· Case Report ·

Clinical observations of integrated traditional Chinese medicine rehabilitation interventions after the treatment of severe organophosphorus pesticide poisoning

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Abstract

Background Acute organophosphorus pesticide poisoning (AOPP) is one of the most common critical conditions encountered in clinical practice, with an estimated annual incidence exceeding 3 million cases worldwide. Most cases of AOPP result from accidental ingestion or deliberate self-poisoning. Owing to its high toxicity, AOPP can lead to multi-organ dysfunction affecting the lungs, liver, and kidneys, and may be fatal in severe cases. Although conventional emergency treatments have markedly improved survival rates, many patients experience long-term complications such as neuromuscular deficits, respiratory dysfunction, and impaired ability to perform activities of daily living. Therefore, it is essential to develop effective post-acute rehabilitation strategies.

Objective To describe the clinical course and review the effectiveness of traditional Chinese medicine (TCM) rehabilitation strategies after severe AOPP.

Methods This paper presents the clinical course of a patient with severe AOPP who underwent comprehensive rehabilitation using TCM comprising acupuncture, electrotherapy, pulmonary and swallowing function training, and herbal adjuvant therapy.

Results Following the integration of TCM rehabilitation with conventional supportive care, the patient demonstrated substantial improvements in muscle strength, respiratory function, swallowing ability, and overall functional independence.

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Conclusion TCM-based comprehensive rehabilitation may serve as a valuable adjunct to standard care in patients recovering from AOPP. Early implementation of TCM-based rehabilitation may facilitate functional recovery and improve long-term outcomes. Further clinical studies are warranted to confirm the broader applicability of TCM-based rehabilitation.

Keywords: organophosphorus pesticide poisoning, integrated traditional Chinese medicine rehabilitation, acupuncture, dysphagia

Introduction

Acute organophosphorus pesticide poisoning (AOPP) is one of the leading causes of poisoning-related mortality worldwide, particularly in developing countries. According to epidemiological data, AOPP accounts for approximately 20%–50% of all poisoning cases, with a mortality rate ranging from 3%–40%[1]. AOPP is mainly associated with accidental ingestion of pesticides, occupational exposure, and deliberate self-poisoning. After entering the body through the skin, gastrointestinal tract, or respiratory tract, organophosphorus compounds rapidly inhibit cholinesterase activity, resulting in dysfunction of the cholinergic system. This subsequently leads to a series of toxic manifestations, including muscarinic symptoms (such as salivation, wheezing, nausea, and vomiting), nicotinic symptoms (such as muscle fasciculations, convulsions, and respiratory distress), and central nervous system symptoms (such as anxiety, coma, and seizures)[2]. In severe cases, AOPP may result in acute pulmonary edema, respiratory failure, cardiogenic shock, hepatic and renal dysfunction, and multiple organ failure, which may ultimately lead to death.

Although the acute mortality rate of AOPP has decreased with advances in modern emergency medical care, current treatment strategies mainly focus on life support and detoxification during the acute phase via gastric lavage, administration of cholinesterase reactivators, atropine administration, hemoperfusion, and plasma exchange [3]. These therapeutic approaches play a crucial role in saving lives. However, after successful rescue in the acute stage, a considerable proportion of patients experience long-term functional impairments. Some patients develop complications during the recovery period, such as acute respiratory distress syndrome, pulmonary injury, delayed neuropathy, and gastrointestinal dysfunction, which prevent them from returning to normal daily activities and markedly impair their quality of life[4]. Particularly during the rehabilitation stage following emergency treatment, the effective evaluation and management of these sequelae present major challenges in clinical practice[5]. At present, systematic and effective interventions for these long-term functional impairments remain limited and are often overlooked in clinical treatment, leading to delayed functional recovery and even loss of independence in performing activities of daily living [6].

Traditional Chinese medicine (TCM) provides a theoretical framework for AOPP rehabilitation. In TCM theory, the severe neuromuscular deficits and delayed neuropathy caused by AOPP are primarily categorized as “Wei syndrome” (flaccidity syndrome) or “Bi syndrome” (impediment syndrome). By applying targeted treatments based on this syndrome differentiation, TCM has gradually opened a new avenue for patient recovery [7]. TCM-based rehabilitation integrates

multiple therapeutic approaches, including acupuncture, electroacupuncture, tuina (therapeutic massage), herbal medicine, and functional training. These interventions can enhance the body's self-regulatory capacity, improve nervous system function, promote blood circulation, and alleviate muscle atrophy. Notably, TCM rehabilitation has demonstrated unique therapeutic advantages in the recovery of neurological disorders, respiratory diseases, and post-poisoning rehabilitation. In recent years, an increasing number of clinical studies have supported the beneficial role of TCM rehabilitation in functional recovery among patients with AOPP. In particular, acupuncture and electroacupuncture have been shown to effectively improve neuromuscular function, swallowing function, and respiratory function in affected patients [8].

This study aimed to retrospectively review the comprehensive TCM rehabilitation performed in the successful management of a patient with severe AOPP, and to explore the potential mechanisms and clinical efficacy of TCM rehabilitation in improving the sequelae of AOPP. Through this case report, we seek to provide useful evidence for clinical practice and offer new insights and strategies for the rehabilitation management of patients with AOPP.

Materials and Methods

A 37-year-old woman ingested approximately 270 mL of dichlorvos at home on 10 September 2024. Shortly thereafter, she developed coma, was unresponsive to verbal stimuli, and presented with frothing at the mouth. No limb tremors or urinary and fecal incontinence were observed. She was immediately transferred to the emergency intensive care unit of our hospital. Upon admission, emergency treatments were promptly initiated, including gastric lavage, cathartic enema, endotracheal intubation with mechanical ventilation, gastric mucosal protection, detoxification therapy, plasma transfusion, and supportive treatments to maintain the acid-base balance, fluid and electrolyte balance, and nutritional support. Repeated hemoperfusion and plasma exchange were also performed. The patient experienced repeated failed attempts at weaning from mechanical ventilation and extubation. Therefore, a tracheostomy was performed on 1 October 2024. After clinical improvement, the patient was discharged on 15 October 2024 and transferred to a local hospital for continued treatment. However, on 16 October 2024, the patient suddenly developed dyspnea accompanied by cyanosis of the lips and tachycardia, and was again transferred to the emergency department of our hospital for treatment. After her condition stabilized, she was transferred to our department for further management. Before the poisoning event, the patient had no history of cardiovascular or cerebrovascular diseases, pulmonary diseases, renal diseases, or endocrine disorders. She denied any history of drug or food allergies and had no history of surgery or trauma.

Physical examination on admission revealed a body temperature of 36.7 ℃, pulse rate of 121 beats/minute, respiratory rate of 23 breaths/minute, blood pressure of 112/91 mmHg, and oxygen saturation (SpO_2) of 93%. The borderline hypoxemia (SpO_2 93%) on admission was considered multifactorial, primarily resulting from a pulmonary infection with copious sputum retention, and exacerbated by compromised airway clearance owing to AOPP-induced respiratory muscle weakness. The patient appeared lethargic and weak, with a pale complexion. She had intermittent coughing with the expectoration of large amounts of white viscous sputum and had no control of urination or defecation. A nasogastric tube and tracheostomy tube were in place. The patient was in a passive position. She could cooperate with the physical examination but was unable to speak. Assessments of orientation,

memory, judgment, comprehension, calculation ability, and cognitive function could not be completed owing to poor cooperation. The convergence reflex could not be assessed. The patient was unable to perform facial movements, including closing the eyes, frowning, wrinkling the forehead, puffing the cheeks, or whistling. She exhibited dysarthria and severe dysphagia (grade 5). Her muscle tone was slightly decreased. The muscle strength was grade 3 in the proximal and distal muscles of both upper limbs and grade 1 in the proximal and distal muscles of both lower limbs. Both superficial and deep sensations in the four limbs were reduced to varying degrees. The abdominal reflex was symmetrical. Tendon reflexes were present bilaterally, including the biceps reflex, triceps reflex, radial periosteal reflex, knee reflex, and Achilles tendon reflex. Coordination tests, including rapid alternating movements of the upper limbs, the finger-to-nose test, and the heel-knee-shin test, could not be performed owing to poor cooperation. No pathological reflexes were elicited. The total Barthel Index score was 0, indicating complete dependence in performing activities of daily living. Electrocardiography showed sinus tachycardia with T-wave changes.

Western medical diagnoses comprised limb motor dysfunction, speech disorder, dysphagia, severe dependence in performing activities of daily living, tracheostomy placement, organophosphate-induced delayed neuropathy, moderate anemia, hypoproteinemia, severe malnutrition, and electrolyte metabolism disorder. The TCM diagnosis was pesticide poisoning resulting in deficiency of both Qi and Yin. On the day of admission, the patient received symptomatic and

Table 1. Laboratory examination findings.

Category	Test item	Result	Reference Range
Complete Blood Count	Red blood cell count ($\times 10^{12}$/L)	2.21	3.5−5.5
	Hematocrit (%)	22.9	36.0−50.0
	Hemoglobin (g/L)	66	110−160
Liver and Renal Function, Electrolytes	Alkaline phosphatase (U/L)	135	35−100
	Total protein (g/L)	50.8	60.0−85.0
	Albumin (g/L)	22.6	35.0−55.0
	Cholinesterase (U/L)	2516	3930−10800
	Glucose (mmol/L)	3.74	3.89−6.11
	Urea (mmol/L)	1.79	2.86−8.20
	Creatinine (μmol/L)	21	44−106
	Potassium (mmol/L)	3.24	3.50−5.30
	Sodium (mmol/L)	135	137−147
	Chloride (mmol/L)	93.8	99.0−110.0
	Calcium (mmol/L)	1.77	2.11−2.52
Inflammatory Markers	C-reactive protein (mg/L)	32	0−8
	ESR (mm/h)	49.0	2.0−25.7
Cardiac Enzymes	Creatine kinase-MB (U/L)	28	0−24
Serum Myoglobin	Myoglobin (ng/mL)	141.86	0−80.00
Coagulation Tests	Prothrombin time (s)	12.7	10.0−14.0
	Activated partial thromboplastin time (s)	29.6	22.0−38.0
	Fibrinogen (g/L)	3.78	2.00−4.00
Urinalysis	Urinary leukocytes (/μL)	3+ (500/μL)	(−)
	Urinary leukocytes (HPF)	3−6	0−3
	Occult blood (/μL)	2+ (80/μL)	(−)

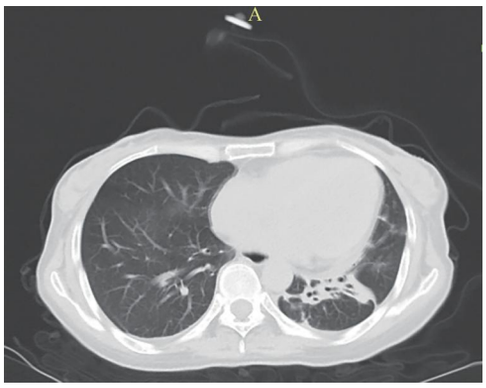

Figure 1. Chest CT scan showing bilateral scattered patchy opacities in the lungs, suggesting infection in the left lower lobe.

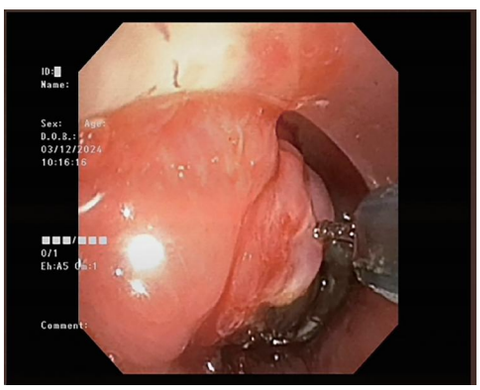

Figure 2. Fiberoptic bronchoscopy image showing granulation tissue hyperplasia at the upper edge of the tracheostomy tube.

supportive treatments, including citicoline for neurotrophic support, correction of electrolyte imbalances, albumin supplementation, nebulized acetylcysteine solution, oxygen therapy, sputum suction, tracheostomy care, and enteral nutritional support via nasogastric feeding.

Physical examination on 17 October 2024 revealed that the patient was conscious but appeared fatigued, with copious sputum that was difficult to expectorate. The limb motor dysfunction, speech disorder, and dysphagia persisted (Kubota water swallowing test: grade 5).

An individualized, multidimensional rehabilitation program was implemented. Scalp acupuncture was performed at Sishencong (EX-HN1) with a needle retention time of 30 minutes. Electroacupuncture was applied to Ding Sanzhen, Quchi (LI11), and Zusanli (ST36) using a disperse-dense wave at a frequency of 2/100 Hz, with the intensity adjusted in accordance with the patient's tolerance for 30 minutes. For the dysphagia, microneedle acupuncture at Jinjin (EX-HN12) and Yuye (EX-HN13) was performed with the swift pricking technique to induce minor bleeding. Neuromuscular & functional training comprised comprehensive limb training including passive range-of-motion exercises (30 minutes/session) and progressive resistance training. Electric-assisted standing training was conducted for 20 minutes daily to improve orthostatic tolerance. Swallowing training consisted of ice stimulation to the posterior pharyngeal wall (3 sets/day), lingual resistance exercises, and the Mendelsohn maneuver. Pulmonary interventions focused on diaphragmatic breathing exercises and manual chest wall percussion for secretion clearance.

On 18 October 2024, the patient's hemoglobin concentration was <60 g/L and the hematocrit was 20.6%. A hematology consultation was requested, and 2 units of suspended red blood cells were transfused.

On 27 October 2024, the anemia had improved. Laboratory tests showed that the serum albumin concentration was 34.2 g/L and serum potassium concentration was 2.60 mmol/L. The patient had an intermittent cough with copious sputum and recurrent abdominal distension with marked bloating. Emergency whole-abdomen CT showed no abnormalities in the liver, spleen, bilateral kidneys, or bladder; however, there was a small amount of fluid in the rectouterine pouch, and infection in the left lower lung lobe. The abdominal distension was considered to be related to gastrointestinal injury caused by pesticide poisoning, resulting in decreased gastrointestinal function and poor absorption. To address the persistent abdominal distension, targeted TCM gastrointestinal interventions were

implemented on 27 October 2024. Approximately 500 g of crushed fennel seeds (*Foeniculum vulgare*) were stir-fried until they were fragrant and warm (approximately 40–50 ℃), wrapped in a cotton bag, and applied to the umbilical region (Shenque, RN8) for 20 minutes twice daily. Abdominal massage comprising manual clockwise circular rubbing and kneading (Mo-fa and Rou-fa techniques) was performed for 15 minutes daily. The massage focused on the specific acupoints Zhongwan (RN12), bilateral Tianshu (ST25), and Qihai (RN6) to promote intestinal peristalsis.

Following 9 days of integrated treatment, the abdominal distension had substantially improved and normal defecation and flatus had resumed by 5 November 2024. The muscle strength of both upper limbs had substantially increased, with proximal and distal muscle strengths of grade 5 in both upper limbs and grade 1+ in both the proximal and distal muscles of the lower limbs. The superficial and deep sensations of the limbs remained reduced to varying degrees. Physical therapy for the upper limbs was suspended, and rehabilitation focused on the lower limbs, swallowing function training, and rectal control training.

On 11 November 2024, the patient still had dysphagia (Kubota water swallowing test: grade 4). The muscle bulk of the limbs was symmetrical, muscle tone was slightly decreased, and muscle strength was grade 5 in the proximal and distal muscles of both upper limbs, grade 1 in the proximal and distal muscles of the left lower limb, and grade 2 in the proximal and distal muscles of the right lower limb. The limb function and swallowing function had improved substantially, and symptomatic treatment was continued.

On 22 November 2024, an overflow of intermittent light-red blood from the tracheostomy site after sputum expectoration led to the suspicion of airway mucosal injury. A respiratory medicine consultation was requested, and pulmonary angiography showed scattered patchy blurred opacities in both lungs, predominantly in the left lower lobe (Figure 1). There were no abnormalities in the major vessels, no pleural effusion bilaterally, and the pulmonary arteries appeared normal. Hemostatic treatment was initiated with hemocoagulase (1 ku daily) and tranexamic acid injection (0.5 g daily).

On 26 November 2024, the patient still had an intermittent cough with copious, thick sputum that was difficult to expectorate, and a small amount of light-red blood continued to overflow from the tracheostomy site. After multidisciplinary discussion, fiberoptic bronchoscopy was performed and revealed granulation tissue hyperplasia at the upper margin of the tracheostomy tube (Figure 2), resulting in approximately 50% luminal stenosis. Mild mucosal erosion with bleeding was observed in the lower trachea. Mucosal swelling was noted in bronchi at various levels in both lungs, and purulent secretions were observed in the left lower lung lobe. Sputum suction combined with bronchoalveolar lavage of the left lower lobe was performed, and anti-infective therapy with ceftazidime (2 g every 12 hours) was initiated.

On 2 December 2024, the sputum production decreased and became easier to expectorate and there was no longer any blood overflow from the trachea. Sputum culture showed *Pseudomonas aeruginosa* that was not multidrug-resistant. The dysphagia persisted but had improved (Kubota water swallowing test: grade 3). The muscle strength was grade 5 in the proximal and distal muscles of both upper limbs and grade 4 in the proximal and distal muscles of both lower limbs. The infection was effectively controlled, and muscle strength had improved. Physical therapy for the upper limbs was discontinued, while the remaining treatment regimen remained unchanged.

On 3 December 2024, the patient continued to produce a large amount of sputum. Hyperplastic granulation tissue remained at the upper margin of the tracheostomy tube, with approximately 50% luminal stenosis leading to poor sputum drainage and preventing decannulation, which resulted in dyspnea. The granulation tissue was successfully removed via electrocautery performed under general anesthesia with fiberoptic bronchoscopy. The airway mucosa showed mild hyperemia and edema. Nebulized dexamethasone (10 mg) was administered to reduce the mucosal edema. Physical therapy, swallowing rehabilitation training, and pharmacological treatment were continued.

On 9 December 2024, the patient showed marked dyspnea during intermittent tracheostomy tube occlusion trials, with the SpO_2 fluctuating between 92% and 98%. No obvious cough was observed, and a small amount of white viscous sputum was expectorated. Electroacupuncture and exercise training were discontinued, and treatment was mainly focused on pulmonary rehabilitation and swallowing therapy to facilitate the patient's adaptation to the occlusion of the tracheostomy tube.

On 11 December 2024, the patient developed a cough with copious sputum, expectorating yellow, thick sputum that was difficult to clear, and a small amount of blood at the tracheostomy site. This was considered to be related to airway mucosal injury or the recent removal of airway polyps. Ambroxol (15 mg every 12 hours) was injected to promote sputum expectoration, and tranexamic acid injection (0.5 g daily) was administered for hemostatic therapy. Pulmonary rehabilitation, swallowing training, and aerobic training were continued.

On 17 December 2024, the patient was producing less sputum that was easily expectorated. The SpO_2 was 97%. The muscle strength was grade 5 in the proximal and distal muscles of both upper limbs and grade 5 in the proximal and distal muscles of both lower limbs. There was mild dysphagia (Kubota water swallowing test: grade 2). An otorhinolaryngology consultation was requested, and the tracheostomy tube was replaced with a metal tracheostomy tube. Physical therapy was discontinued, while nebulization therapy, expectorant treatment, intermittent tracheostomy tube occlusion, swallowing rehabilitation training, and speech training were continued.

On 23 December 2024, the SpO_2 was 98%. Sputum production was minimal and could be spontaneously expectorated. No blood overflow was observed from the tracheostomy site, and the patient reported no discomfort such as chest tightness or dyspnea. The patient was able to phonate. Removal of the tracheostomy tube did not result in dyspnea. The tracheostomy site healed well without redness, swelling, or exudation. The patient was able to walk independently, with normal swallowing and speech function, and was discharged from the hospital. At the 6-month follow-up after discharge, the pulmonary function had returned to normal, and the patient was able to perform routine physical activities.

Discussion

AOPP is a common and highly lethal form of poisoning characterized by sudden onset and rapid progression. Clinically, most cases of AOPP result from accidental ingestion or deliberate self-poisoning. The toxic compounds rapidly inhibit cholinesterase activity, inducing severe muscarinic, nicotinic, and central nervous system manifestations [3,4]. While advances in emergency medical treatments (*e. g.*, gastric lavage, antidotes, blood purification) have markedly decreased acute-phase mortality, a considerable proportion of survivors develop long-term complications such as delayed neuropathy, speech and swallowing disorders, and

profound motor dysfunction [5,6]. It is essential to address these sequelae early and systematically to restore bodily functions and improve long-term quality of life.

In the present paper, we retrospectively analyzed the rescue and rehabilitation process of a patient with severe AOPP. After the acute toxic progression was effectively controlled by conventional Western medicine, the patient remained completely dependent (Barthel Index: 0) with deep coma, tracheostomy placement, and severe limb weakness. From the perspective of TCM, the severe neuromuscular deficits caused by AOPP are considered a systemic depletion of Qi and Yin induced by profound toxic heat. Furthermore, the prominent clinical manifestation-profound muscle weakness and motor dysfunction is categorized as Wei syndrome (flaccidity syndrome). According to the foundational TCM text Huangdi Neijing (Yellow Emperor's Inner Canon), the paramount guiding principle for treating this condition is "treating flaccidity by uniquely selecting the Yangming meridian" [7]. The Yangming meridian is regarded as the "sea of water and grain" and the primary source of Qi and blood; when its flow is abundant, the muscles and tendons are properly nourished.

This classic TCM theory guided our highly targeted integrated TCM rehabilitation strategy. For motor dysfunction, the acupuncture protocol featured Yangming acupoints, such as Quchi (LI11) and Zusanli (ST36). Combined with electroacupuncture, this treatment forcefully stimulated Qi circulation in the meridians to nourish the malnourished muscles and promote neuromuscular junction recovery [8]. To address the central nervous system impairment and prolonged coma status, scalp acupuncture at Sishencong (EX-HN1) was selected to regulate the Shen (spirit) and stimulate the Du meridian, thereby promoting neuroplasticity and cognitive awakening. For the severe dysphagia, we performed microneedle quick-pricking at the sublingual points Jinjin (EX-HN12) and Yuye (EX-HN13). TCM theory suggests that this technique clears local heat, resolves blood stasis, and opens the sensory orifices. From an integrated medical perspective, this local pricking, combined with low-frequency electrical stimulation and ice stimulation therapy, provides direct physical excitation to the glossopharyngeal and hypoglossal nerves to restore swallowing reflexes [9,10].

Closely tied to the recovery of the motor and bulbar functions was the improvement of the patient's respiratory status. Notably, the initial hypoxemia was not solely driven by the localized pulmonary infection, but was exacerbated by AOPP-induced respiratory muscle weakness. The subsequent integrated rehabilitation training specifically addressed this neuromuscular deficit. By progressively restoring overall and respiratory muscle strength, the interventions effectively enhanced the airway clearance and cough efficacy, ultimately resolving the underlying cause of the hypoxemia.

During the rehabilitation process, the patient also experienced marked gastrointestinal dysfunction presenting as severe abdominal distension. In TCM theory, this symptom is attributed to "Qi stagnation in the Middle Jiao" following toxic insult. To address this, we implemented fennel warm compresses on the umbilical region (Shenque, RN8) to warm the meridians and dispel cold, as the volatile oils in fennel effectively relieve intestinal vasospasm. This was synergistically combined with abdominal massage targeting the Ren and Yangming meridians (Zhongwan RN12, Tianshu ST25) to restore the descending function of the gastrointestinal tract [11]. These targeted TCM external therapies rapidly alleviated the abdominal distension within days, accelerating the overall functional recovery and nutritional absorption.

This case suggests that for patients with AOPP, early

initiation of systematic TCM rehabilitation training after successful emergency treatment may substantially shorten the time required for functional recovery and reduce the disability rate [12]. TCM rehabilitation emphasizes a holistic perspective combined with precise syndrome differentiation. By leveraging classical theories (such as treating Wei syndrome via the Yangming meridian) and integrating them with modern physical rehabilitation techniques, TCM effectively addresses the limitations of conventional medicine in functional reconstruction [13,14]. However, this study represents a single-case experience. Prospective, multicenter studies with large sample sizes are required to verify these therapeutic mechanisms and provide robust evidence-based support for AOPP rehabilitation based on TCM.

Conclusion

Integrated TCM rehabilitation training plays a positive role in the functional recovery of patients after AOPP [14,15]. Systematic and individualized TCM rehabilitation interventions may achieve marked improvements in neurological, respiratory, swallowing, and motor functions, thereby enhancing the patient's ability to perform activities of daily living and promoting overall recovery [16]. TCM rehabilitation emphasizes syndrome differentiation and holistic regulation, which forms an effective complement to modern Western medical treatment strategies [17]. Particularly in the rehabilitation of functional impairments resulting from AOPP sequelae, TCM demonstrates favorable clinical outcomes and considerable potential for broader clinical application. Early implementation of TCM rehabilitation after successful emergency treatment may improve the long-term quality of life and reduce disability rates. Future multicenter studies with large sample sizes are needed to further validate the therapeutic efficacy and underlying mechanisms of TCM rehabilitation after AOPP.

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Author contributions

Hao Wu, Xueying Du, and Hao Su contributed to the investigation, data collection, analysis, and interpretation of the study. Li Wang participated in methodology

development, validation, and manuscript revision. Xiaobing Li conceived and designed the study, supervised the project, and critically revised the manuscript. All authors read and approved the final manuscript.

Conflict of interest

All authors declare no conflicts of interest.

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