Case Report

Bilateral Compartment Syndrome of the Leg Complicating Tetanus Infection

Gregory J. Loren, MD*  
L. Randall Mohler, MD†  
Robert A. Pedowitz, MD, PhD†

The incidence of tetanus infection worldwide has declined substantially since the 1940s with the widespread availability and legislated administration of tetanus toxoid vaccines. Concomitant with the declining infection rate is diminished clinical suspicion of tetanus infection in the early disease stage. Although the most threatening manifestations of tetanus involve the respiratory and autonomic nervous systems, significant musculoskeletal complications including acute fractures of the vertebral body,¹,² femoral neck,³ acromion,⁴ and sternum⁵ as well as subacute myositis ossificans⁶,⁷ and osteoarthrosis⁸ have been reported. This article reports a patient who developed bilateral compartment syndrome of the leg during the sustained tonic and reflex contractions characteristic of tetanus.

CASE REPORT

A 36-year-old man born and residing primarily in Mexico sustained a fall of approximately 6 feet from a ladder. He presented to the emergency room several days after the initial trauma complaining of progressive severe spasmodic pain regionally about the right shoulder.

Physical examination revealed repetitive markedly painful generalized muscle contractions. Passive right shoulder external rotation was diminished consistent with a posterior glenohumeral dislocation. The humeral head was reduced and maintained in a guslinger spica. The patient was discharged but returned the following day with continued severe spasmodic pain. Because of the unclear nature of the disease, the patient was admitted for further assessment. Neurologic evaluation was unremarkable for seizure activity. Progressive abdominal pain and rigidity prompted surgery and urology consultations, which were inconclusive.

Five days after admission, the patient complained of severe bilateral leg pain. Oral temperature was 39.7°C. His leukocyte count was 14,500 and erythrocyte sedimentation rate was 62. Serum creatine phosphokinase was elevated at 35,485 IU/L, and urinalysis was consistent with rhabdomyolysis.

Anterior leg compartments were tense with marked pain on passive ankle and hallux plantar flexion. Compartment pressure measurements were 54 and 82 mm Hg in the right and left anterior compartments, respectively. Emergent bilateral anterior and lateral compartment fasciotomies were performed. Myonecrosis was extensive in the left anterior compartment and limited in the right. Serial debridements were necessary prior to delayed dermotomy closure.

Biopsy of the involved muscle of the left leg demonstrated neurogenic atrophy as well as necrosis. The postoperative course was notable for continuing rhabdomyolysis, which was managed with aggressive hydration and urine alkalinization to preclude renal failure. Sustained painful tonic spasms involving the extremities and spine extensors persisted. Illness associated with abdominal rigidity continued. Comprehensive medical and infectious evaluations were negative, including blood, urine, and cerebrospinal fluid cultures, computed tomography of the head, and magnetic resonance imaging of the spine.

The diagnosis of tetanus was proposed approximately 2 weeks after presentation with the clinical recognition of facial spasm or grimmacing (riasus sardonius) and masseter rigidity (trismus). Tetanus skin test was negative, consistent with no prior vaccination. Tetanus antibody titers obtained at diagnosis and repeated at 10 days were 0.173 IU/mL and 0.028 IU/mL, respectively. Titers <3 IU/mL are suggestive of no or inadequate prior immunization. No skin wounds were apparent.

Treatment consisted of diazepam to control skeletal muscle spasms and metronidazole to eradicate the clostridium tetani infection. Passive immunotherapy with tetanus immunoglobulin was administered, and active immunization with tetanus toxoid was initiated. Gradual clinical resolution of the muscle tetany occurred over the next 2-4 weeks.

DISCUSSION

Tetanus is characterized by uncontrolled persistent tonic muscle spasm with violent reflex exacerbation, resulting from the action of a potent neurotoxin. The causative organism is Clostridium tetani. Infection may incite severe systemic impairment and musculoskeletal injury and is frequently fatal, especially at the extremes of life. Any wound or infected area can serve as a nidus for the disease.

Despite the availability, efficacy, and safety of a vaccine, tetanus continues to be a disease primarily of unvaccinated or inadequately vaccinated adults. From 1991-1994, 201 cases of the disease were reported to the Centers for Disease Control and Prevention.
from 40 states, an average annual incidence of 0.02 case per 100,000 people in the United States. Only 12% had received a primary series of tetanus toxoid before the onset of illness. An acute injury was reported in 77% of cases; however, only 43% received tetanus toxoid as wound prophylaxis. During the same period, 1598 cases of tetanus infection were reported in Mexico. In the United States, estimates of underreporting reach 60%. The risk and severity of tetanus infection increase markedly with age. Of the 188 patients for whom age was known in the 1991-1994 CDC surveillance, 101 (54%) were >60 years and 10 (5%) were <20 years. In cases with known outcome, the case-fatality rate was 25% overall, ranging from 11% in those 30-49 years to 54% in those >80 years. An extensive serological survey indicated 30% of Americans do not have levels of antitetanus antibody considered protective, with immunity declining to 28% in people >70 years.

Acute injuries account for approximately 70% of domestic cases. Other identified conditions include chronic ulcers, abscesses, gangrene, and parenteral drug use and less frequently burns, open fractures, and animal or human bites. Because approximately 23% of cases remain cryptogenic, trivial unrecalled trauma may admit sufficient spores to produce infection, prompting reconsideration of the concept of a tetanus-prone wound.

Clinical manifestations of C. tetani infection result from the elaboration and action of the potent neurotoxin tetanosporamin. Generalized tetanus is a constellation of trismus, diffuse muscle rigidity, and generalized spasms, involving tonic contractions of muscle groups causing opisthotonus, flexion and abduction of the arms, and extension of the lower extremities. Despite the resemblance of the generalized spasms to epileptic convulsions, the tetanus victim remains conscious and experiences severe pain.

Tetanus toxin produced in the vicinity of injury enters the nervous system primarily via the presynaptic terminals of alpha-motor neurons, causing local failure of neuromuscular transmission. Denervation may occur in muscles near the site of injury. From the neuromuscular junction, the toxin then exploits the retrograde axonal transport system, traveling to the neuronal cell bodies in the brain stem motor nuclei and spinal cord ventral horns, expressing its major pathogenic action.

After entering the central nervous system, the toxin migrates trans-synaptically to inhibitory interneurons, including both local glycinergic interneurons and descending GABAergic neurons from the brain stem. By preventing transmitter release from these cells, tetanosporamin leaves the motor neurons without inhibition. This produces muscular rigidity by raising the resting firing rate of motor neurons and also generates spasms by inhibiting the termination of reflexive contractions.

The motor system then responds to afferent stimuli with intense sustained simultaneous contractions of agonist and antagonist muscle groups, characterizing the tetanic spasms. Once the toxin has been translocated into the neuron, it is no longer accessible for neutralization, explaining the progression of the disease for several days after appropriate antitoxin administration. Toxic binding is an irreversible event. Recovery of the neuromuscular junction relies on new axonal terminal sprouting.

The incubation period ranges from 3 days to 3 weeks. Fever 38°-39.5°C may be present. Because tetanosporamin has a specific affinity for facial motor neurons, the early signs of trismus and risus sardonicus are noted in >50% of cases. Some degree of abdominal rigidity usually is detectable at presentation. The typical generalized tetanic spasm is the most dramatic manifestation of the disease. Paroxysmal tonic spasms usually are brief but intensely painful.

Respiratory compromise was the most common cause of death in tetanus prior to the advent of intensive pulmonary care. However, central nervous system and systemic sequelae of hypoxia still occur due to delayed or inadequate treatment. Autonomic dysfunction, a leading cause of mortality, is due to disinhibition of sympathetic reflexes causing cardiac arrhythmia, labile hypertension, peripheral vascular constriction, cardiomyopathy, and a generalized catabolic state. Additional systemic complications of tetanus infection and management include aspiration, atelectasis, pneumonia, venous thrombosis, pulmonary embolism, decubitus ulcers, ileus, acute peptic ulcer, rhabdomyolysis, and acute renal failure.

Common peroneal neuropathy due to compression at the level of the proximal fibula has been recognized in the tetanus patient after prolonged sedation. Precautions including antirotation boots or flotation mattresses are recommended. Long-term systemic sequelae of tetanus infection are uncommon.

Acute orthopedic injuries including fractures of the femoral neck, neonatal acromion, and sternum have been described. Compression fracture of one or more vertebral bodies occurs in approximately 50% of cases, but fracture most commonly occurs in the region of the third to seventh thoracic vertebrae. Involvement of cervical and lumbar segments has been described but is rare.

The mid-thoracic spine is especially vulnerable to this injury. The consequent thoracic kyphosis is variable. No outcome evaluations of this complication have been detailed.

It is unclear whether the posterior shoulder dislocation in our case was caused by the fall or resulted from regional muscle contraction. Analogous to convulsive seizure disorders, the internal rotators may conceivably overwhelm the external rotators during tetanic contractions, resulting in posterior glenohumeral dislocation.

Compartment syndrome secondary to active tetanus has not been reported previously. In this case, bilateral anterior or leg compartments were affected. Previous reports have detailed anterior leg compartment syndrome consequent to sustained and repetitive muscle contractions, including prolonged tetany.
after salicylate poisoning, muscle spasm after androgen therapy, postpartum eclampsia, generalized tonic-clonic seizure activity, and acute physical exertion.

During vigorous isometric muscle contraction, intramuscular pressure increases to levels that compromise blood flow and render the muscle ischemic while the contraction is maintained. Adequate circulation relies on the rapid recovery of blood flow between contractions. Intensive muscle work acutely increases muscle volume because of increased blood content, increased capillary permeability, intracellular edema, and restricted venous and lymphatic outflow, leading to elevation of the intracompartmental pressure. Hemorrhage from torn muscle fibers also contributes to intracompartmental edema and compression.

Sustained muscle rigidity and reflex antagonistic spasms characterize tetanus infection. With prolonged tetany, reperfusion during interval muscle contractions is decreased. Increased exertional muscle volume with concomitant edema and hemorrhage in a restricted osseofascial compartment contribute further to tissue ischemia and acute myonecrosis.

Additional musculoskeletal sequelae of tetanus infection may be disabling.Joint contractures due to myositis ossificans and a high incidence of osteoarthrosis have been reported following severe tetanus infection.

Tetanus is diagnosed clinically with laboratory assistance confined to the exclusion of other diagnoses and to the determination of the antitetanus antobody titer. Lack of an apparent portal of entry does not exclude the diagnosis. Patients with generalized tetanus require intensive care and often mechanical ventilation. Benzodiazepines are the most efficacious agents for the control of tetanic spasms and rigidity. Antitoxin mediated neutralization of tetanospasmin that has not yet entered the nervous system shortens the disease course and may reduce the severity.

Human tetanus immunoglobulin (500 U intramuscularly) should be administered once spasms are controlled. At a different site, adsorbed tetanus toxoid (0.5 mL) is given, as immunity is not conferred by the disease. Metronidazole (500 mg administered every 6 hours for 7-10 days) is initiated. Debridement of a wound is indicated only for local management.

Tetanus is entirely preventable by routine childhood immunization and recommended adult tetanus toxoid administration every 10 years thereafter. In the setting of acute wound management, toxoid prophylaxis and tetanus immunoglobulin administration in patients with incomplete or unknown immunity are specific.

REFERENCES