Original Article

Staged surgical management of sinus tarsi syndrome: our experience of 273 cases

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Background: The sinus tarsi syndrome (STS) is a common foot and ankle disease with controversial pathogenesis and treatment procedures. This long-term study aimed to analyze the effect of a staged surgical strategy for STS.

Methods: Clinical data were retrospectively analyzed in 273 STS patients [129 men and 144 women; mean age: 36 years (10–60 years)] treated between 2006 and 2016. The 89 patients underwent different surgeries, including sinus tarsal debridement, subtalar joint stabilization, sinus tarsal denervation, tarsal coalition resection, or subtalar arthrodesis. The patients' American Orthopedic Foot & Ankle Society (AOFAS) ankle-hindfoot scores, visual analogue scale (VAS) scores for pain during daily activities, and 36-item short-form health survey (SF-36) scores at the first visit and latest follow-up were assessed by paired *T*-test.

Results: The 89 patients who failed conservative treatments first underwent tarsal sinus soft tissue debridement, with 52 patients remaining in remission after 2 years. The other 37 patients with relapse underwent further surgeries. Five of the 19 patients with subtalar instability were cured following ligament reconstruction surgery. Two of the four patients with severe neurological signs recovered after nerve release surgery. Five of the 10 patients with tarsal coalition were cured by resection of the talocalcaneal bridge. A total of 21 patients failed their second operations due to peroneal spasm, and were eventually successfully treated by subtalar arthrodesis. In addition, subtalar arthrodesis was directly performed in the remaining four patients with peroneal spastic flatfoot. After the final operations, all patients achieved satisfactory results. The AOFAS ankle-hindfoot scores increased from 34.83±12.21 preoperatively to 85.52±7.07 postoperatively (t=–24.62, P<0.01), the VAS scores decreased from 8.14±1.52 to 2.14±1.00 (t=24.65, P<0.01), and the SF-36 scores increased from 36.58±11.36 to 86.22±9.17 (t=–28.13, P<0.01).

Conclusions: In this study, we observed that 67% (184/273) of patients with STS need a staged surgical management. According to the etiology, symptoms, and severity, soft tissue surgery is the first choice. However, simple soft tissue surgeries may fail to achieve long-term results. Once the symptoms recur and become difficult to cure, the staged surgical strategy for STS we proposed can be the best choice to achieve long-term results.

Keywords: Sinus tarsi syndrome (STS); surgical treatment; subtalar arthrodesis; peroneal spasm; ankle sprain

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Introduction

Initially described in 1958 by Denis O'Connor, sinus tarsi syndrome (STS) is a nebulous condition characterized by pain in the lateral ankle and tarsal sinus (1). STS diagnosis is based on pain in the sinus tarsi region of the subtalar joint; however, its exact etiology remains poorly defined (2). Patients may present with minor instability of the subtalar joint, ligament tears, arthrofibrosis, unrecognized ganglion cysts, or degenerative joint changes. Brunner and Gächter suggested that the development of the sinus tarsi syndrome may quite often be due to an instability in the hindfoot (3). But they did not find that other more complicated reasons can also cause this disease. Improved techniques, such as Magnetic resonance imaging (MRI) and subtalar arthroscopy, may allow for more precise diagnosis (4).

Some STS patients experience symptoms of peroneal spasm, valgus hindfoot, and limited varus motion. Peroneal spasm, first described by Sir Robert Jones in 1905, was later found to be caused by intertarsal bars and anomalies restricting tarsal motion (5). Subtalar arthroscopic debridement is the treatment of choice for STS, and is sometimes combined with ankle stabilization (6). Based on our experience, it is quite difficult to treat patients with STS combined with peroneal spasm. Previous reports (3,7,8) have indicated that tarsal coalition resection, drug treatment, foot and ankle orthoses, and peroneal muscle release may have short-term effects; however, treatments for peroneal spasm should aim to not only treat the contracted peroneal muscle but also relieve the cause of the irritation (9).

Considering the complex etiology, STS can easily relapse after treatment. To date, no therapeutic protocol for STS has been proposed, and there are no published guidelines for selecting optimal treatments. Therefore, the present study aimed to design a protocol for selecting optimal treatments for the treatment of STS. To this end, we paid close attention to STS patients for more than a decade, and designed a suitable treatment algorithm. Different treatments were aimed at the corresponding causes and pathogeneses, and the patients were continuously followed up. Subsequent methods were implemented upon treatment failure, until the patients were completely cured. In this study, following the designed treatment process, all patients obtained good curative effects. We present the following article in accordance with the STROBE reporting checklist (available at https://dx.doi.org/10.21037/apm-21-1694).

Methods

Patient characteristics

Three hundred and ten patients with STS admitted to Ruijin Hospital Affiliated to Shanghai Jiaotong University School of Medicine from January 2006 to December 2016 were retrospectively analyzed, with 16 patients lost to follow-up. All patients suffered from hindfoot pain. The diagnostic criteria for STS (1,3-5,10-17) were as follows: (I) pain and swelling of the hindfoot and midfoot; (II) tenderness at the tarsal sinus; (III) limited varus movement of the hindfoot; (IV) increased pain during positive varus movement; (V) no obvious abnormality on X-ray films and Computed tomography (CT) scans; (VI) edema and soft tissue hyperplasia at the tarsal sinus on MRI images; and (VII) enhancement of the myoelectric activity of peroneal muscles indicated by electromyography (EMG) in some patients. Patients meeting at least five of the above criteria were eligible for inclusion in this study.

Twenty-one patients with trauma (and its complications) or other causes of systemic inflammation, skeletal muscle and/or soft tissue tumors, and connective tissue diseases were excluded. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). This study was approved by the Ethics Committee of Shanghai Ruijin Hospital [No. 75 (2013)], and signed informed consent was provided by all patients.

Finally, a total of 273 patients (129 males and 144 females) with an average age of 36 years (range, 10–60 years) were included in the analysis. The disease course ranged from 2 months to 10 years.

Propose treatment protocol for STS

We analyzed the treatment experience of early cases and summarized a set of treatment strategies. We then developed a set of treatment procedures based on the following principles: (I) simple and convenient treatments are chosen first. If they fail, more complex measures will be taken; (II) non-invasive or minimally invasive methods are given priority. If these treatments fail, more invasive treatments will be adopted; (III) symptomatic relief for the patient is addressed first. If symptoms recur, other surgical treatments will be carried out to eliminate the causes.

First, conservative treatments, including rest, protective

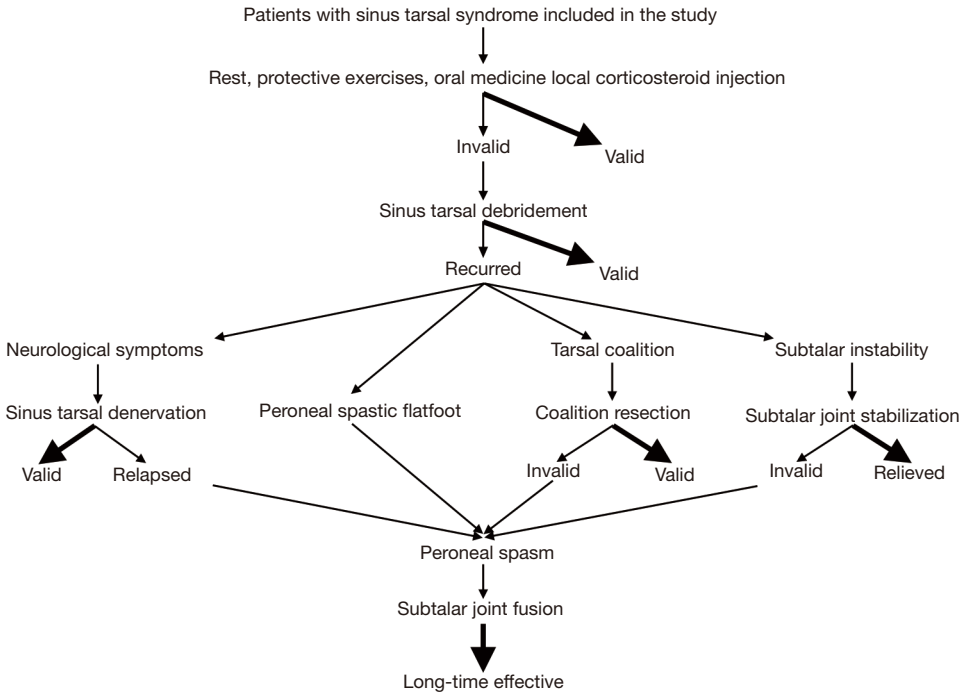

Figure 1 The designed protocol for treating sinus tarsal syndrome.

exercises, local corticosteroid injection (1 mL Diprospan and 1 mL lidocaine; once), and oral non-steroidal anti-inflammatory drugs (NSAIDs) (Celebrex; 0.2 g, once a day for 2 weeks) were implemented (15). As a result, 184 patients were cured by these conservative treatments. However, the symptoms were unrelieved or recurrent in the remaining 89 cases.

Initially, the surgical patients underwent sinus tarsal soft tissue debridement (3,8). If this procedure was unsuccessful, we needed to further determine the causes that were not previously identified. The patients then underwent further surgeries as follows. Subtalar ligament reconstruction was performed in patients with chronic subtalar instability (18). Selective nerve dissection was performed in patients with disorders of nociception and proprioception in the tarsal sinus region (10). For STS patients combined with peroneal spasm, subtalar joint fusion was performed (19). All patients were treated according to the designed protocol (*Figure 1*).

Outcome measures

The initial etiology, symptoms, signs, treatments received, and the efficacies of various treatments were retrospectively analyzed for all included patients. Subsequently, the visual analogue scale (VAS) pain scores were assessed at 3 months after conservative treatments. In addition, the American Orthopedic Foot & Ankle Society (AOFAS) ankle-hindfoot, VAS, and 36-item short form health survey (SF-36) scores were obtained to evaluate the degree of pain, functional activity, and alignment of the affected foot, respectively, both before treatment and at the final follow-up. At the same time, the patient's satisfaction and the time to return to work were also evaluated. The scores were evaluated by the first, third, and fourth authors, who were at least senior resident doctors. These physicians had received unified training and had rich experience in professional scoring.

Statistical analysis

The obtained data were analyzed by paired *t*-test with the SPSS 19.0 software (SPSS Inc., Chicago, IL, USA) to assess differences between pre- and post-treatment values.

Results

Preoperative symptoms and signs in patients

At the time of onset, the clinical symptoms of the patients were similar, manifesting as pain in the midfoot and

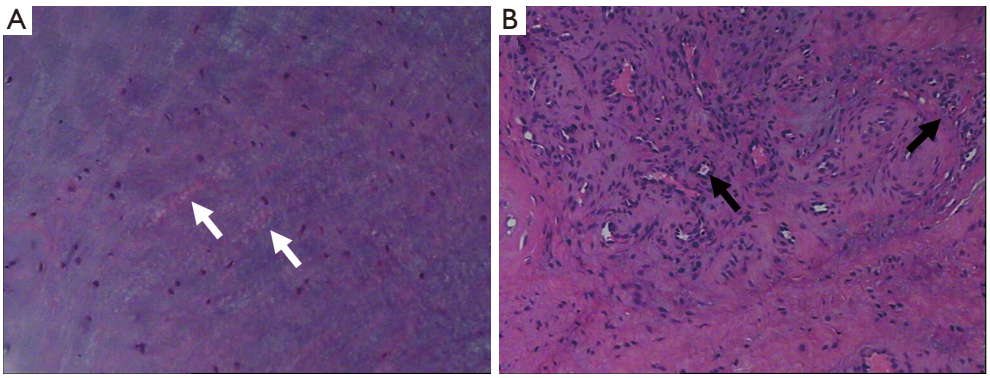

Figure 2 This is a 43-year-old female patient. She felt pain in the tarsal sinus after she sprained left ankle, which lasted for 3 months. Two weeks of conservative treatment was ineffective. She underwent subtalar arthroscopy to remove the hyperplastic synovium in the tarsal sinus. The proliferative synovium biopsy (H&E staining, 10×10) showed fibromyxoid degeneration [white arrows showed in (A)] and vascular hyperplasia [black arrows showed in (B)] in the synovium.

hindfoot as well as deep tenderness at the tarsi sinus. Pain was aggravated during walking and varus motion. Some patients had accompanying peroneal spasm and limited active and passive varus motions. Four patients had severe preoperative symptoms and could not walk normally without crutches; eight had pain in the lower leg and at the bottom of the heel, and 16 complained of giving way. None of the included patients had preoperative contraindications.

Treatment outcomes based on the designed protocol

All cases underwent conservative treatments before surgery. Tarsal sinus debridement was first applied for the 89 surgical patients with recurrent symptoms. Fifty-two patients remained in remission, while the remaining 37 patients, who had relapsed within 2 years, underwent further surgery. Five of the 19 patients with subtalar instability were cured following ligament reconstruction surgery (a typical case is shown in *Figures 2* and *3*). Two of the four patients with severe neurological signs recovered after nerve release surgery. Five of the 10 patients who suffered from tarsal coalition were cured by coalition resection. After the second operation, 21 patients still had recurrence within 2 years. We carefully reevaluated the conditions and analyzed the potential causes of failure. We noticed that these patients had a common symptom, peroneal spasm, which had not appeared or been diagnosed previously.

In addition, four patients with bony abnormalities combined with peroneal spasm (two cases of flatfoot and two cases of tarsal coalition with subtalar arthritis) showed recurrence within 6 months after conservative treatment. Local corticosteroid injection and tarsal sinus debridement failed to relieve the symptoms of peroneal spasm. Eventually, a total of 25 patients with peroneal spasm who failed previous treatments were successfully treated by subtalar arthrodesis (as shown in *Figure 4*). At the final follow-up, 21 patients had no pain and five showed obvious pain relief, with occasional discomfort on uneven road surfaces. The gait of the affected limb was normal after subtalar arthrodesis. Peroneal spasms were completely relieved without recurrence. A typical case is shown in *Figures 5* and *6*.

Postoperative rehabilitation guidance

The patients needed to keep the wound dry for 2 weeks after the operation. The wound dressing could be changed every 3–5 days, and sutures could be removed at approximately 2 weeks postoperatively. The patients were then instructed to lift the affected limb and actively move the ankle and toe joints. Weight-bearing activities could begin 2 weeks after soft tissue debridement of the tarsal sinus. The ankle joint required brace fixation after subtalar ligament reconstruction. Full weight-bearing exercise could be performed under the protection of braces 4–6 weeks after surgery, and normal shoes could be worn for full weight-bearing exercise 6–8 weeks postoperatively.

Similarly, orthosis fixation was required within 6 weeks after subtalar arthrodesis. At 6 weeks postoperatively, weight-bearing activities under the protection of an

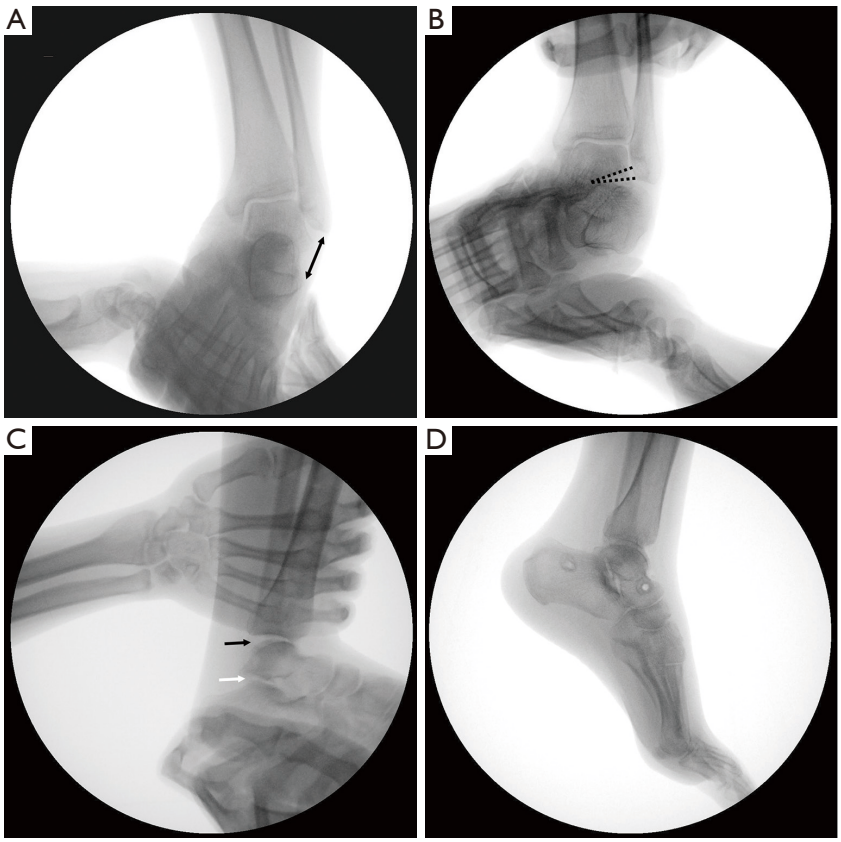

Figure 3 The symptoms recurred 2 months after the operation. Intraoperative stress radiography indicated that the subtalar and posterior ankle joints were unstable. Varus stress radiography (A) showed that the space between calcaneus and lateral malleolus was enlarged (the black arrow), and the calcaneus was obviously varus, but the tibiotalar joint surface was compatible. Broden's view (B) showed that the posterior facet of the subtalar joint was obviously varus (black dotted line). The anterior drawer test (C) showed that the calcaneus moved forward obviously (the white arrow) and the posterior space of ankle joint increased (the black arrow). Arthroscopic debridement was performed again, and subtalar joint ligament reconstruction was performed (D).

ankle joint fixator could be performed according to the condition of bone fusion. At 8–10 weeks after the operation, normal shoes could be worn for full load and flat floor exercises. Low-intensity weight-bearing activities, such as climbing stairs, jogging, and cycling, could be performed 3 months after surgery. High-intensity activities such as fast running and ball games could be performed 6 months postoperatively.

Clinical outcome

Eighty-nine patients were followed up for at least 2 years after the final surgery. The AOFAS scores were 34.83±12.21 preoperatively and 85.52±7.07 postoperatively (t=–24.62, P<0.01). The VAS scores were 8.14±1.52 preoperatively and 2.14±1.00 postoperatively (t=24.65, P<0.01). The SF-36 scores were 36.58±11.36 preoperatively and 86.22±9.17 postoperatively (t=–28.13, P<0.01). The data summarized in *Table 1* indicated that the last treatment was successful.

Sixty-eight patients were very satisfied with the treatment effect, and the other 21 patients thought that the treatment effect was good. All patients returned to normal work in an average of 4 months (3–6 months) after the last operation.

In our series, five patients suffered from sural nerve neuralgia. Eight patients felt numbness on the outside of the dorsal foot. Loss of motion of the hind foot due to subtalar joint fusion. Seven patients felt pain in the back of their feet after long-term weight-bearing activities. These symptoms are relatively mild and can be tolerated by the patient without receiving other treatments.

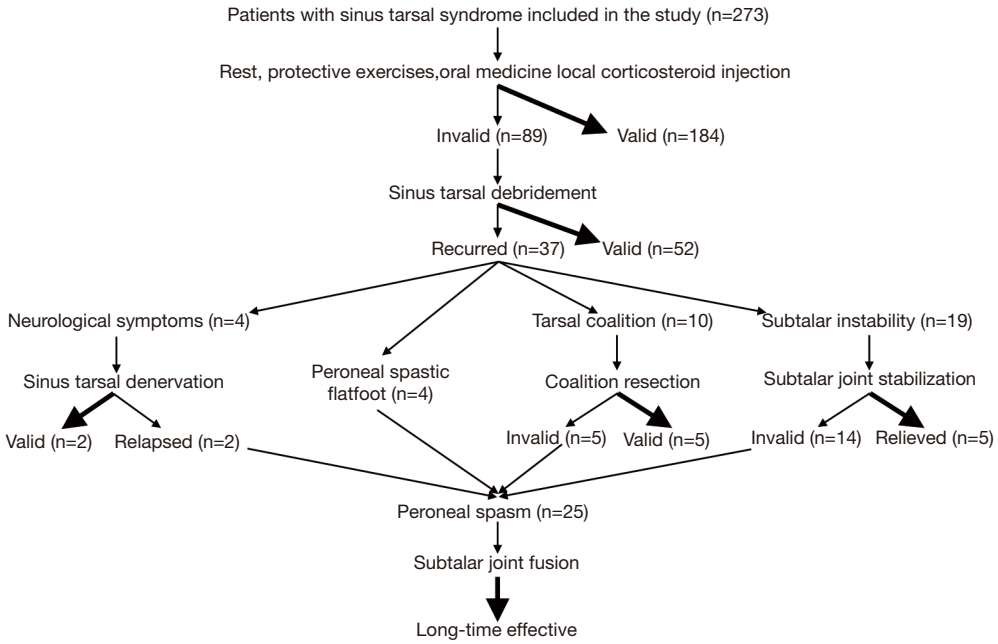

Figure 4 Therapeutic outcomes based on the designed protocol.

Discussion

The present study followed a protocol for selecting optimal treatments for STS, and all patients treated accordingly had successful therapeutic outcomes.

The pathogenesis of this disease is not clear, and it may be related to the abnormal bone structure of the hindfoot. It may also be related to the disorder of the soft tissue around the sinus tarsal. The most common etiologies of STS are foot and ankle injuries, including ankle sprain (16,20,21) and joint instability caused by ligament injuries (3,8,14,15,18), which account for approximately 70–86% of all STS cases (20). The remaining 30% of cases may be caused by inflammatory reactions and ankle deformities (17,22), such as in rheumatoid arthritis, gout, pes cavus (12), and flatfoot (13). As reported previously, extensor digitorum brevis injury, posterior tibial tendon tear (7,11,17), posttraumatic joint fibrosis (18,22), blood supply changes in the tarsal sinus (23), sinus innervation damage (14,15), lack of proprioceptive sensation (10), hallux valgus with forefoot abduction (24), and osteomyeloma (25) may cause STS. However, regardless of etiology, STS is primarily diagnosed by preoperative physical and auxiliary examinations. This study did not include patients with STS caused by systematic inflammation or tumor-related diseases, and instead only focused on investigating pathological changes in the tarsal sinus. There are many treatment methods mentioned in the literature, but the effects are different. The reasons for the poor treatment effect are also more complicated. In this study, we try to clarify the entire treatment process of the patient and summarize the reasons for the effectiveness and failure of the treatment.

STS can be easily diagnosed by clinical symptoms and signs. In the treatment process, it is desirable for the simplest treatment method to yield good therapeutic effects. In accordance with the established treatment process, we gradually carried out surgical treatment, and ultimately achieved satisfactory results. Based on previous reports, our successful experiences, and lessons from failure, we further detected several possible pathogeneses of STS recurrence, including non-specific inflammation, instability of the subtalar joint, neurological disorders, and peroneal spasm, which was more difficult to treat.

All patients were first treated conservatively. According to patient compliance and actual situations, we selected different conservative treatments. Approximately 81% of patients (184/226) were effectively treated by these conservative treatments, including oral medicines, local corticosteroid injection, physiotherapy, brace protection, and functional exercises. Approximately 19% (42/226) of patients suffered from simple synovitis as well as complex etiologies, and for these patients, no obvious effect was

Figure 5 A 27-year-old male patient with pain in the sinus tarsi and peroneal spasm of left lower limb with no obvious cause (A, gray arrow, contracted peroneal tendons; white arrow, edema at the tarsal sinus). Slight hindfoot valgus (B), with no obvious abnormalities observed on X-ray films (C). The first operation was performed to debride the soft tissue of the sinus tarsi, and no apparent abnormal changes were observed intraoperatively (D,E). Postoperative plaster fixation was performed for the varus position (F). Three months after surgery, the peroneal spasm had recurred, and the pain had not improved (G, white arrow, contracted peroneal tendons). In the second operation, the dorsolateral cutaneous branch of the superficial peroneal nerve (H, white arrow) was truncated and implanted in the fibula (I, white arrow).

observed with simple conservative treatments. For this reason, tarsal sinus soft tissue debridement was performed via open or subtalar arthroscopic procedures. As shown above, 50% (21/42) of patients who underwent this procedure achieved long-term efficacy.

In patients who experienced treatment failure, we further analyzed the causes of failure, searching for occult causes. In cases of nerve damage in the tarsal sinus resulting from ankle sprain or nerve injury around the ankle, especially abnormal electrical activity of the superficial peroneal nerve, which caused severe pain, tarsal sinus denervation was performed. As a result, 50% (2/4) of these patients were successfully treated. If further examination revealed subtalar joint instability, which could also be caused by tarsal sinus debridement, subtalar joint stabilization was attempted by reconstructing the ankle lateral ligament

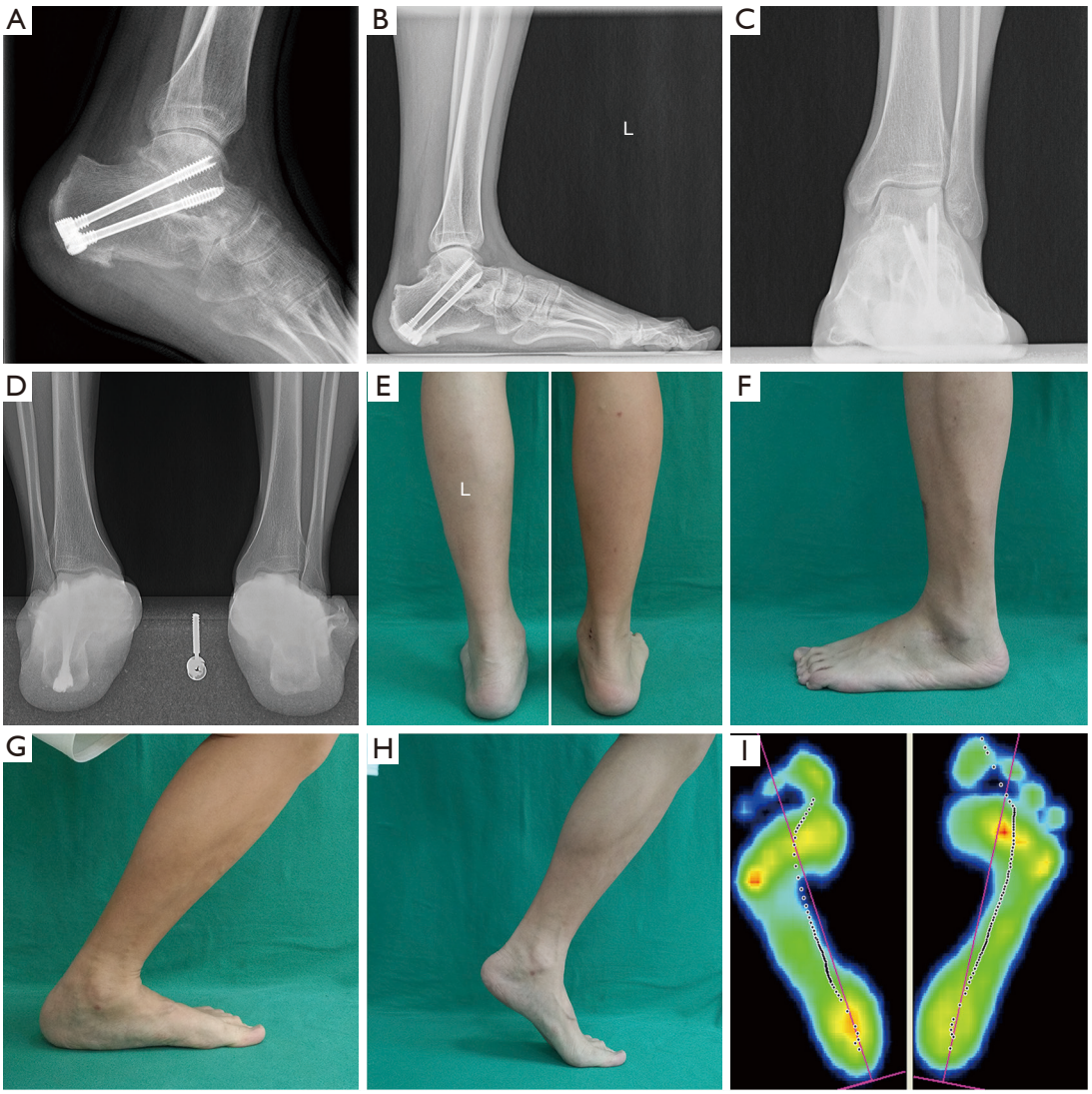

Figure 6 Pain was relieved for 6 months, but recurred, accompanied by convulsions. Neurological diseases were ruled out based on a diagnosis by the Department of Neurology. Finally, the patient underwent subtalar arthrodesis (A). Postoperative follow-up for 10 years showed no significant limitations in the patient's plantar flexion and dorsiflexion [(B-D) X-ray data; (E,F) alignment photos; (G,H) motion images]. Plantar pressure test results were normal, with even pressure distribution (I); the patient experienced no discomfort when walking. The patient was very satisfied.

Table 1 Score changes in the 89 surgical patients

Score	First visit	Final follow-up	t value	P value
AOFAS score	34.83±12.21	85.52±7.07	−24.62	<0.01
VAS score	8.14±1.52	2.14±1.00	24.65	<0.01
SF-36 score	36.58±11.36	86.22±9.17	−28.13	<0.01

complex or the interosseous talocalcaneal ligament. As a result, approximately 77% (10/13) of these patients were effectively treated. In cases of obvious peroneal tendon contracture and serious valgus hindfoot and pain, with ineffective soft tissue surgery, talocalcaneal arthrodesis was performed to achieve long-term results.

We retrospectively reviewed cases with treatment failure after soft tissue surgery and found a common feature that these patients all had varying degrees of peroneal spasm. Therefore, for STS patients with peroneal spasm, if sinus tarsi debridement is insufficient in removing the stimulating factors and alleviating the contracted peroneal tendons, subtalar joint fusion should be performed to thoroughly remove the soft tissue of the subtalar joint, including the synovial membrane, ligaments, fat, scars, and nerves, to eliminate inflammation and neurological disorders. Additionally, the procedure could also correct the alignment of the talus and calcaneus and stabilize the subtalar joint.

We previously conducted a follow-up study on patients treated with subtalar arthrodesis over an average of 9 years (19). Ankle joint activity showed no significant changes after subtalar arthrodesis, and some compensatory activity was identified in the anterior midfoot joint, which may accelerate joint degeneration. However, such degeneration was mild, and the patients experienced no pain.

As shown above, the symptoms of STS are few, but the causes are complex, requiring comprehensive recognition of the disease. Only scientific management and accurate treatment of these patients can obtain long-term effects. All of the patients involved in this study were finally successfully treated following this therapeutic process.

The present study had several limitations that should be noted. Firstly, different tarsal sinus debridement and subtalar arthrodesis procedures were performed in this trial, which might have introduced confounding factors. Secondly, a relatively low rate of follow-up might have introduced selection bias. Finally, this was a single-center retrospective study without a control group, and the conclusion might not be firm. A study with higher-level evidence is required to confirm our findings.

Conclusions

STS is a common disease of the foot and ankle area, which is often caused by ankle sprains. For the treatment of STS, we designed a protocol that could help to select optimal treatment strategies for good therapeutic outcomes. We suggest that patients with mild symptoms, single causes, and short disease course could be healed by conservative methods or soft tissue surgeries first. Those with peroneal spasm were difficult to treat because of the various associated causes and sophisticated pathogenesis. Talocalcaneal arthrodesis is indeed an effective treatment for STS with peroneal spasm, as we confirmed in the study.

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://dx.doi.org/10.21037/apm-21-1694

Data Sharing Statement: Available at https://dx.doi.org/10.21037/apm-21-1694

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://dx.doi.org/10.21037/apm-21-1694). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). This study was approved by the Ethics Committee of Shanghai Ruijin Hospital [No. 75 (2013)]. Informed consent was obtained from all individual participants included in the study.

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