Botulinum toxin type A for rehabilitation after a spinal cord injury: a case report

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ABSTRACT

A 56-year-old man became quadriplegic, bed bound, and carer-dependent secondary to cervical osteomyelitis. Three years later, he presented with generalised spasticity, crouched posture, and a large sacral pressure sore. The severe spasticity in his hips and knees prevented ischial sitting. Injections of botulinum toxin type A to both hamstrings and gastrosoleuli controlled the flexor spasticity of his lower limbs and facilitated rehabilitation and wound healing through proper positioning, wound care, stretching, and weight-bearing exercises. A few weeks later, the patient could better position himself in bed (prone lying) and on his wheelchair (ischial sitting). His spasm-related pain lessened and his mobility and activities of daily living improved. The sacral pressure sore healed completely a few months later. The patient could sleep better, feed with set-up and adaptive aids, groom, dress, and transfer himself with minimal assistance. The effects of botulinum toxin extended beyond just spasticity reduction. His upper extremity function, mobility, and social well-being were all improved through better positioning.

Key words: botulinum toxin type A; clostridium botulinum; muscle spasticity; osteomyelitis; spinal cord injuries

INTRODUCTION

Complete spinal cord injury is irreversible. Muscle power and sensation is lost, leading to spasticity, pressure ulcers, neurogenic pain, and restricted activities of daily living and mobility. Botulinum toxin type A was initially used by ophthalmologists to treat blepharospasm and strabismus. Its use has been extended to the treatment of gait disorders, spasticity, and dystonia after cerebral or spinal cord injuries.1 It is one of the 7 neurotoxins produced by Clostridium Botulinum, a species of anaerobic, gram-positive, rod-shaped bacteria. It weakens the muscles without affecting the synthesis of acetylcholine by reducing the release of acetylcholine from the presynaptic motor axons. This chemical denervation develops over a course of a few days to weeks and lasts for 3 to 5 months. Although the effect of botulinum toxin type A is irreversible, the clinical response slowly

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subsides, owing to collateral sprouting from the terminal nerves.

CASE REPORT

In 2007, a 56-year-old man presented with a 3-year history of complete quadriplegia following osteomyelitis of the cervical spine (C5). He was bedridden and carer-dependent owing to multiple dynamic contractures of both legs (Fig. 1). Spasticity in his hips and knees prevented ischial sitting and he developed a pressure sore over the sacral region because of the prolonged crouched position (Fig. 2a). He had generalised pain in his legs, which was movement-related, dull, aching, and increased during spastic cramps. Opioid analgesics were not effective and his sleep was disturbed. Oral baclofen helped reduce the generalised spasticity to a lesser extent only.

Botulinum toxin type A was first injected in both hamstrings and in both gastrosoleus 8 months later. This was followed by long-leg serial casting for 3 weeks to correct the spasticity, then followed by stretching and weight-bearing exercises (Fig. 3). The modified Ashworth score improved from grade 3 to 2, indicating reduction of spasticity. One week later, the patient could better position himself in bed (prone lying) and on his wheelchair (ischial sitting), had reduced spasm-related pain and improved mobility and activities of daily living. The sacral pressure sore began to heal, indicated by measured improvement in the National Pressure Ulcer Advisory Panel’s staging system from stage 4 to 2. It healed completely a few months later (Fig. 2b). The visual analogue score for pain improved from 7 to 2, and the Barthel scores from 0 to 6/30. The patient could sleep better, feed with a set-up and adaptive aids, groom, dress, and transfer himself with minimal assistance.

DISCUSSION

Many drugs are available to control spasticity by acting within the central nervous system or on the skeletal muscle. These drugs need to be titrated adequately to achieve optimal efficacy, but may sometimes cause undesirable side-effects and interfere with rehabilitation. Most of them need to be administered on a regular and long-term basis. Surgical intervention is invasive and irreversible and the outcome may not be as expected. Therefore, botulinum toxin type A may have a role in the treatment of focal spasticity.
after spinal cord injury, as has been seen in cerebral palsy and traumatic brain injury.

About 70% of patients are spastic one year after injury, but not all require treatment. Patients with post-traumatic spasticity have a higher incidence of flexion contractures, decubitus ulcers or poor perineal hygiene (because of the tight adductor). Realistic goals should aim to improve quality of life.

The exact mechanism underlying spasticity remains unknown. Studies on central paresis (upper motor neurone syndromes) and spasticity indicate that the monosynaptic response to stretch is enhanced, whereas the long latency (polysynaptic) stretch reflex is reduced in strength. The effect is strong facilitation of transmission in the monosynaptic reflex pathway from Ia sensory fibres to alpha motor neurons. There is evidence that reduced GABAergic interneurons mediate presynaptic inhibition of Ia afferent terminals and reduce recurrent inhibitions of alpha motor neurons resulting in increased muscle tone and stretch reflexes. The final pathway is excessive involuntary muscle contractions. Botulinum toxin acts to block the presynaptic release of acetylcholine from nerve terminals, leading to chemical denervation and muscle weakness without affecting the synthesis of acetylcholine.

Spasticity interferes with the activities of daily living in 91% of patients with spinal cord injuries; flexor spasm interferes with sleep in 82% of patients with incomplete lesions and 50% with complete lesions. Botulinum toxin treatment for spasticity improves function, as well as ambulation, walking speed time, frequency of spasm, and pain in patients with incomplete spinal injuries. Improvement in function facilitates treatment. In our patient, both the spasticity score and functional gains in his activities of daily living improved, contributing to his overall emotional well-being.

Pain is usually the most pressing complaint. 23% of patients with cervicothoracic cord injury are willing to trade relief of pain for loss of bladder, bowel or sexual function. The pain-prevalence rates have been reportedly between 34 to 90% and are affected by level, cause, completeness of injury and the presence of depressive symptoms. There is a discrepancy concerning the prevalence of pain in spinal cord injury because of the lack of a standard classification. The International Society for the Study of Pain has proposed a scheme for characterising spinal-cord-injury pain. This taxonomy broadly divides pain into 2 types: nociceptive and neuropathic. Nociceptive pain is further divided into musculoskeletal and visceral types, whereas neuropathic pain is divided into that experienced above, below, and at the level of injury. Pain is presented under each sub-classification in order to facilitate more specific treatment. This taxonomy may represent a major step forward in the management of spinal-cord-injury pain. Although a variety of oral drugs and surgical options have been tried with varying degrees of success, identification of the pain type remains the most important step in the appropriate management of pain.

Spinal pain pathology is not fully understood. Pain reduction after botulinum toxin treatment may result from a combination of the reduction in muscle spasm, intramuscular muscle spindle discharges (which convey non-nociceptive sensations to the spinal cord), the inhibitory effects of Renshaw cells on the 1A inhibitory interneurons, and indirect effects on the spinal neurons (as seen in radio-labelled animal model studies). It is difficult to identify the type, origin, and pathology of spinal pain. Our patient experienced considerable pain relief as indicated by his improved visual analogue score and sleep quality. This was attributed to the combined effects of the reduction in spasticity and non-nociceptive input by the toxin.

The clinical benefits of botulinum toxin depend...
primarily on its peripheral actions by inhibiting acetylcholinesterase release. More distant effects of botulinum toxin have been noted after repeated dosages in patients with generalised neuromuscular paralysis. There is no convincing evidence that botulinum toxin type A acts directly on the central nervous system when injected intramuscularly in humans. Nevertheless, studies suggest that the toxin affects the functional organisation indirectly through peripheral mechanisms. In studies of animal brain tissue after injections of high doses of $^{125}$I-labeled botulinum toxin type A, the toxin was detected in the brain parenchyma and blood vessels. Nevertheless, there is a lack of in vivo evidence of botulinum toxin type A in the blood stream and of its crossing the blood brain barrier at therapeutic doses.

Thus, botulinum toxin type A has a complex mode of action and long-term studies are needed to determine whether distant effects are due to cumulative effects of the toxin or due to spread through the blood brain barrier. In our patient, although no distant or central effects were noted, better positioning after spasticity reduction improved his functional outcomes. Botulinum toxin type A facilitated his rehabilitation and its effects extended beyond just spasticity reduction; upper extremity function, mobility, and social well-being all improved as a result of better positioning.

REFERENCES