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## SIMULTANEOUS THREE-COLUMN REVISION RECONSTRUCTION OF THE CERVICAL SPINE IN EARLY DEEP SURGICAL SITE INFECTION COMPLICATED BY SEVERE ANGULAR KYPHOTIC DEFORMITY: A CLINICAL CASE

**Abstract.**
Background. Angular kyphotic deformity of the cervical spine represents one of the most severe forms of spinal pathology, often associated with progressive neurological deficits, severe pain, sagittal imbalance, and reduced quality of life. While postlaminectomy syndrome and ankylosing spondylitis are well-studied causes, cervical angular kyphosis secondary to deep surgical site infection (SSI) remains poorly described in the literature.
Objective. To present the clinical, radiological, and surgical outcomes of a simultaneous three-column revision reconstruction of the cervical spine in a patient with early deep SSI complicated by severe angularly photic deformity.
Methods. A 57-year-old male developed early deep SSI following staged anterior cervical discectomy and fusion, complicated by spondylitis, epidural abscess, and progressive angular cervical kyphosis. A three-stage single-session surgical strategy was applied, including anterior corpectomy, posterior decompression with instrumented fixation, and anterior column reconstruction with a titanium mesh cage.
Results. At 10-month follow-up, significant pain relief, neurological improvement, and restoration of sagittal alignment were achieved. The angular kyphosis was corrected by 46°, ODI and NDI scores improved to mild disability, and no signs of recurrent infection were observed. Conclusion. Early deep SSI of the cervical spine may lead to rapidly progressive angular kyphotic deformity requiring complex revision surgery. Simultaneous three-column reconstruction represents an effective and safe strategy for infection control, neurological recovery, and restoration of sagittal balance in selected patients.

**Keywords:** cervical kyphosis; surgical site infection; three-column reconstruction; revision spine surgery; sagittal balance; cervical spine.

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## ОДНОМОМЕНТНАЯ РЕВИЗИОННАЯ ТРЁХКОЛОННАЯ РЕКОНСТРУКЦИЯ ШЕЙНОГО ОТДЕЛА ПОЗВОНОЧНИКА ПРИ РАННЕЙ ГЛУБОКОЙ ИНФЕКЦИИ ОБЛАСТИ ХИРУРГИЧЕСКОГО ВМЕШАТЕЛЬСТВА, ОСЛОЖНЁННОЙ ВЫРАЖЕННОЙ УГЛОВОЙ КИФОТИЧЕСКОЙ ДЕФОРМАЦИЕЙ: КЛИНИЧЕСКОЕ НАБЛЮДЕНИЕ



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**Аннотация.**
Актуальность. Угловая кифотическая деформация шейного отдела позвоночника относится к наиболее тяжёлым формам вертебральной патологии и сопровождается выраженным болевым синдромом, неврологическим дефицитом, нарушением сагиттального баланса и снижением качества жизни. В то время как постламинэктомический синдром и болезнь Бехтерева хорошо изучены, данные об угловом кифозе инфекционного генеза крайне ограничены. Цель. Представить результаты одномоментной ревизионной трёхколонной реконструкции шейного отдела позвоночника у пациента с ранней глубокой инфекцией области хирургического вмешательства, осложнённой угловой кифотической деформацией. Материалы и методы. Описано клиническое наблюдение 57-летнего пациента с ранней глубокой ИОХВ после многоэтапных передних декомпрессивно-стабилизирующих вмешательств, осложнившихся спондилитом, эпидуральным абсцессом и прогрессирующим угловым кифозом. Выполнена одномоментная трёхэтапная хирургическая коррекция. Результаты. Через 10 месяцев после операции отмечено значительное уменьшение болевого синдрома, регресс неврологических нарушений, восстановление сагиттального профиля шейного отдела позвоночника и отсутствие признаков рецидива инфекции. Заключение. Ранняя глубокая инфекция области хирургического вмешательства может приводить к формированию тяжёлых угловых кифотических деформаций шейного отдела позвоночника. Одномоментная трёхколонная реконструкция является эффективным методом лечения, обеспечивающим санацию очага инфекции, коррекцию деформации и восстановление стабильности позвоночника.

**Ключевые слова:** шейный кифоз; инфекция области хирургического вмешательства; ревизионная хирургия; трёхколонная реконструкция; сагиттальный баланс; позвоночник.

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## ERTA CHUQUR JARROHLIK SOHASINING INFEKSIYASI BILAN ASORATLANGAN OG'IR BURCHAKLI KIFOZTIK DEFORMATSIYADA BO'YIN UMURTQA POG'ONASINING BIR BOSQICHLI UCH USTUNLI REVIZION REKONSTRUKSIYASI: KLINIK HOLAT

**Annotatsiya.**
Dolzarbligi. Bo'yin umurtqa pog'onasining burchakli kifoztik deformatsiyasi og'ir klinik kechish, nevrologik buzilishlar, saggital muvozanatning izdan chiqishi va hayot sifatining pasayishi bilan kechadi. Infeksion kelib chiqishga ega bo'lgan bunday deformatsiyalar adabiyotlarda kam yoritilgan. Maqsad. Erta chuqur jarrohlik sohasining infeksiyasi bilan asoratlangan bo'yin umurtqa pog'onasining og'ir burchakli kifoztik deformatsiyasida bir bosqichli uch ustunli revizion rekonstruksiya natijalarini taqdim etish.
Material va usullar. 57 yoshli bemorda oldingi bo'yin umurtqa operatsiyalaridan so'ng rivojlangan chuqur infeksiya, spondilit va epidural abstsess fonida progressiv kifoztik deformatsiya kuzatildi. Bir bosqichda uch ustunli jarrohlik rekonstruksiyasi amalga oshirildi.



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Natijalar. Operatsiyadan 10 oy o‘tgach, og‘riq sindromining sezilarli kamayishi, nevrologik holatning yaxshilanishi, saggital profilning tiklanishi va infeksiya qaytalanishining yo‘qligi qayd etildi. Xulosa. Erta chuqur infeksiya bo‘yin umurtqa pog‘onasida og‘ir kifoztik deformatsiyaga olib kelishi mumkin. Bir bosqichli uch ustunli rekonstruksiya deformatsiyani tuzatish, infeksiyani nazorat qilish va umurtqa barqarorligini tiklashda samarali usul hisoblanadi.
**Kalit so‘zlar:** bo‘yin kifozi; jarrohlik infeksiyasi; revizion jarrohlik; uch ustunli rekonstruksiya; saggital balans.

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**Introduction.** Angular kyphotic deformity is one of the most severe manifestations of cervical spine pathology, leading to the development of vertebrogenic pain syndrome, myelo- and radiculopathy, disruption of the global sagittal balance and a decrease in the quality of life of patients [1, 2, 3]. The etiology of the development of angular kyphosis of the cervical spine is multipotent [4, 5, 6]. The structure of the leading factors includes postlaminectomy syndrome, rheumatological diseases (ankylosing spondylitis, Bechterew's disease) and infectious processes (spondylitis, surgical site infection (SSI)) [7, 8, 9]. The incidence of cervical kyphosis after multilevel laminectomy without posterior instrumental fixation reaches 15–24% in adults and 37–100% in children [10, 11, 12, 13]. Instrumental fixation, laminoplasty, minimally invasive anterior (Joe operation) and dorsal (foramenotomy) decompressive interventions reduce the risk of kyphosis development in the postoperative period [14, 15, 16]. Ankylosing spondylitis, manifested by the formation of thoracic hyperkyphosis and lumbar hypolordosis, leads to the formation of chin-on-chest deformity, changes in the gaze angle and requires the performance of extraapical vertebrotomies type 3 according to SRS-Schwab (2014) to correct the sagittal balance [17, 18, 19, 20]. Despite the existing body of data reflecting the features of the clinical picture, diagnosis and surgical treatment of kyphotic deformity of the cervical spine against the background of postlaminectomy syndrome and Bechterew's disease, information on angular kyphosis against the background of infectious processes is sharply limited and is represented by isolated publications [21, 22, 23]. The aim of the publication is to present the results of simultaneous revision three-column reconstruction of the cervical spine in a patient with deep early infection of the surgical site, complicated by the formation of angular kyphotic deformity. Clinical Observation: A 57-year-old patient was admitted to the Spinal Surgery Department No. 6 of the St. Petersburg Research Institute of Phthisiopulmonology of the Russian Ministry of Health in January 2022. Upon admission, he complained of chronic vertebrogenic pain in the cervical spine with an intensity of up to 7 points on the visual analog scale (VAS) radiating down the dorsum of the left upper limb, numbness in the fourth and fifth fingers of the left hand, and muscle weakness in the arms. His medical history revealed that the patient had been experiencing vertebrogenic pain in the cervical spine radiating to the left shoulder joint since September 2020. He underwent staged courses of conservative pain medication (NSAIDs) and neurotropic therapy without a lasting therapeutic effect. ENMG results of the upper extremities (March 2021) indicated the presence of a preganglionic lesion in the C6–C8 spinal roots. According to an MRI of the cervical spine from March 2021, Polysegmental degenerative-dystrophic changes in the spinal motion segments C3–C7, as well as spinal stenosis with the formation of a disc-radicular conflict, were detected. Based on the clinical presentation and radiographic examination data, the patient underwent surgery at his place of residence in May 2021: anterior cervical discectomy, spinal canal decompression, and interbody fusion at the C5–C6 and C6–C7 levels. The



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postoperative period was uneventful, with partial relief of radicular pain (intensity up to 5 points on the VAS scale).

Six months after the initial surgery, the patient returned due to persistent clinical complaints. A clinical and instrumental examination was performed, and a decision was made to perform a staged surgery consisting of anterior cervical discectomy, spinal canal decompression, and C4-C5 fusion. The early postoperative period was complicated by the development of a deep SSI, for which empirical antibacterial therapy was administered (parenteral vancomycin 1 g twice daily for 3 weeks). Revision surgeries (necrectomy, abscessotomy, or removal of interbody cages) were not performed. MRI data of the cervical spine following deep SSI (16 days after anterior cervical discectomy and C4-C5 fusion) indicate the presence of an epidural abscess and focal myelopathy at the C2-C3 level, a prevertebral abscess at the C2-C6 level, and spondylitis at the C3-C5 level. Over time, with the use of antibacterial therapy, stabilization of the patient's general condition and laboratory parameters was achieved. However, the intensity of vertebrogenic and radicular pain syndrome increased to 8 points. At the time of hospitalization at the St. Petersburg Research Institute of Physiotherapy, the patient complained of pain in the cervical spine radiating to the upper extremities with an intensity of up to 7 points on the VAS scale. The decrease in quality of life, assessed using the Oswestry Disability Index (ODI) and Neck Disability Index (NDI) questionnaires, was 47% and 62%, respectively (severe). The neurological status was Frankel type D (spinal cord damage in the C5–Th1 segments with sensory disturbances). Radiographic examination revealed an angular kyphotic deformity of the cervical spine measuring 48° according to Cobb, cSVA 12 mm, T1S 30°. The general somatic condition of the patient was moderate. Given the presence of chronic vertebrogenic pain syndrome, neurological deficit, and angular kyphotic deformity of the cervical spine, indications for surgical intervention were determined. The first stage, using the right-sided anterior cervical approach according to RB Cloward [24], exposed bone structures at the C3–C7 level. Visually, pronounced cicatricial adhesions were noted in the retropharyngeal space, with intimate adhesion of the posterior esophageal wall to the scar tissue at the C6–C7 level. To prevent esophageal perforation during the mobilization of the anterior column of the spine, a nasogastric tube was inserted. Using a high-speed bone burr, Kerrison rongeurs, and microsurgical dissectors, a corpectomy of the C4–C6 bodies was performed, decompressing the spinal canal at the corresponding level.

Correction of kyphotic deformity after corpectomy was not performed due to the impossibility of installing the Caspar screw distractor (the length of post-resection diastasis C3-C7 is 6 cm) and because of bilateral synostosis of the C3-C4 facet joints. The anterior cervical approach was provisionally sutured. The second stage included bilateral C3-C4 facetectomy type 1 according to SRS-Schwab (2014), posterior transpedicular fixation of C2-C3, Th1-2 according to Medica free-hands and posterior fusion at the C2-Th2 level with autograft fragments. The third stage included instrumental distraction of the anterior spinal column and installation of a titanium block mesh filled with autobone (harvested from the anterior iliac spine). The wounds were drained and sutured. The surgery lasted 10 hours, the volume of operative blood loss was 850 ml (13.5% of the circulating blood volume). The postoperative period was uneventful, the wounds healed by primary intention. The drains were removed on the 2nd day, verticalization in a cervical orthosis on the 3rd day after surgery. The intensity of vertebrogenic pain syndrome after 10 months was 2 points according to the VAS, radicular pain



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syndrome in the upper extremities was relieved, ODI - 15%, NDI - 14%. The magnitude of correction of kyphotic deformity of the cervical spine was 46° according to the Cobb scale. According to bacteriological examination of the surgical material, no microbial growth was detected. The results of the histological examination indicate the presence of degenerative changes in bone tissue with unevenly expressed lymphoplasmacytic infiltration. The diagnosis was moderate chronic nonspecific inflammation. Postoperatively, the patient underwent a 6-week course of oral antibiotic therapy: amoxicillin + clavulanic acid.

**Discussion.** The incidence of SSI in vertebrology ranges from 2.1 to 16.3%, while in the overall structure of SSI, the development of deep peri-implant infection as an independent nosological form of infectious complication is recorded with a frequency of up to 20% [8, 25]. According to the temporal classification of V. Prinz and P. Vajkoczy, it is customary to distinguish early (limited to 6 weeks from the date of surgery), delayed (>6 weeks) and late (>12 months) SSI [26]. It is the timing of SSI development that is one of the key criteria for choosing the tactics of further treatment. In conditions of early SSI, it is possible to preserve metal structures, while in case of delayed and late SSI, either a one-stage replacement of fixing elements in combination with antibacterial therapy for at least 6 weeks, or a stepwise tactic with primary removal of implants, antibacterial therapy and subsequent restabilization is necessary [27]. The Russian version of the modified classification of V. Prinz and P. Vajkoczy is presented in Table 1. A systematic literature review published by a multicenter team of authors indicates a number of significant trends in the area under consideration: 1) a shift in the microbiological spectrum of SSI pathogens towards resistant forms (MRSA cultivation frequency - 35-71%, MRSE - 43%); 2) the possibility of preserving metal structures in case of superficial SSI development both in the delayed and late postoperative periods; 3) the need for removal or one-stage replacement of metal structures in the overwhelming majority of cases of deep SSI, regardless of the time of development [27]. Considering the presented clinical case, it should be noted that the development of deep SSI in the early postoperative period dictated the need for removal of interbody implants with one-stage posterior instrumental fixation to ensure the stability of the cervical spine. In turn, the optimal scope of bacteriological research to verify the causative agent of SSI includes sowing of wound discharge for non-specific flora and sonication of the implant surface with an ultrasonic destructor, followed by cultivation of the material on anaerobic low-pathogenic flora (medium - blood agar). The duration of etiotropic antibacterial therapy is at least 6 weeks, 2 weeks of which - with parenteral administration. It is also necessary to consider the tactics of primary surgical intervention, in which the operating surgeons gave preference to the ACDF (anterior cervical discectomy and fusion) technique. One of the algorithmic tools in choosing a surgical approach for degenerative pathology of the cervical spine is the K-line parameter, originally proposed by T. Fujiyoshi et al. for patients with ossification of the posterior longitudinal ligament [28]. In our opinion, one of the mandatory components of preoperative radiological examination of patients with degenerative pathology of the cervical spine, along with MRI,The most important diagnostic tools are functional sagittal radiography and CT. For example, the CT results after the initial surgery indicated the presence of segmental ossification of the longitudinal ligament in the patient. Moreover, functional sagittal radiographs at the preoperative stage could have indicated a K-line (+) sagittal profile in the patient and shifted the



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surgical approach toward posterior decompressive intervention (laminoplasty or laminectomy with instrumented fixation of C4–C7).

**Table 1.** Russian version of the SSI classification according to V. Prinz and P. Vajkoczy

| Parameter | Early SSI (≤ 6 weeks) | Delayed and late SSIDelayed: > 6 weeksLate: > 12 months |
|---|---|---|
| Clinical picture | "Acute" local and systemic manifestations: fistula formation, local pain, hyperemia, fever | "Chronic" manifestations: peri-implant bone resorption, instability of metal structures, sluggish pain syndrome |
| Microbiological spectrum of pathogens | Highly pathogenic microorganisms: • Staphylococcus aureus • Streptococcus spp. • Gram-negative bacteria (E. coli, Klebsiella spp., Pseudomonas aeruginosa) | Low-pathogenic and resistant microorganisms: • Coagulase-negative staphylococci (MRSE, MRSA) • Anaerobic bacteria (Propionibacterium acnes) |
| Biofilms | Immature | Mature |
| Surgical tactics | Necrectomy (debridement), preservation of metal structures | Removal or replacement of metal structures (in the absence of spondylodesis); sonication of removed implants followed by bacteriological examination, including the detection of low-pathogenic flora (culture medium - blood agar) |
| Antibacterial therapy | Parenteral administration - up to 2 weeks, then orally 4-10 weeks | Parenteral administration - up to 2 weeks, then orally 4-10 weeks |

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