Post-polio syndrome: renaissance of poliomyelitis?

Síndrome pós-polio: renascimento da poliomielite?

Claudio Andre Barbosa de Lira[1], Rodrigo Luiz Vancini[2], Francisco Romero Cabral[3], Bolivar Saldanha Sousa[4], Fábio Carderelli Minozzo[5], Abrahão Augusto Juviniano Quadros[6], Vânia D'Almeida[7], Acary Souza Bulle Oliveira[8], Antonio Carlos da Silva[9]

ABSTRACT

Poliomyelitis is an acute and infectious viral disease, transmitted primarily through oral-fecal contact or directly, person to person. Approximately 90% of the individuals infected by the polio virus do not present symptoms; however, the affected individuals can show a variety of symptoms if the virus reaches the bloodstream. In up to 2% of cases, the virus reaches the central nervous system preferably infecting and destroying the motor neurons, resulting in muscular weakness and acute flaccid paralysis. Despite the expressive reduction in the number of cases, many people live with the consequences of the acute illness, thus representing a burden to the public healthcare systems. Many of these people present new manifestations as signs and symptoms that are called post-polio syndrome. It can be defined and characterized by new neuromuscular symptoms, which occur at least 15 years after a period of clinical and functional stability in patients with previous history of symptomatic poliomyelitis. The signs and symptoms characterizing the post-polio syndrome include new muscular weakness, muscular fatigue and atrophy, pain in joints and muscles, sleep disorders, intolerance to cold, respiratory and swallowing difficulties, and recent weight gain. Therefore, the aim of this review is to present the physiological changes caused by the new manifestation of symptoms in individuals with poliomyelitis.

Keywords: Poliomyelitis; Postpoliomyelitis syndrome; Poliovirus; Neuromuscular diseases; Muscular atrophy

RESUMO

A poliomielite é uma doença aguda e infecciosa causada por vírus, cuja transmissão ocorre primariamente pela via oral-fecal ou por transmissão direta, de pessoa a pessoa. Aproximadamente 90% dos infectados pelo vírus da poliomielite não apresentam sintomas, entretanto, os indivíduos afetados podem exibir uma variedade de sintomas se o vírus atingir a corrente sanguínea. Em até 2% dos casos, o vírus atinge o sistema nervoso central infectando e destruindo, preferencialmente, os neurônios motores, levando o indivíduo a um quadro de fraqueza muscular e paralisia flácida aguda. Apesar da expressiva diminuição do número de casos de poliomielite, muitas pessoas convivem com as consequências da doença aguda, onerando os sistemas públicos de saúde. Muitas destas pessoas apresentam uma nova manifestação de sinais e sintomas que em conjunto foram denominados de síndrome pós-poliomielite, esta pode ser definida e caracterizada por novos sintomas neuromusculares que ocorrem ao menos 15 anos após um período de estabilidade clínica e funcional ter sido atingida, em pacientes com história prévia de poliomielite sintomática. Os sinais e sintomas que caracterizam a síndrome pós-poliomielite são: a nova fraqueza muscular, a fadiga muscular, a atrofia muscular, a dor muscular e articular, distúrbios do sono, a intolerância ao frio, dificuldades respiratórias e de deglutição e o aumento recente de peso. Portanto, o objetivo desta revisão é apresentar as alterações fisiológicas decorrentes da nova manifestação de sintomas nas pessoas com poliomielite.

Descritores: Poliomielite; Síndrome pós-poliomielite; Poliovírus; Doenças neuromusculares; Atrofia muscular

INTRODUCTION

Poliomyelitis, frequently called polio or infantile paralysis, was first recognized as a disease by Jakob Von Heine, a German orthopedic surgeon, in 1840. The term poliomyelitis derives from Greek, in which 'polio' means grey, 'myelo' refers to the spinal cord and 'it is' denotes inflammation[1]. It is an acute and

[1] PhD; Adjunct professor at Universidade Federal de Goiás – UFG, Goiânia (GO), Brasil.

[2] Post-graduate student (Doctorate degree) of the Graduate Program in Pharmacology from Universidade Federal de São Paulo – UNIFESP, São Paulo (SP), Brazil.

[3] Researcher at Instituto do Cérebro (INCE) of Instituto Israelita Albert Einstein – IIEPAE, São Paulo (SP), Brazil.

[4] MD at the Department of Physiology of Universidade Federal de São Paulo – UNIFESP, São Paulo (SP), Brazil.

[5] Lecturer of Physical Education at the Department of Physiology of Universidade Federal de São Paulo – UNIFESP, São Paulo (SP), Brazil.

[6] Post-graduate student (Doctorate degree) of the Graduate Program in Neurology/Neurosciences from Universidade Federal de São Paulo – UNIFESP, São Paulo (SP), Brazil.

[7] Adjunct professor at the Department of Biosciences of Universidade Federal de São Paulo – UNIFESP, São Paulo (SP), Brazil.

[8] Affiliate professor at the Department of Neurology of Universidade Federal de São Paulo – UNIFESP, São Paulo (SP), Brazil.

[9] Associate professor at the Department of Physiology of Universidade Federal de São Paulo – UNIFESP, São Paulo (SP), Brazil.

Corresponding author: Francisco Romero Cabral – Avenida Albert Einstein, 627/701 – Morumbi – CEP 05651-901 – São Paulo (SP), Brasil – Tel.: 11 3747-1266 – e-mail: romero.cabral@hotmail.com

Received on Mar 2, 2009 – Accepted on Mar 27, 2009

infectious disease caused by a virus composed of a single ribonucleic acid (RNA) chain, whose transmission takes place primarily via oral-fecal contact (through objects, food and/or water contaminated with feces) or via direct transmission from person to person (through nasopharyngeal secretions)[2].

Poliovirus, the causative agent of poliomyelitis, was identified in 1908 by the American biologist and physician Karl Landsteiner. It belongs to the genus Enterovirus and to the family *Picornaviridae*[1]. Poliovirus presents three serotypes (I, II and III) that can cause paralysis, and serotype I is most frequently found in cases of paralytic disease, followed by serotype III. Poliovirus has high infectivity and its ability to stay and multiply in the host is 100%. However, it has low pathogenicity, with 0.1 to 2.0% of the infected individuals developing the paralytic form of the disease. This pathogenicity varies according to the type of poliovirus (type I is the most pathogenic and type II is the least pathogenic) and to factors inherent to the host (it is higher in adolescents and adults). Mortality due to poliomyelitis varies between 2 and 10%, but it can be much higher, depending on the clinical features.

Although about 90% of individuals infected by the poliomyelitis virus do not present symptoms, since the infection is limited to the gastrointestinal tract and to the nasopharyngeal region, the affected individuals may exhibit a variety of symptoms if the virus reaches the bloodstream[1-2]. Only in 0.1 to 2.0% of cases, the virus reaches the central nervous system (CNS), infecting and destroying especially the motor neurons, resulting in muscular weakness and acute flaccid paralysis, fasciculation and hyporeflexia[2].

Several types of paralysis may occur depending on the location of the affected neuron. In the spinal type, which is the most common, the infected individual presents asymmetrical paralysis, especially in the lower limbs. The bulbar type, when associated with weakness of the muscles innervated by the cranial nerves, and finally, the bulbospinal polio, which is a combination of the two other types[2].

Considering that poliovirus affects the spinal motor neurons when it reaches the CNS, in this context, poliomyelitis is a neuromuscular disease. These diseases represent a group of conditions that involve the motor unit, that is, the lower motor neuron cell body, its extension, the neuromuscular junction or the skeletal muscle. Neuromuscular diseases include motor neuropathies, conditions in which morphological or biochemical neuronal abnormalities are present. Such diseases are characterized by involvement of the lower motor neuron cell body and the main examples include acute anterior poliomyelitis, progressive spinal muscular atrophy and motor neuron disease[3].

In the acute infection of paralytic poliomyelitis, the virus invades the CNS, causing partial or total lesion of the spinal motor neurons, with denervation of some muscular fibers, resulting in flaccid paralysis. During the rehabilitation stage, by means of neuronal plasticity, axonal budding occurs re-innervating the muscular fibers denervated by the acute infection; hence, at least the muscular functional capacity is partially re-established. This recovery of functional capacity is named latency period or stability plateau and is directly related to the number of neurons preserved[4]. This complex neurophysiologic process lasts from six to eight weeks and generates "giant motor units", since one motor neuron that used to control 200 muscular fibers starts controlling 800 to 1,000 fibers[5]. Additionally, it contributes to recovery of muscular functional capacity, hypertrophy of the remaining muscular fibers and increased number of type I fibers (slow contraction fibers)[6].

Poliovirus has infected and victimized thousands of people all over the world; only after the development of the inactivated virus vaccine by Jonas Salk, in 1955, and then with the attenuated virus vaccine, by Albert Bruce Sabin, in 1961, we saw a reduction in the number of poliomyelitis cases in the world. In Brazil, the Salk vaccine started being used in 1955, in very limited range vaccinations promoted by the state and municipal health secretariats, basically in Rio de Janeiro and São Paulo. In July 1961, the Sabin vaccine was officially adopted in Brazil to replace the Salk vaccine due to its low cost, innocuousness, easy administration, in addition to the longer protective effect and the ability to multiply in the gastrointestinal system, thus allowing the elimination of the vaccine virus to the environment. After that, vaccination campaigns were carried out in several Brazilian capital cities with vaccines distributed by the Ministry of Health.

In 1988, some organizations, such as the World Health Organization, United Nations Children's Fund, Rotary International Club and the Centers for Disease Control and Prevention in the United States adopted measures aiming to eradicate poliomyelitis by 2000. Although the purpose was not achieved, this program was successful, taking into account that on the year it was launched there were 350,000 cases of poliomyelitis, notified in 125 endemic countries as opposed to 1,409 cases notified until October 2008. Nowadays the disease is still not eradicated in four countries – Afghanistan, India, Nigeria and Pakistan[7].

In Brazil, the last poliomyelitis epidemics recorded was in 1984, and the last case was registered in 1989. After 1990, Brazil has met all the criteria established by the International Certification Commission of

Poliomyelitis Eradication. In 1994, it received a certificate for interrupting autochthonous transmission of the poliovirus.

With the advent of immunization, the incidence of cases has drastically decreased all over the world. However, a fraction of patients who had previously developed polio in the 1960's and 1970's are currently showing the late effects of poliomyelitis. These effects are clinically manifested as muscular weakness and fatigue, muscular and joint pain, respiratory and sleep disorders, dysphagia, among others, and the set of symptoms is called post-poliomyelitis syndrome.

Post-poliomyelitis syndrome

Post-poliomyelitis syndrome (PPS) was first described in 1875, by Raymond, who reported a case of a 19-year-old patient previously affected by paralytic poliomyelitis, developing a clinical picture characterized by new muscular weakness and atrophy[8]. The patient presented paresis in the left arm and leg. About 100 years later, studies have shown that patients with a previous clinical history of paralytic poliomyelitis could develop, after years of clinical and functional stability, new signs and symptoms, such as loss of muscular strength and atrophy. Since then, PPS started being recognized by the medical-scientific community as a clinical condition that can affect individuals with a past history of paralytic poliomyelitis[9-10].

PPS can be defined and characterized by new neuromuscular symptoms occurring at least 15 years, after a period of clinical and functional in patients with a previous history of symptomatic poliomyelitis. The PPS signs and symptoms include new muscular weakness, fatigue, atrophy and pain, joint pain, sleep disorder, cold intolerance, respiratory and swallowing difficulties and recent weight gain[4,8,11]. Neuromuscular symptoms may occur in limbs that were previously affected by the disease or not. The process is characterized by a slow worsening of PPS signs and symptoms; therefore, it is a progressive disease[4-5,8,11].

Although the pathophysiology of these symptoms is not clear, different mechanisms have been proposed. The most commonly accepted argument is that degeneration or dysfunction of giant motor units, manifested by peripheral deterioration (axon and/or neuromuscular junction), are probably the result of excessive metabolic demand by the giant motor units (muscular overuse)[12-14]. However, there are several hypotheses associated with the pathophysiology of PPS, including muscular disuse, normal loss of motor units with aging, predisposition to degeneration of the motor neuron due to glial, vascular and lymphatic damage, viral reactivation or persisting infection, immunological factors related to poliomyelitis[15-16], effect of growth hormone, combined effect of overuse, disuse, pain, weight gain and other illnesses.

In general, patients at the highest risk of developing PPS have a history of more severe acute poliomyelitis. However, several patients with a typical history of PPS had a history of mild acute poliomyelitis with excellent clinical recovery. Some factors are associated with the new progressive weakness[5,17]: age at initial infection (the older the individual, the higher the risk of presenting new neurological symptoms); history of hospitalization and the use of ventilation support during the acute phase of poliomyelitis; paralysis in all limbs (quadriparesis); intense weakness in the acute phase of poliomyelitis; recent weight gain; muscular pain associated with physical exertion, and patient's current age; and duration of clinical stability.

The prevalence of PPS is estimated as 22 to 87% among individuals with any sequelae of paralytic poliomyelitis[4,8,11]. This variation is related to the definition of PPS adopted, the diagnostic criteria used and the characteristics of the population studied. Codd et al.[18], in an epidemiological study, found that 22% of individuals affected by paralytic poliomyelitis had new signs and symptoms related to PPS. Increased awareness of the population about PPS increased the prevalence to 68% when the same population was interviewed three years later[13].

The diagnosis of PPS requires a clinical approach to rule out other neurological, orthopedic or psychiatric diseases or even the normal consequences of aging, since these could develop the same signs and symptoms as PPS. Because there are no biochemical and/or physiological markers available to help in the diagnosis, the distinction between the symptoms related to PPS and other common health conditions, in the elderly population, represents a growing challenge for healthcare professionals[13].

PATIENT CARE

It is extremely important that the patient with post-polio syndrome be evaluated and followed up by a professional team including neurologists, rheumatologists, orthopedic surgeons, pneumonologists, physical educators, physical therapists, nutritionists and psychologists, to evaluate the grade of functional involvement and to propose new treatment strategies. Although patients who had poliomyelitis have already overcome their limitations and feel extremely motivated to perform their daily tasks, when the symptoms of the post-polio syndrome emerge, the individuals need an effective follow-up with a multiprofessional team to evaluate the motor functional deterioration, respiratory capacity, as well as psychological

assessment regarding acceptance of the new physical disabilities.

As previously described, intense physical exercise with the purpose of gaining muscular mass may be one of the factors triggering the post-polio syndrome. However, some exercises are beneficial and fundamental to prevent problems caused by immobility. Previous studies[11,19] already confirmed the importance of muscular conditioning to improve the quality of life of patients. Some symptoms, such as fatigue, weakness and pain, are triggered when exercise programs with progressive difficulty are implemented. On the other hand, exercises practiced in a warm pool usually help in the physical conditioning promoting mobility and reducing the pain.

Patients with impaired respiratory function must be very carefully monitored and aware of the development of signs of a pulmonary infection. They must receive prophylactic treatment with antibiotics, immunization against flu and *Pneumococcus* and avoid smoking. Excess weight seen in some patients may contribute to reduced mobility, development of osteoarthrosis and respiratory insufficiency due to hypoventilation and obstructive sleep apnea. Nevertheless, it is usually difficult to lose weight due to reduced mobility; therefore, nutritionists are extremely important team members.

Pain control may be difficult because it is usually generalized and not limited to a joint or limb. Simple physical procedures, such as heat, cold, massage and passive stretching may be very helpful; transcutaneous electrical nerve stimulation and acupuncture may also help in treatment.

FINAL REMARKS

Although paralytic poliomyelitis has been eradicated in Brazil as well as in most countries in the world, it is estimated that nowadays there are still 12 million people with poliomyelitis sequelae. These patients represent a burden to the healthcare system, especially those diagnosed with PPS. Therefore, research in different areas of biological and health sciences are essential to understand the disease pathophysiologic mechanisms and provide better quality of life to patients.

Investigations involving physiological and biochemical approaches may serve as the background to understand the neural degeneration that occurs in patients with PPS, in addition to being an interesting model to study the repercussion of physical/motor sequelae on one or more systems and on individual functional capacity. These studies may bring important contributions to healthcare professionals working in areas such as clinical neurology, exercise physiology, physical rehabilitation, physical therapy and correlated areas.

REFERENCES

1. Chamberlin SL, Narins B, coordenadores. The Gale encyclopedia of neurological disorders. Detroit: Thomson Gale; 2005.
2. Cohen JI. Enteroviruses and reoviruses. In: Kasper DL, Braunwald E, Hauser S, Longo D, Jameson JL, Fauci AS. Harrison's principles of internal medicine. 16th ed. New York: McGraw-Hill Professional; 2004. p. 1143-8.
3. Oliveira ASB, Zanoteli E, Gabbai AA. Doenças neuromusculares. In: Borges DR, Rothschild HA, editores. Atualização terapêutica. São Paulo: Artes Médicas; 2007.
4. Trojan DA, Cashman NR. Pathophisiology and diagnosis of post-polio syndrome. Neurorehabilitation. 1997;8(1):83-92.
5. Gawne AC, Halstead LS. Post-polio syndrome: pathophysiology and clinical management. Crit Rev Phys Rehabil Med. 1995;7(2):147-83.
6. Agre JC, Rodríquez AA, Tafel JA. Late effects of polio: critical review of the literature on neuromuscular function. Arch Phys Med Rehabil. 1991;72(11): 923-31.
7. Dutta A. Epidemiology of poliomyelitis – options and update. Vaccine. 2008;26(45):5767-73.
8. Nollet F, de Visser M. Postpolio syndrome. Arch Neurol. 2004;61(7):1142-4.
9. Kayser-Gatchalian MC. Late muscular atrophy after poliomyelitis. Eur Neurol. 1973;10(6):371-80.
10. Mulder DW, Rosenbaum RA, Layton DD Jr. Late progression of poliomyelitis or forme fruste amyotrophic lateral sclerosis? Mayo Clin Proc. 1972;47(10): 756-61.
11. Trojan DA, Cashman NR. Post-poliomyelitis syndrome. Muscle Nerve. 2005;31(1):6-19.
12. Borg K, Borg J, Dhoot GK, Edström L, Grimby L, Thornell LE. Motoneuron firing and isomyosin type of muscle fibres in prior polio. J Neurol Neurosurg Psychiatry. 1989;52(10):1141-8.
13. Dalakas MC. The post-polio syndrome as an evolved clinical entity. Definition and clinical description. Ann N Y Acad Sci. 1995;753:68-80.
14. Grimby G, Einarsson G, Hedberg M, Aniansson A. Muscle adaptive changes in post-polio subjects. Scand J Rehabil Med. 1989;21(1):19-26.
15. Gonzalez H, Khademi M, Andersson M, Wallström E, Borg K, Olsson T. Prior poliomyelitis-evidence of cytokine production in the central nervous system. J Neurol Sci. 2002;205(1):9-13.
16. Trojan DA, Collet J, Pollak MN, Shapiro S, Jubelt B, Miller RG, et al. Serum insulin-like growth factor-I (IGF-I) does not correlate positively with isometric strength, fatigue, and quality of life in post-polio syndrome. J Neurol Sci. 2001;182(2):107-15.
17. Trojan DA, Cashman NR, Shapiro S, Tansey CM, Esdaile JM. Predictive factors for post-poliomyelitis syndrome. Arch Phys Med Rehabil. 1994;75(7): 770-7.
18. Codd MB, Mulder DW, Kurland LT, Beard CH, O'Follon WMO. Poliomyelitis in Rochester Minnesota 1935-1955. Epidemiology and long term sequelae. A preliminary report. In: Halstead LS, Wiechers DD, editors. Late effects of poliomyelitis. Miami, FL: Syumposium Foundation; 1984.
19. Jubelt B, Agre JC. Characteristics and management of postpolio syndrome. JAMA. 2000;284(4):412-4.