Functional reconstruction of ischemic contracture in the lower limb

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【Abstract】Objective: To discuss the method of functional reconstruction of ischemic contracture in the lower limb and propose a classification protocol for ischemic contracture in the lower limb based on its severity and prognosis.

Methods: A total of 42 patients with ischemic contracture in the lower limb were included in this study. According to different types of disturbance and degrees of severity, surgical reconstructions consisting of nerve decompression, tendon lengthening or transfer, intrinsic foot muscle release and sural-tibial nerve anastomosis were performed in every patient.

Results: Postoperatively, all patients were able to walk on flat ground. Drop foot was corrected in 10 patients, and 5 patients still felt some difficulty during stair activity. Split Achilles tendon transfer to flexor hallucis longus tendon was performed in 12 patients, and their walking stability was improved. Seven patients accepted ipsilateral sural-tibial nerve anastomosis, and sensitivity recovery reached to S2 in 2 patients and S3 in 5 patients.

Conclusions: Ischemic contracture in the lower limb is a devastating complication after lower limb trauma. The prevention of contracture is much more important than the treatment of an established contracture. Split Achilles tendon transfer to flexor hallucis longus tendon and sural-tibial nerve anastomosis, which was initially implemented by us, could improve the functional recovery of ischemic contracture in lower limbs, and thus provides a new alternative for functional reconstruction of ischemic contracture in the lower limb.

Key words: Ischemic contracture; Classification; Recovery of function

In 1881, Volkmann firstly reported ischemic contracture featured in myodegeneration, necrosis, cicatrization, contracture, and consequently functional impairment at the hand and forearm resulting from insufficient blood supply as a result of over-tight bandaging after fractures of the elbow. Thomas summarized 109 cases of ischemic contracture and found that those with grave bruise sustained ischemic contracture under the condition of neither use of bandage nor splintage. The author accordingly perceived that exogenic blood vessel compression is not the only reason triggering ischemic contracture. It is currently deemed that there are high swelling and pressure in the soft tissues of the interfascial spaces after limb trauma, which will directly lead to progressive ischemic necrosis of muscles and corresponding nerve cords. At the advanced stage, the necrotic muscles is substituted by fibrous tissues and thereupon ischemic contracture emerges.²

Most interfascial space symptom can be diagnosed and treated at early stage owing to gradually increased recognition on its pathophysiological mechanism. As a result, the incidence of ischemic contracture has been obviously diminished. However ischemic contracture that greatly impairs limb function can be seen clinically every year both domestically and internationally. The treatment of ischemic contracture is complex. Various functional reconstruction methods including nerve decompression, tendon lengthening or transfer have been reported in the literature, but most of them target at upper limb’s ischemic contracture and those concerning lower limbs are few. We report here our experience in surgical treatment and functional reconstruction in 42 cases of ischemic contracture in lower limbs during the period of 1977 to 2007 and present a modified proposal on clinical classification and surgical procedures.
METHODS

General data
There were 42 patients in this series including 28 males and 14 females ranging in age from 12 to 55 years and averaging 32.5 years. The causes of injury were fractures around the knee joint and lower leg in 27 cases, knee joint replacement in 2 cases, replantation after mutilation of the lower limbs in 3 cases, arterial injury in 7 cases, and soft tissue injury in 3 cases. Surgical treatment and functional reconstruction were performed from 3 months to 8 years after injury.

Surgical procedures
An S-shaped incision was made from the upper ankle to the popliteal fossa to cut down the musculus triceps surae and partially resect necrotic and cicatricial deep layer muscles, decompress the tibial nerve and incompletely necrotic muscular branches dominated by the nerve, and then prolong Achilles tendon and flexor hallucis longus tendon. If the flexor hallucis longus tendon was completely necrosed, Achilles tendon strip was incided to anastomose the distal end of the flexor hallucis longus tendon. If sensory loss (S0) at footplate area was noticed by preoperative examination and a large segment of tibial nerve necrosis was confirmed during operation, the sural nerve was cut off at the posteroinferior aspect of the external malleolus and transferred via anterior aspect of Achilles tendon to anastomose the tibial nerve for reconstruction of footplate sensation. For those combined by grave intrinsic contracture and toe deformity, it is appropriate to perform interosseus dissection, lateral fixing chorda extension, and metatarsophalangeal/interphalangeal articular capsule and collateral ligament release.

RESULTS

Postoperative follow-up showed that all patients enable to walk on flat ground without difficulty postoperatively. Footdrop was mitigated in 10 cases. Five cases felt difficulty in going up or down stairs and walking on slope roads. The symptom of ground-grasping weakness for the great toe was vanished and walking stability meliorated in 12 cases treated by crossing graft of Achilles tendon to flexor hallucis longus. Among 7 patients treated by anastomosis of the sural nerve of affected limbs with the tibial nerve, the sensation scale was assessed as S2 in 2 patients and S3 in 5 patients. Such refractory problems including no sensation on hard object as walking and unhealed sores following stab or burn wound have been well tackled. Typical case is shown in Figure 1.

DISCUSSION

Mild or moderate ischemic contracture in the lower limb is easy to be misdiagnosed as common peroneal nerve injury. Both of them may have the signs of footdrop and sensory loss, but the sensory loss for common peroneal nerve injury generally appears at lateral dorsum pedis combined by limited active dorsal extension. Ischemic contracture in the lower limb often associates with sensory loss at footplate; both active and passive activities of ankle joint are limited. The therapeutic outcome for severe ischemic contracture in the lower limb is generally dissatisfactory; hence prevention is more significant than treatment. Based on the case analysis in our series, the time for tourniquet wrapping should not be too long. Prophylactic open decompression of deep fascia of the leg should be performed for patients with limb mutilation and undergoing operation for arterial injury. For those with grave swelling of the leg, internal fixation should be performed as early as possible if condition is permitted. For those in whom emergency operation cannot be conducted, great attention should be paid to the tension of plaster immobilization and bandage, as well as the blood circulation of the limbs. Rapid, thorough, sufficient cut-open and

Figure 1. A female, 20 years old, underwent gastrocnemius muscle release and crossing lengthening of the Achilles tendon in the left leg because of ischemic contracture for 12 months caused by interfascial space symptom after operation of left tibial plateau fracture. A: Before operation; B: After operation.
decompression are mandatory to return blood supply of the interfascial space. For interfascial space symptom of the leg, two incisions from medial and lateral approaches are necessary to decompress four interfascial space of the leg. For interfascial space of the foot, two dorsal incisions and one medial incision on the footplate are required for decompression of several interfascial spaces.\(^{3,4}\)

In accordance with Tsuge’s\(^5\) classification on ischemic contracture of the forearm, we divided ischemic contracture in the lower limbs into three types. In type I, the extent of the damage is relatively localized, and only deep flexor is involved; the dorsal extension of the foot is below 15 degrees; there is normal flexation function for the knee joint and digital sensation is assessed as S2. Achilles tendon lengthening is favored to secure a sound prognosis. In type II, all the flexors of the leg are involved; the dorsal extension of the foot is limited to 15-30 degrees and fails to reach functional position as knee joint keeps a flexed position; there is footdrop and evidently restricted activity; toe sensation on the footplate exists without evident intrinsic muscle symptoms; there is grade II muscle strength for the gastrocnemius muscle and grade 0 for deep layer muscles. The treatment regimens include decompression of the muscles and tibial nerve, crossing extension of tendons and interosseus peeling. Its prognosis is not promising. In type III, all flexors and partial extensors are involved and there is sensation loss in footplate. In addition to above-mentioned protocols, such treatment measures as graft of the sural nerve to the tibial nerve can effectively recover suppedaneous sensation, surgical anastomosis of the sural nerve with the tibial nerve can effectively recover suppedaneous sensation, and ankle orthosis are optional. Temporary internal fixation is needed after ankle orthosis.

Deformities incurred by ischemic contracture in lower limbs mainly consist of equinus, equinovarus, cavus, claw toe or hammer toe, and footdrop. Severe contracture may simultaneously induce above-mentioned various deformities, but equinovarus concurrent claw toe is rarely seen. The etiology of these deformities is complex and may be implicated by the number of affected muscles of the leg, the injury degree of the intrinsic muscles of the foot, as well as concurrent nerve injury.\(^{5,8}\)

Tenolysis, resection of fibrotic contracted zone, tendon lengthening and transposition are most commonly used methods for reconstruction of foot deformity, Kikuchi\(^9\) used the transposition of the flexor pollicis longus muscle tendon to treat footdrop. Owen et al\(^10\) used disconnection and transposition of the anterior tibial muscle tendons to treat equinus. Flexor hallucis longus takes an important part in maintaining normal gait, which, together with gastrocnemius muscle and soleus muscle, is responsible for foot-raising and walking.\(^11\) We found that patients involved in the muscles at posterior crural region and treated by only resection of contracted zone or lengthening of Achilles tendon and posterior tibial muscle tendon, often feel weakness as leg-raising to walk, unsteady gait and have a tendency to fall down. In this series, 12 patients who underwent crossing graft of Achilles tendon strip to reconstruct flexor hallucis longus achieved a good effect.

For patients sustaining ischemic contracture in lower limbs associated with nerve injuries, early exploration is preferred. Nerve decompression should be performed as early as possible if there is scar contracture and nerve compression. Nerve function would partly recover one year later if the nerve cord is not completely interrupted.\(^12\) Prompt decompression is conducive to pain relief and early recovery of sensation. It is suggested by some authors that autologous neural transplantation is preferred if exploration found nerve cord interruption.\(^5\) Seddon\(^13\), however, propose that the prognosis of autologous neural transplantation is poor for patients with neural functional disturbance caused by ischemia and necrosis of the tibial nerve. Therefore they do not advocate this treatment for patients with ischemic contracture. We deem that for tibial nerve breakage, surgical anastomosis of the sural nerve with the tibial nerve can effectively recover suppedaneous sensation, and avoid potential injury of stab wound or burns during walking.\(^5\)

Ischemic contracture is a grave complication following lower limb injuries. It will greatly impact patients’ function and quality of life. The prevention of ischemic contracture is much more important than treatment. Vigilance is needed to obviate it. Early diagnosis and surgical treatment, as well as early functional exercises after operation are essential to achieve a good result. The surgical procedures that we initially adopted consisting of the crossing transfer of Achilles tendon strip
to the Flexor hallucis longus and anastomosis of the sural nerve with the tibial nerve, can partly reconstruct and recover the neural function. It is an alternative of treatment for functional reconstruction of grave ischemic contracture in the leg.

REFERENCES


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