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Nursing outcomes of traditional Chinese medicine adjunctive therapy on osteofascial compartment syndrome: a review†

Review

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Abstract: The rate of disability due to acute osteofascial compartment syndrome (OCS) is high, and the therapeutic effect of decompressive fasciotomy is not ideal. This paper retrospectively reviews the modern treatment of OCS, including Western medicine and Traditional Chinese medicine (TCM), mainly in the context of the advantages of TCM in the treatment process of decompressive fasciotomy or conservative treatment to the patients who are suffering from OCS. It was found that TCM treatment reduced the levels of serum creatine kinase (CK), lactate dehydrogenase (LDH), and aspartate aminotransferase (AST); it is beneficial to the elimination of swelling and pain. TCM adjunctive therapy promotes patients' postoperative functional recovery and decreases the occurrence of fasciotomy in patients; TCM can relieve tissue hypoxia of compartments and prevent necrosis of muscle and nerve tissue. TCM treatment improves the quality of medical service and ensures the safety of OCS patients. This paper aims to summarize the function of TCM in the treatment of OCS, provide reference for the clinical treatment of OCS, and improve the nursing/medical outcomes of OCS.

Keywords: *decompressive fasciotomy • nursing outcomes • osteofascial compartment syndrome • traditional Chinese medicine • treatment • quality of care*

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1. Introduction

The definition of osteofascial compartment syndrome (OCS) is tissue perfusion pressure increasing in a compartment tightly surrounded with fascias, which is caused by the vasodilation of arterioles, increased permeability of vessel walls, and increased plasma filtration.[1] OCS affects 8 per 100,000 people and is 10 times more common in men than in women. A recent study showed that the incidence of fasciotomy varied from 2% to 24%.[2,3] It was reported that OCS had an incidence rate of 30.4%, especially in the shaft and proximal regions of the tibia.[4] Intracompartmental pressure (ICP) monitoring is essential to avoid a delay in OCS diagnosis.[5] Fasciotomy is needed when the ICP is >30 mmHg, which is used as a diagnosis threshold. A normal regular ICP reading does not exclude OCS; a commercially available monitor is not entirely reliable, despite the application of the correct technique.[5] So far, Western medicine has some shortcomings in the diagnosis of OCS.

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OCS is mainly connected with injuries, terminal or chemical damage of tissues, ischemia, the activity of toxins in patients, or muscle necrosis.[1] It is mostly seen in the forearm, thigh, buttock, shoulder, hand, and foot.[3] It can also be seen in the abdomen, but it presents in the limbs more commonly.[1] OCS is life-threatening and one of the most litigious diagnoses in orthopedic surgery; it is also considered a surgical emergency.[6] It can lead to ischemia, increase in tissue perfusion, and eventually necrosis when there is delay in diagnosis and treatment[1,7]; however, there is little consensus about OCS diagnosis among experts.[6]

Surgeons worldwide adopt the method of decompressive fasciotomy in treating OCS patients. Therefore, pressure-based thresholds for diagnosing OCS may result in overtreatment with fasciotomy.[8] The incidence of complications associated with fasciotomy has been reported to be as high as 87%.[4] In China, some orthopedists have cured OCS using Traditional Chinese medicine (TCM) adjunctive therapy. TCM seems to be effective for patients suffering from OCS. This review describes the usage of TCM treatment for OCS, aiming to improve the medical/care quality for OCS patients. It mainly demonstrates the herbal effects of TCM application by internal or external routes and TCM acupuncture methods, which reduce the metabolic toxins in the affected limbs and reduce the swelling and pain of the affected limbs.

2. The pathogenesis of OCS

2.1. Etiology

2.1.1. Western medicine etiology

Fractures in the extremities are the most common etiological precipitants, but non-long-bone fractures and soft tissue injury can also result in OCS, especially when the patient is on anticoagulation therapy or has an underlying bleeding disorder.[9] Many surgeons insist that open fractures naturally decompress the pressure of the limb and may not be as prone to compartment syndrome as closed fractures. However, small fascial tears resulting from open fractures cannot absolutely deliver the compartment pressure. Both soft tissue and vascular injuries are unusual but essential causes of OCS.[3] Only few cases have been reported after high-energy road traffic accidents; OCS also occurs after a relatively minor trauma.[3] The etiology of OCS can also be iatrogenic, Transradial angiography and intervention can result in compartment syndrome.[10] The incidence of OCS was 1.3% in China during radial artery intervention, which needed to be dealt with emergently.[10,11] There are extremely rare cases in which no reasons have been found for OCS after extensive medical investigations, e.g., a young 31-year-old lady who developed forearm OCS after a 1-night oppression.[3] The guidelines for clinical diagnosis classify it as a clinical entity rather than separation into grades, which highlights the current limitations in diagnosing and treating OCS.

2.1.2. TCM etiology

From the viewpoint of TCM, when a limb is affected after severe trauma, edema or hematoma occurs, which may lead to blocked blood circulation, limb pain, numbness, and even tissue infection and necrosis. According to the meridian dialectics, when the meridians and blood circulation are blocked, the main manifestations are pain, swelling, abnormal sensation, and so on. TCM usually stresses that “unblocked means no pain, and pain means blocked.” According to *The Yellow Emperor’s Classic of Internal Medicine · Plain Questions · Theory of Exercising Pain*: “The meridians circulates endlessly and circle around endlessly, and the cold air flows into the meridians later... if it is in the meridian, the Qi is blocked, so it will be painful”.[12]

2.2. Progress of clinical diagnosis

Diagnosis of OCS remains clinical mainly; the hallmarks have been the 6P symptoms: pain out of proportion, pallor, paraesthesia, paralysis, pulselessness, and pain with passive stretching of the muscles in the involved compartments. Pain out of proportion and pain with passive stretching of the fingers are usually considered the first and the most sensitive signs of OCS in a noncomatose patient, in contrast to pulselessness, which has been reported as a late or even end-stage sign.[13,14] Whether regional anesthesia can delay the diagnosis of OCS is still debated.[3] The diagnosis and treatment of OCS should be standardized even though there is no unified consensus currently. In China, OCS is divided into Grade 1, Grade 2, and Grade 3 according to skin tension and pain sensitivity. Grade 3 is the most serious sign with obvious tension blisters, but the pain is weaker than in Grade 2.[15]

2.3. Pathological diagnosis principle

2.3.1. Western medicine diagnosis principle for diagnosis

The best available evidence suggests a role of certain biomarkers and repetitive compartment pressure monitoring as the most reliable adjuncts to diagnosis. Myoglobinuria and serum troponin level may assist in diagnosing OCS. Some studies have shown that the

levels of serum tumor necrosis factor (TNF)-α and interleukin (IL)-6 significantly increased after injury, which is due to the fact that the ischemia and hypoxia of muscles and nerves in the osteofascial compartment promote the release of metabolites and inflammatory substances into the blood circulation. OCS results in serum TNF-α and IL-6 increasing, which further aggravates the local exudative edema and inflammatory reaction. Therefore, the changes of serum TNF-α and IL-6 and other cytokines are often regarded as important parameters to evaluate the OCS patient's condition and have good predictive value for the OCS grade.[16] Serum creatine kinase (CK) is associated with poor outcomes in OCS patients. Serum CK level >300 U/L is a sensitive predictor, and CK level >10,000 U/L is a specific predictor of poor outcomes in OCS patients.[17] Further research must establish an international consensus on the lower extremity of OCS diagnosis. The biggest challenge for OCS diagnosis is how to convince doctors regarding the effectiveness of nonsurgical treatment and the avoidance of fasciotomy as the treatment standard.[18] As reported earlier,[18] nonsurgical interventions facilitate an improvement in muscle contractile function following pathological conditions of OCS. This approach will be seen as impractical by some people, as it challenges the present view that compartment decompression should be performed in all cases.[7]

2.3.2. TCM diagnosis principle

The core principle of TCM is syndrome differentiation considering the basic treatment principle of surgical diseases. It is necessary to distinguish *Yin* and *Yang*, deficiency and excess, exterior and interior, cold and heat. The development of surgical diseases can be divided into 4 stages: initial stage, purulent stage, ulceration stage, and muscle growth stage. Drugs are also used according to different stages and different causes. At the same time, we should pay attention to emotional comfort and reasonable diet. The differentiation of *Yin* and *Yang* syndrome in TCM focuses on clinical symptoms and the whole body, distinguishing the true and false *Yin* and *Yang* symptoms, as well as the growth and decline and transformation of *Yin* and *Yang* syndromes.[19] The most often used TCM herbal medicines for treating OCS are listed in Table 1.

3. Western medical treatments

3.1. Pressure measurement

ICP monitoring is important to avoid a delay in diagnosis. An emergency decompressive fasciotomy is needed if the ICP is >30 mmHg, indicating OCS occurrence, which is used as a threshold to aid in diagnosis.[5]

Physical appearance of Chinese herbal medicine	Name of Chinese herbal medicine	Pharmacological effects of Chinese herbal medicine
	*Angelica sinensis*	Anti-inflammatory effect: *Angelica* decoction has a significant inhibitory effect on acute and chronic inflammation caused by many inflammatory agents
	*Carthamus tinctorius*	Activating blood circulation and removing blood stasis: The yellow pigment in *Carthamus tinctorius* can significantly inhibit rabbit platelet aggregation induced by ADP and has a pronounced, apparent deaggregation effect on aggregated platelets. It can dissolve microthrombus. Pharmacological experiments also showed that it had a significant inhibitory effect on experimental thrombus in rats, with an inhibition rate of 73.4%.
	Licorice	Detoxification effect: Experiments show that licorice and its various preparations have a specific detoxification effect on poisoning due to other drugs and body metabolite poisoning, which can alleviate poisoning symptoms and reduce the mortality of poisoned animals. The main effective ingredient of licorice detoxification is glycyrrhizin.

(*Continued*)

Table 1. Continued

Physical appearance of Chinese herbal medicine	Name of Chinese herbal medicine	Pharmacological effects of Chinese herbal medicine
	Peach kernel	Anticoagulant effect: Peach kernel decoction can significantly prolong the clotting time in mice, prolong the bleeding time and clotting time in rabbits, and inhibit the retraction of blood clots.
	*Ligusticum chuanxiong*	Anti-ischemia-reperfusion injury effect: 4 mmol/L ligustrazine has a concentration-dependent protective effect on hypoxia–reoxygenation of ventricular myocytes. It can inhibit the contracture of injured cells, improve the survival rate of damaged cells, and inhibit the decrease of the Na^+ concentration ratio in the myocardium. Ligustrazine protects the myocardium by maintaining the integrity of biofilm and myocardial fiber structure and reducing mitochondrial damage.
	Radix Paeoniae Rubra	Anti-inflammatory and antiallergic effect: This effect is seen because Radix Paeoniae Rubra combined with licorice has a strong synergistic effect.
	*Polyporus umbellatus*	The effect of promoting immunity and protecting the liver: It can increase the number of decreased peritoneal macrophages in mice induced by CCl_4, has no inhibitory effect on lipid peroxidation in mice, has preventive impact on toxic hepatitis in mice, and can significantly promote the production of antibodies against hepatitis-B surface antigen (anti-HBs) in guinea pigs, bears, and monkeys.
	*Poria cocos*	Bacteriostatic effect: *Poria cocos* decoction has an inhibitory effect on *Staphylococcus aureus*, *Mycobacterium tuberculosis,* and *Proteus* spp.
	White *Atractylodes* rhizome	Anti-inflammatory and antibacterial effect: *Atractylodes macrocephala* has an inhibitory effect on flocculent epidermis, starkella, and meningococci.

Note: All the pictures are cited from the *Baidu* website. All the TCM herbs listed in this table are commonly used in OCS adjunctive therapy, and they are effective when applied with both internally and externally.
ADP, adenosine diphosphate; OCS, Osteofascial Compartment Syndrome; TCM, Traditional Chinese medicine.

Table 1. Main medicinal herbs of TCM in the literature.

In 1976, Mubarak found that high ICP sustained for 6–8 h results in irreversible soft tissue damage. Since then, Torlincasi et al.[1] advocate that the ideal time frame for fasciotomy is within 6 h, and fasciotomy is not recommended after 36 h following injury. Fasciotomy is performed to avoid complications, such as amputation and gangrene, but it may lead to overtreatment. What is worse, pressure-based thresholds for diagnosing OCS may not achieve success always.[8] However, the treatment for OCS is focused on early decompression and is not unlimited conservative treatment.[11] Cepková et al.[3] insist that ICP >30 mmHg is prone to OCS. Many authors currently agree that ICP should be compared with systemic diastolic pressures (ΔP) even if the threshold of ΔP (differential pressure = diastolic blood pressure – compartment pressure) is quoted to be between 30 mmHg and 45 mmHg according to different authors.[3] Regular monitoring of tissue compartmental pressures – and hence emergency intervention – has been shown to prevent morbidity and permanent disability.[20] Beniwal and Bansal[20] have proved that not a single case remained undiagnosed on taking the value of ΔP >40 mmHg as the criterion for diagnosing OCS. The most common complication of OCS after incision and decompression is high infection rate, and it has the disadvantages of large incision, more blood oozing, and long exposure time, needing a 2-stage operation to eliminate the wound.[21] Although the importance of accurate and timely OCS diagnosis is universally agreed, the method and indications for pressure measurement remain unclear and inconsistent.[6]

3.2. Fasciotomy surgical treatment

OCS is a progressive acute illness that can lead to a total or partial loss of limb sensorimotor functions (or even severe organ failure) if it is not diagnosed and treated in time. Therefore, it is critical to diagnose and treat OCS progress at its earliest stage.[10,11] Fasciotomy through multiple small skin incisions, which can be useful to release pressure with fewer complications, is a simple and effective strategy for the treatment of early OCS in children.[11] Vaseline gauze covers postoperative wounds, requiring long-term and frequent dressing, increasing the infection rate, and it is not conducive to wound drainage and granulation tissue culture, resulting in a long period of hospitalization and poor outcomes. Timely incision and decompression have a high limb salvage rate, and these interventions can effectively treat fracture, improve rehabilitation, reduce infection and skin grafting, and shorten hospital stay, thus increasing the cost[22]; the procedures can cause secondary suture, skin scar, sensory disturbance, and skin ulcer.[10]

3.3. Limitations and challenges in Western medicine

The fatality rate of OCS can be as high as 47% abroad. For awake, oriented, and cooperative patients, OCS diagnosis is based on clinical symptoms, including swelling, tautness, irrationality, altered sensation, and continuous and severe pain due to passive stretching, but they may not be adequately assessed in unconscious patients.[23] OCS diagnosis with the “6P” signs is not applicable in the clinic, because it represents the late stage of OCS, and fasciotomy treatment is often not ideal.[24] The accuracy and reliability of these clinical symptoms have been shown to be poor.[6] The natural presentation of pulselessness does not occur until ICP has surpassed arterial pressure, so pulselessness is a poor indicator of tissue perfusion.[1,2] Fasciotomy has some disadvantages, such as high cost, secondary infection, and the need for repeat skin grafting. TCM just makes up for these shortcomings of fasciotomy.

4. Outcomes of TCM treatment

4.1. External outcomes

TCM nursing should carry out dialectical nursing interventions besides Western medicine, attaching much attention to patients’ clinical symptoms, adopting acupuncture and moxibustion to relieve pain and detumescence.[25] At present, integrated TCM and Western medicine has become an important feature in Chinese medical nursing, which has achieved effective outcomes (Table 2). Combining mirabilite with borax and borneol powder can reduce swelling, improve local blood circulation, facilitate edema regression, and have a significant effect on contusion and sprain. Meanwhile, 40% boron powder has more advantages than 10% powder.[25,26] In TCM external therapy, the *Xiao Zhong Zhi Tong plaster* could help save time for subsequent surgical treatment and facilitate a faster recovery[27] as well as *Shujin Huoxue washing prescription* or *Baxian Xiaoyao powder.*[25] In areas with severe local swelling, *Poria cocos* and *Coix lacryma* seeds are used to soak and urinate, together with yellow rice wine to soak and scrub, so as to stop bleeding without stasis and reduce swelling.[28] *Longzhong Xiaozhong Zhitong mixture* is a preparation of the Gansu Traditional Chinese Medicine Hospital, which has the functions of promoting blood circulation, removing blood stasis, promoting diuresis, relieving swelling, promoting *Qi,* and relieving pain; it has a significant effect on limbs in the early stage of trauma; it can effectively improve tissue oxygen supply and reduce intrafascial pressure.[29] These clinical trials

Study	Research methods	Components of TCM	Research object	TCM method	Research results
Xu Yaqun[25]	A case–control trial, comparing the total effective rate of clinical outcomes	*Saposhnikovia divaricata* 3 g, *Schizonepeta tenuifolia* 3 g, *Rhizoma chuanxiong* 3 g, licorice 3 g, *Angelica* 6 g, *Atractylodes macrocephala* 10 g, Cortex Moutan 10 g, *Sophora flavescens* 15 g, Cortex Phellodendri 6 g.	Patients undergoing fasciotomy of the lower leg	External	Observation group: 84.21%; control group: 77.78%
Wang Qunxiang et al.[26]	A case–control trial, comparing the pain scores and swelling values	Mirabilite group 40%: borax 400 g, borneol powder 100 g, Lanum 50 g, and moderate amount of vaseline.	Surgical treatment of leg fracture	External	40% mang boron powder has advantages
Zhou et al.[27]	Case report	*Phellodendron, Radix notoginseng, Rheum rhabarbarum, Gardenia jasminoides, Sanguisorba officinalis,* and *Paeonia suffruticosa* (Andr.) and 12 Chinese herbs.	Forearm compartment syndrome	External	Saved the time for decompressive fasciotomy and improved the overall prognosis of the patient
Guofeng[28], Liang Songming[30]	Review and book	Pericarpium Citri Reticulatae Viride, dried tangerine or orange peel, agalloch eaglewood, *Cyperus rotundus*, *Rosa banksiae*, *Carthamus tinctorius*, *Angelica* tail, peach kernel, frankincense, ground beetle etc.	OCS patients	External	Promoting *Qi* to relieve pain, promoting blood circulation, and removing blood stasis
Dongchun[29]	RCT, which compared pain relief and swelling regression	Longzhong Xiaozhong Zhitong Mixture: Radix Paeoniae Rubra, the dried rhizome of *Rehmannia*, Herba Lycopi, pseudo-ginseng, *Rosa banksiae*, Pericarpium Citri Reticulatae Viride, peach kernel, *Ligusticum chuanxiong*, leech	Grade 1 and 2 patients with calf OCS	Oral	The difference was statistically significant ($P < 0.05$)
Meiling[31]	Observational study	Earlier stage: *Angelica* 12 g, Radix Paeoniae Rubra 12 g, *Dipsacus* 12 g, *Clematis* 12 g, raw coix seed 30 g, mulberry parasite 30 g, *Rhizoma drynariae* 12 g, *Acanthopanax senticosus* 12 g. Later stage (>7 weeks): *Paulownia* bark 6 g, penetrating bone grass 6 g, frankincense 6 g, myrrh 6 g, *Angelica* 5 g, Pericarpium *Zanthoxyli* 10 g, *Rhizoma chuanxiong* 3 g, *Carthamus tinctorius* 3 g, *Clematis* 3 g, licorice 3 g, *Saposhnikovia divaricata* 3 g, *Angelica dahurica* 3 g.	Patients with tibiofibular fracture	Used internally and externally	The healing time is 8–11 weeks, and the fracture healing time is shortened.
Hongtian[32]	RCT, compared transit operation cases, cure time, and symptom improvement time	*Atractylodes macrocephala*, *Poria cocos*, *Alisma*, *Polyporus umbellatus, Carthamus tinctorius*, Radix Paeoniae Rubra, myrrh, *Rhizome chuanxiong*, Pericarpium Arecae, *Rosa banksiae*, each 10 g. *Salvia miltiorrhiza*, plantain seed, each 15 g; grilled licorice 6 g.	Patients with early OCS	Oral	The difference was statistically significant ($P < 0.05$)
Zhu Zhixiong[33]	RCT, compared the time of swelling subsiding, pain relief, peripheral artery from weak to strong.	*Angelica sinensis* 25 g, *Carthamus tinctorius* 10 g, *Trionyx sinensis* 15 g, natural copper 15 g, *Rhizoma cibotii* 15 g, *Rhizoma drynariae* 25 g, myrrh 10 g, frankincense 10 g, Lutong 10 g, peach kernel 5 g, *Panax Notoginseng* powder 6 g, *Rhizoma corydalis* 9 g.	Patients with OCS	Oral	The result in the observation group was better than in the control group.
Yu Xiaoyun and Li[34]	RCT, compared CK and SOD level	Peach kernel 10 g, *Carthamus tinctorius* 6 g, *Rhizoma chuanxiong* 10 g, Radix Paeoniae Rubra, frankincense, myrrh, *Trionyx sinensis*, *Clematis chinensis*, *Stephania tetrandra*, *Pheretima* 10 g each, *Salvia miltiorrhiza* 30 g, Radix Rehmanniae Praeparata 15 g, Radix Paeoniae Alba 10 g, *Angelica sinensis* 15g, Radix Astragali 20 g, *Atractylodes macrocephala, Polyporus umbellatus*, *Poria cocos*, *Alisma* 12 g each.	Patients with OCS	Oral	The difference was statistically significant ($P < 0.05$)
Chou Jianwei et al.[35]	RCT, compared the time for swelling to subside and pain to relieve	*Carthamus tinctorius*, *Angelica*, peach kernel, *Ligusticum chuanxiong*, *Polyporus*, *Poria* 15 g each, *Alisma*, *Rhizoma corydalis*, myrrh, frankincense 10 g each, roasted licorice 6 g.	Patients with OCS	Oral	The difference was statistically significant ($P < 0.05$)

(*Continued*)

Table 2. Continued

Study	Research methods	Components of TCM	Research object	TCM method	Research results
Ying[36]	RCT, compared the effective rate	Peach kernel 9 g, *Angelica sinensis* 9 g, *Ligusticum chuanxiong* 6 g, *Trogopterus* dung 6 g, *Gentiana macrophylla* 3 g, *Cyperus rotundus* 3 g, *Notopterygium* root 3 g, *Achyranthes bidentata* 9 g, *Carthamus tinctorius* 9 g, myrrh 6 g, *Pheretima* 6 g, licorice 6 g.	Patients treated with VSD after OCS	Oral	Routine group: 80%; conventional + TCM group: 88%; routine + hyperbaric oxygen group: 88%; routine + TCM + hyperbaric oxygen treatment group: 92%.
Pang Zhihao et al.[37]	RCT, compared CK, LDH, AST indicators	Qingredu granules (YYZZ Z20070916): honeysuckle, Chinese violet, dandelion, buffalo horn, wild chrysanthemum, Folium Isatidis, Radix Rehmanniae, Radix Scrophularia, Cortex Moutan.	Patients with OCS	Oral	Observation group: CK, LDH, AST indicators decline.
Wang Kaijun[38]	RCT, compared swelling subsiding and wound healing time	*Angelica sinensis* 15 g, *Scutellaria Baicalensis* Georgi 15 g, *Carthamus tinctorius* 12 g, *Cassia* twig 12 g, peach kernel 10 g, pollen 12 g, licorice 8 g, mulberry branch 12 g, soft-shelled turtle 15 g.	Patients with OCS	Oral	Outcome in observation group was better than in control group, and serum CK/LDH level decreased.
Wei Bing[39]	RCT, compared wound healing effective rate.	Peach kernel 12 g, *Carthamus tinctorius* 15 g, Radix Rehmanniae Praeparata, *Angelica*, *Ligusticum chuanxiong*, Radix Paeoniae Rubra 12 g each, Radix Astragali 30 g, *Coix* kernel 20 g, *Atractylodes macrocephala* 12 g, *Polyporus umbellatus*15 g, *Alisma* 12 g, honeysuckle 15 g, dandelion 15 g, grilled licorice 6 g.	Patients with OCS	Oral	The observation group wound healing was better than that in control group.
Li Jianfei[40]	RCT, compared fasciotomy and rate of adverse events.	*Poria cocos* 12 g, *Stephania tetrandra* 10 g, motherwort 18 g, cinnamon 12 g, *Atractylodes macrocephala* 15 g, *Astragalus* 30 g, *Salvia miltiorrhiza* 15 g, Herba Lycopi 12 g, licorice 6 g, *Achyranthes bidentata* 15 g, *Panax notoginseng* 15 g, *Sangusis draconis* 2 g.	Patients with OCS	Oral	The difference was statistically significant ($P < 0.05$)
Shi Meng and Yu[41]	RCT, compared total effective rate	Ligusticum *chuanxiong*, *Angelica Sinensis*, Carthamus *tinctorius*, Radix Paeonia Rubra, peach kernel, leech, Pericarpium Citri Reticulatae Viride, *Gardenia* 15 g each, Herba Lycopi, Radix Rehmanniae, *Rosa banksiae* 12 g each, licorice 6 g.	Patients with OCS	Oral	Observation group: 85%; control group: 65%

Note: AST, serum glutamate oxaloacetate transaminase (aspartate aminotransferase); CK, creatine kinase; LDH, lactate dehydrogenase; OCS, osteofascial compartment syndrome; RCT, randomized controlled trial; SOD, superoxide dismutase; TCM, traditional Chinese medicine; VSD, vacuum negative pressure suction surgery.

Table 2. Usage of TCM in the literature.

report the external use of TCM and achievement of the reduction and prevention of OCS clinical symptoms.

4.2. Outcomes of oral medication

TCM oral decoction has significant clinical value.[42] *Atractylodes macrocephala*, *Poria cocos*, *Rhizoma Alismatis*, *Polyporus umbellatus*, plantain herb have the effects of diuresis, promoting the reabsorption and metabolism of exudates. *Salvia miltiorrhiza*, myrrh, *Ligusticum chuanxiong,* and *Rosa banksiae* can activate blood circulation and remove blood stasis, regulate the repair and regeneration of tissues and blood vessels, and reduce inflammatory exudation.[32–34] Similar to *Shentong Zhuyu* decoction, it comes from *Yilin* and it is a famous prescription for arthralgia treated by Wang Qingren, a famous medical scientist in the Qing Dynasty. It can improve local blood circulation, and modern pharmacological studies have also confirmed that the extracts of *peach kernel*, *Ligusticum chuanxiong,* and *Angelica* can reduce vascular resistance, improve microcirculation, inhibit platelet aggregation, and prevent thrombosis. *Achyranthes bidentata*, *Cyperus,* and licorice can resist inflammation and relieve pain.[43,36] TCM prescription *Huoxue Quyu* decoction reconstructs the circulation and prescription *Powder of Five Drugs with Poria* promotes detumescence and is anti-inflammatory.[33] Self-made *Sanyu Lishui* decoction made in water, when taken in 300 mL portions 2 times a day, has a significant adjunctive effect on OCS.[35] *Qingredu granule* (Z20070916) is

a proprietary Chinese medicine developed by modern technology in the Foshan Hospital of Traditional Chinese Medicine according to Professor Chen Weiliang's experience in treating heat-toxic fire in the early stage of trauma. It has the characteristics of high curative effect, few adverse effects, and convenient use.[37] Self-made *Gushing Fuyuan* decoction combined with VSD can significantly promote the OCS patient's recovery after tibiofibular fracture.[38] The mechanism may be related to the reduction of serum CK and LDH, inhibition of the production of oxygen free radicals, and protection of skeletal muscle cells.[38] Modified *Taohong Siwei* decoction combined with negative pressure closure drainage technique is effective in treating limb OCS, which is better than negative pressure closure drainage alone.[39] Oral TCM decoction is mainly used to promote water, reduce swelling, relieve pain, and replenish *Qi*, which is conducive to improving the relevant symptoms of OCS patients.[40] The *Huoxue Xiaozhong recipe* treatment needs 2 courses.[41] We summarize the above TCM formulations and give examples of several mostly used herbal products and their pharmacological effects in Table 1.

4.3. Acupuncture and moxibustion outcomes

Pain is the earliest symptom of OCS. Patients with severe postoperative incision pain can be punctured at ZusanliST36, NeitingS44, HeguLI4, and other acupoints, and sedative painkillers can also be used.[44] Acupuncture at WeiyangBL39, YinlingquanSP09, ZusanliST36, QuchiLI11, HeguLI4, and SanyinjiaoSP6 can manage detumescence, infiltration, and dampness.[25] ZusanliST36 acupoint is the combination of *stomach meridians of foot Yangming;* stimulating ZusanliST36 has the effects of rationing *Qi* and activating blood, strengthening the body, invigorating meridians, and activating collaterals.[45] Acupuncture at NeitingS44 acupoint has the effect of relieving heat and relieving viscera, calming nerves, and relieving pain.[46] It is the original acupoint of *the large intestine meridian of hand Yangming*. SanyinjiaoSP6 is the intersection of the liver, spleen, and kidney pulse,[47] WeiyangBL39 can recuperate *Qi* and blood,[48] and YanglingquanGB34 can treat muscle paralysis.[49]

On taking nursing observations for 30 min, if the temperature of the limb increases, the skin tension decreases, the pulse strength recovers, and the tissue pressure is <3.5 kPa, acupuncture is effective.[50] The wrist–ankle acupuncture is used for analgesia; more than half of patients have satisfactory analgesic effect.[51] TCM cupping therapy in early OCS prevention has positive effects; the main contents of observation are as follows: blood circulation, sensation, skin color, temperature, scald or burn, skin collapse, swelling, pain, tightness of glass cupping, the color of drainage, fluid volume, progressive fresh bleeding, and clot.[52] After extensive acupuncture on sterile and intact skin, the blood, toxin, and histamine between tissues and fascia can seep out, thus reducing the pressure between fascia.[53] The "needling method" effectively prevented the occurrence of heel OCS. There is no theory of "needling" in ancient literature; because of its diuretic, detumescent, and analgesic effects, it has gradually attracted attention in recent years.[54]

5. Discussion

Although the OCS incidence rate is low, due to its high disability rate, prevention and care are particularly important. Nontraumatic cases are rare but also associated with diabetes, hemophilia, disseminated intravascular coagulation, arteritis, atypical localized infections, Deep Vein Thrombosis (DVT), thrombolysis, and anticoagulation.[9] The gold standards for OCS treatment are early diagnosis and emergent surgical fasciotomy decompression within 8 h. In 66 cases of OCS, Sheridan and Matsen reported recovery of normal function in 68% when the fasciotomy was performed within 12 h, falling to just 8% when performed after 12 h.[7] Not every hospital has the technical equipment to measure ICP; overtreatment based on ICP measurements alone still exists in some hospitals or medical institutions; Fasciotomy is associated with morbidities such as infection, nerve injury, sensory loss, delayed wound closure, and high costs.[4]

Improved understanding of the pathophysiology of OCS and the diagnosis of OCS may soon lead to new methods of diagnosis and possible ways to prevent or treat OCS without the morbidity of fasciotomy.[55] TCM plays an important and vital role in detumescence and anti-inflammatory mode of treatment, TCM has recently become a widely used treatment option for treating OCS.[9] TCM auxiliary nursing has significant effect and low cost, which has improved patient satisfaction and achieved greater social benefits.[31] The detumescence effect of TCM herbs is significantly better than that of mannitol in clinical application, and the clinical symptom improvement time and cure time of OCS are significantly reduced.[32,35,40] Moreover, TCM is superior to low-molecular-weight heparin calcium in the prevention of lower limb DVT,[43] and TCM treatment has less adverse events.[40]

6. Summary and perspective

Given that the pharmacology and operation of TCM have been very successful in ancient China, the conservative treatment of TCM helps patients in terms of promoting blood circulation and detumescence, solidifying

the foundation, and promoting body fluid. Although its efficacy is not as rapid as Western medicine, the focus of the TCM treatment is to remove the disease thoroughly and recuperate the body function. The disability rate of OCS is high. The intervention measures of integrated TCM and Western medicine have significantly improved the limb salvage rate of patients, promoted the rehabilitation process of patients, and improved the satisfaction of patients.

TCM originated in China with a long history. The remarkable curative effect of Chinese herbal medicine has attracted increasing attention from the academic community. This will greatly promote the inheritance and development of TCM. TCM treatment and nursing are not only conducive to the maintenance of human health but also alleviate the health crisis caused by Western medicine, such as the abuse of Western medicine antibiotics. So, the future direction of TCM in the context of treating OCS is to integrate these modalities together, aiming to promote patients' security and rehabilitation.

Contributions to science

At present, surgeons have accepted fasciotomy to treat the high-pressure state of the limb chamber, but this operation has many unsatisfactory therapeutic effects, such as secondary skin grafting. TCM can assist in the treatment of the high-pressure state of the limb chamber, and it also plays a very important role in the detumescence of tissue and other local structures. This paper summarizes the disadvantages of surgical treatment of the osteofascial compartment and summarizes the specific methods and measures of TCM treatment.

Author contributions

Li designed this study. Su and Han conducted the literature search and data extraction. Wang and Han performed quality assessment of the included studies. Su wrote this manuscript and Li edited this review. All authors have read and approved this final manuscript.

Ethical approval

Ethical issues are not involved in this paper.

Conflicts of interest

All contributing authors declare no conflicts of interest.

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