieved intraoperatively. Neither destructive foci in the vertebral bodies nor signs of traumatic effects on the spinal cord and the derivatives were observed with implant position maintained. Bone block was noted to form at the contact area of implant and the bone. Ability to work, habitual life style were shown to be completely restored in 16 (94.1 %) patients at 10-to-11-month follow-up, and the only (5.9 %) patient with osteitis of Th₁₂ complicated with neurologic deficit (C grade [12]) had low muscle strength in lower limbs (4 points)

and the patient complained of transient paresthesia. The result of treatment was evaluated as fair (see **Table 3**).

Outcomes of 21 (50.0 %) patients with spondylitis accompanied by destruction of two vertebral bodies and an adjacent intervertebral disc were assessed as poor in 4.8 % (17 to 27 points).

A patient with spondylitis of L₁-L₂ vertebrae accompanied by compressed spinal cord and paravertebral abscess and concomitant fibrocavernous lung tuberculosis developed tuberculous pleuritis. It was treated with active drainage and antibiotics susceptible to bacterial flora. The condition was arrested and the drainage removed 15 days after the treatment; pleuritic manifestations arrested after 48 days with less sinus infiltration, and complete regression of neurological disorders occurred with further out-patient treatment.

A patient with spondylitis of Th₄-Th₅, lung tuberculosis (S₁-S₂ of the left lung were removed during anterior intervertebral fusion), grade II respiratory insufficiency persisted 13 months after the treatment, and permanent grade III disability granted (**Fig. 2**).

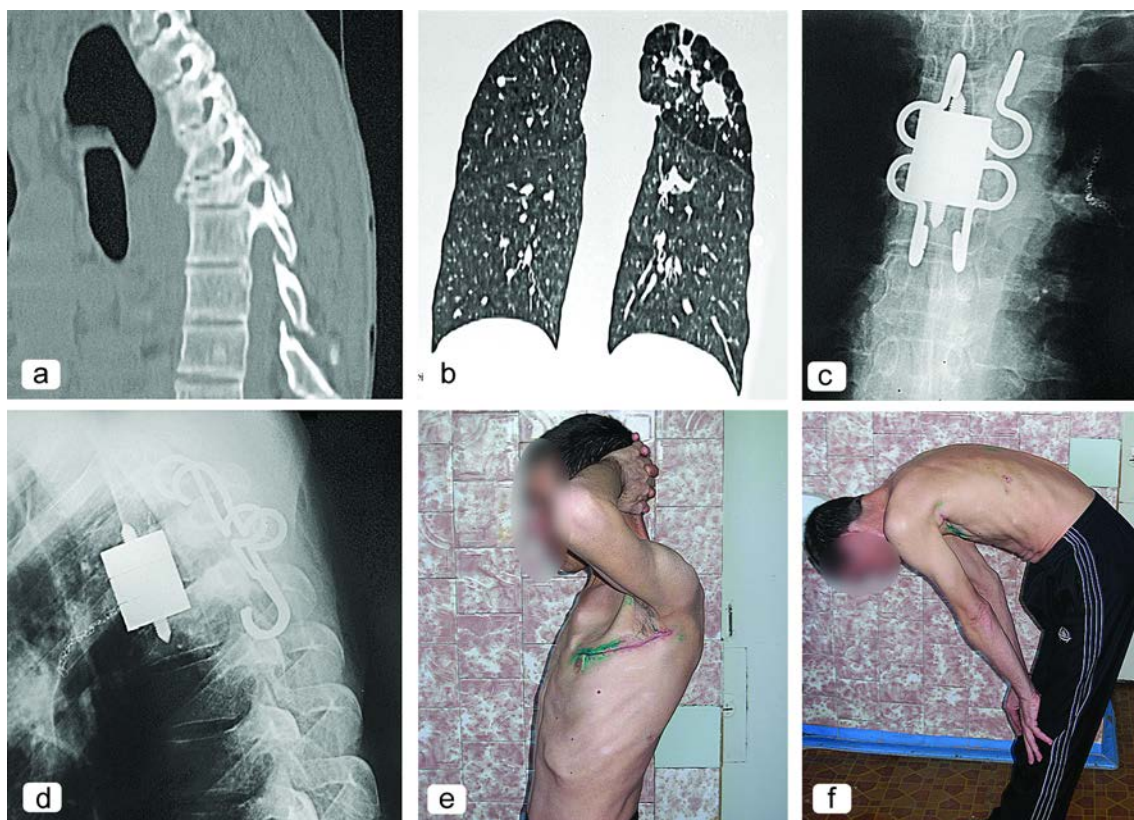


Fig. 2 A 42-year-old patient with lung tuberculosis, tuberculous spondylitis of Th₄-Th₅ vertebrae, compressed Th₅ vertebral body: (a), preoperative CT scan of the spine; (b), preoperative CT scan of the lungs; (c, d), AP and lateral spondylograms 2 months after the surgery; (e, f), functional outcome 12 days after surgical treatment

A patient with spondylolitis of Th₁₂-L₁, compression fracture of Th₁₂ vertebral body, compressed spinal cord and grade D neurological deficit had persisted grade D neurological deficit and could walk with a cane (fair result).

Good results (0 to 5 points) were obtained in 18 (85.7 %) from 21 patients with local spondylitis (Table 3). In-patient length was 90 to 104 days.

No signs of spinal cord compression were absent at the start of out-patient treatment, implant position and kyphosis correction achieved intraoperatively appeared to be stable. Functional visceral and systemic condition is physiologically normal. Immobilization with semi-rigid corsets lasted for 8 to 9 months.

Signs of bone block were observed at 6-to-8-month follow-up. Ability to work restored 11 to 12 months after surgical procedure (see Table 3).

M. tuberculosis was detected in drainage samples 5 to 7 days after the removal in two patients with postoperative abscesses and pleuritic. Samples of 18 patients were found to be PCR negative for the circulating DNA copies of M.tuberculosis, however, chemical therapy continued from 8 to 9 months with repeated bacteriological examination.

Comparative analysis of outcomes of surgical treatment of tuberculous osteitis and local spondylitis ($\chi^2 = 0.095$, $p = 0.758$) showed statistically insignificant differences.

Fair results of surgical treatment were obtained in 7 (33.3 %) from 21 patients with destruction of 2 to 3 vertebrae and adjacent intervertebral disks (see Table 3). Five patients with tuberculous spondylitis and compression of the spinal cord (grade C neurological deficit) maintained neurological deficiency during 5 to 6 months after spondylodesis (AIS grade D) [12]. Ambulation and muscle strength measuring 4 were restored after 8 to 12 months postoperatively. Two patients with grade D neurological deficiency had muscle strength of lower limbs measuring 3. In addition to that, these patients with cellular immune deficiency detected preoperatively had a longer course of complex immunoglobulin therapy.

Radical debridement and implant removal, anterior spondylodesis with porous reinforced im-

plant (pre-soaked in Rifampicin solution of 1.0 per 50.0 ml of saline solution), and active drainage were performed for 3 (14.3 %) patients due to inflammation abscess and sinuses detected 17 to 21 days after anterior spondylodesis. Detoxification and antibacterial therapy with antibiotics susceptible to microflora was administered postoperatively. Surgical treatment completed after 3 months with posterior spondylodesis using self-locking clamp. Outcomes were recognized as poor (see Table 3).

Respiratory ventilation recovered after 4 to 5 months of surgical treatment due to considerably aggressive procedure in patients with spondylitis of the thoracic spine complicated with abscess. Moderate respiratory fibrosis did not lead to considerably impaired ventilation in patients with tuberculous sequelae. The outcome was evaluated as fair.

No active physical activity including vertical loading was allowed for 21 patients with destruction of 2 to 3 vertebrae and 2 to 3 adjacent intervertebral discs following abscessotomy, anterior decompression of the spinal cord and spondylodesis. A 15° correction of kyphosis could be produced intraoperatively. Beller type extension rigid corsets (Dorso Arexe) were recommended for thoracic spine fixation after surgical procedure. External immobilization of lumbar spine was produced with adjustable rigid Otto Bock or DLSS-4000G elements to model the corset for rehabilitation needs. Rigid bracing lasted for 5 to 6 months and was followed by semi-rigid fixation in the daytime within 12 months (Fig. 3).

Complete restoration of spinal function was observed in 11 (52.4 %) patients after 11 to 12 months of surgical treatment. The patients could return to their jobs. Disability was assigned to 10 patients for the period of one year group. At a follow-up permanent grade III disability was granted to 3 patients.

Comparing outcomes of spondylolitis with destruction of 2 vertebral bodies and 2 to 3 vertebral bodies surgical treatment appeared to be more efficient in patients with tuberculosis limited by 2 impaired vertebral bodies ($\chi^2 = 4.011$, $p = 0.045$, the differences being statistically significant).

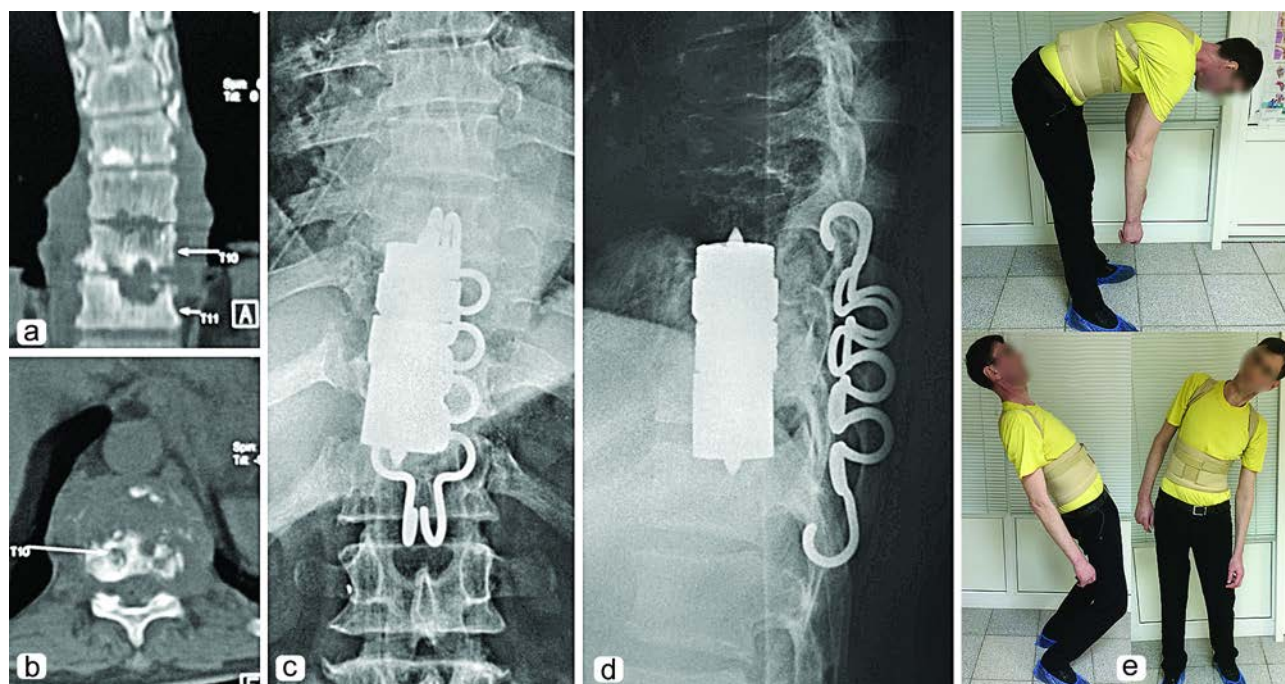


Fig. 3 A 32-year-old patient G. with progressing tuberculous spondylitis of Th₉-Th₁₂ vertebrae: (a, b), preoperative CT scan; (c, d), AP and lateral spondylograms 3 months after combined spondylodesis; (e), functional result 6 months after surgical treatment

DISCUSSION

Untimely detection of tuberculous spondylitis or refusal from surgical treatment (debridement, reconstruction and stabilization of impaired spine segment) at early stage of tuberculosis results in purulent complications, compression of vertebral body (bodies), kyphosis and compression of the spinal cord [10, 11].

Radical and restorative procedures employing a variety of constructs provide adequate spine stabilization. Surgical treatment performed at phase I tuberculosis can help to recover ability to work in 95.6 to 97.1 % of the cases [8, 9, 11]. Reconstructive surgery performed at phase II tuberculous spondylitis has shown to be less efficient functionally with complication rate of 23.8 to 34.5 % [8, 11].

Our findings are in line with literature data. Pa-

tients with progressing tuberculous spondylitis showed longer rehabilitation time with complication rate of 30.9 %.

Timely surgical intervention (prior to purulent complications) allowed for shorter rehabilitation period in 17 patients with tuberculous osteitis and showed 94.1 % of good functional results.

Neither loss of intraoperative correction of kyphotic deformity nor destruction in the vertebrae adjacent to the implant was noted with the usage of combined spondylodesis stabilizing anterior and posterior supporting spine complex. Anterior or posterior spondylodesis is reported to provide insufficient spine stability for patients with progressing spondylitis, with the loss of kyphosis correction in 10 to 15 % of the cases [2, 7, 8].

CONCLUSIONS

1 The usage of combined spondylodesis provided static and dynamic function of the spine restored at 6 months after the surgery in 17 patients.

2. Early ambulation of patients with tuberculous osteitis and spondylitis ensured regression of neurological deficiency with stabilized anterior

and posterior supporting spine complex.

3. Surgical treatment combined with chemotherapy at early stages of spine tuberculosis was shown to prevent purulent and neurological complications and considerably reduce rehabilitation period.

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