



# Long-term efficacy of superficial temporal artery ligation and auriculotemporal nerve transection for temporal cluster headache in adolescent

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## Abstract

**Objectives** Cluster headache is a primary headache disorder, which has affected up to 0.1% population. Superficial temporal artery ligation combined with auriculotemporal nerve transection (SLAT) is one of the surgical alternatives to treat the drug-resistant temporal cluster headache (TCH). The current work aimed to assess the effect of SLAT on TCH patients based on the very long-term clinical follow-up.

**Methods** The current retrospective study had enrolled 20 adolescent TCH patients undergoing SLAT between December 2016 and January 2018. The headache diaries as well as the pain severity questionnaire of the visual analog scale (VAS) had been collected to measure the pain severity before and after surgery.

**Results** The pain-free rates 3 days, as well as 1, 6, and 12 months, after SLAT surgery were 2.00%, 10.00%, 25.00%, and 70.00%, respectively. The frequency of TCH attack daily was found to be markedly reduced on the whole; besides, the pain degree was also remarkably decreased.

**Conclusions** Results in this study indicate that the sustained headache can be relieved after SLAT in adolescent patients with intractable TCH.

**Keywords** Cluster headache · Superficial temporal artery · Auriculotemporal nerve · Headache · Adolescent

## Introduction

Cluster headache (CH), a severe primary headache disease [1], is characteristic of serious pain attacks at temporal, orbital, or supraorbital region, or in at least two of these regions unilaterally, which can last for about 15–180 min, with the attack

frequency being increased from once for every 2 days to eight times daily [2–4]. Given the excruciating nature of the disorder, it is paramount to institute proper treatment for improving the patient life quality due to its excruciating nature.

Some studies suggest that triptan or botulinum toxin A injection therapy can serve as an alternative for CH patients based on their rapid action, but it is difficult to achieve a sustained outcome, which requires repeated injections [5, 6]. In addition, for some patients suffering from episodic CH, prophylactic medication can markedly reduce the frequency of pain attack. Nonetheless, some studies report that the standardized analgesia is not effective; meanwhile, no existing evidence has supported to treat individual attacks with non-steroidal anti-inflammatory drugs (NSAIDs), paracetamol (acetaminophen) or codeine. Furthermore, individuals with CH are more likely to use the prescribed and non-prescribed pain medications, including opiates, and these populations are associated with a higher possibility of drug dependence [7]. Alternative intervention should be taken into account for chronic CH patients that could not benefit from prophylactic medication [8, 9]. Therefore, the surgery is essential at the time of failure in drug therapy.

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Some recent studies show that sphenopalatine stimulation, deep brain stimulation, and vagal nerve stimulation can be used as the therapies for CH patients [10–13]. However, these procedures are associated with serious complications and side effects, including sensory disturbance and intracranial hemorrhage, given the conflicting results in trials [14, 15]. Meanwhile, the surgical equipment is expensive; therefore, they are not widely recommended. As a result, some effective, simple, and low-cost treatments with less complications should be noted. However, little has been reported concerning the long-term efficacy of superficial temporal artery ligation and auriculotemporal nerve transection (SLAT) so far. In this article, a new series of 20 adolescent TCH cases undergoing SLAT had been presented, with the emphasis on the long-term postoperative outcomes.

## Methods

### Cases

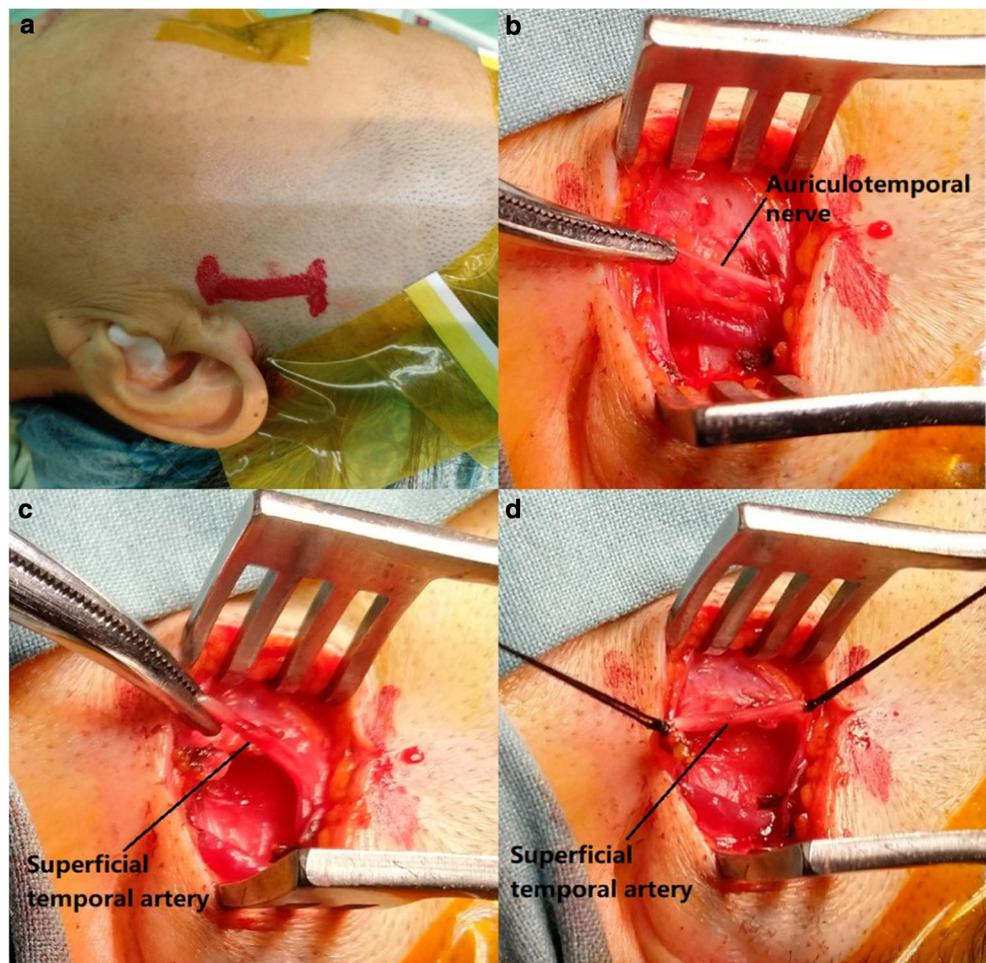
The protocol of this study, as well as the SLAT technique, had been verified by the Ethics Institutional Committee of Xin

Hua Hospital. All the enrolled patients had provided informed consent to participate in this study. Records from 20 adolescent TCH patients undergoing SLAT at Xinhua Hospital by the same surgeon (S.-T.L.) from December 2016 to January 2018 were analyzed. MRI, together with digital subtraction angiography (DSA), had been performed in all patients preoperatively, so as to rule out the possibility of secondary diseases. All patients were diagnosed with cluster headache with pain mainly located in the temporal area.

### Surgery

The operation had been carried out under local anesthesia. All patients had received SLAT in the supine position through a 2–2.5-cm incision above the cheekbones as well as in front of the ear on the painful side. The subcutaneous tissue was bluntly separated; subsequently, the auriculotemporal nerve would be isolated and severed. Thereafter, the superficial temporal artery (STA) would be separated below the auriculotemporal nerve (ATN). Ends of the STA would be ligated and cut off. After adequate hemostasis, the incision was sutured layer by layer.

**Fig. 1** Procedures of superficial temporal artery ligation and auriculotemporal nerve transection. **a** A 2–2.5-cm incision was made on the painful side. **b** The auriculotemporal nerve was severed. **c** The STA had been dissected. **d** The STA had been ligated



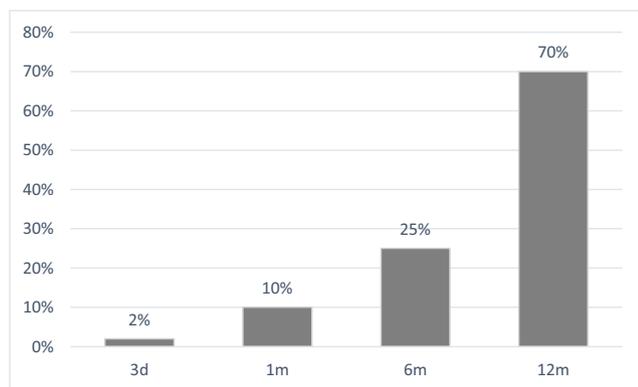
**Table 1** Characteristics of patients

No.	Gender	Age (years)	Duration (months)	Side
1	Male	8	13	Left
2	Female	11	9	Left
3	Male	17	73	Right
4	Female	12	36	Right
5	Male	9	24	Left
6	Female	14	36	Right
7	Male	10	18	Right
8	Female	17	8	Left
9	Male	15	12	Left
10	Male	14	18	Right
11	Female	12	24	Right
12	Male	12	15	Left
13	Male	13	18	Right
14	Male	11	16	Left
15	Female	16	10	Left
16	Male	19	5	Left
17	Female	16	16	Left
18	Female	10	7	Right
19	Male	13	19	Left
20	Male	16	26	Right

None of these patients had taken triptans, prednisone, calcium channel blockers, and other medicines after surgery (Fig. 1).

**Outcome assessment**

All follow-up information would be extracted through the headache diaries as well as the VAS pain grade questionnaire. Besides, outcome data 3 days, as well as 1, 6, and 12 months, after surgery would also be extracted from the headache diaries. Every 28 calendar days would be regarded as 1 month; meanwhile, 3 days, as well as 1, 6 and 12 months, after surgery had been computed separately for every patient. All patients should maintain their headache diaries for the whole



**Fig. 2** The pain-free rates of patients at multiple time points of follow-up. d, day; m, month

**Table 2** The frequency of pain at multiple time points

Follow-up	Frequency of pain (times per day)	P value
Pre-operation	10.65 ± 0.99	
3 days	5.1 ± 0.59	< 0.0001
1 month	3.25 ± 0.47	< 0.0001
6 months	2.2 ± 0.60	< 0.0001
12 months	1.8 ± 0.87	< 0.0001

study period to record their frequencies as well as intensities of headache attack (by VAS pain grade questionnaire, from 0 to 10, in which 0 suggests the absence of pain/discomfort while 10 represents unbearable pain). These time periods were compared with that at baseline (before SLAT surgery).

**Statistical analyses**

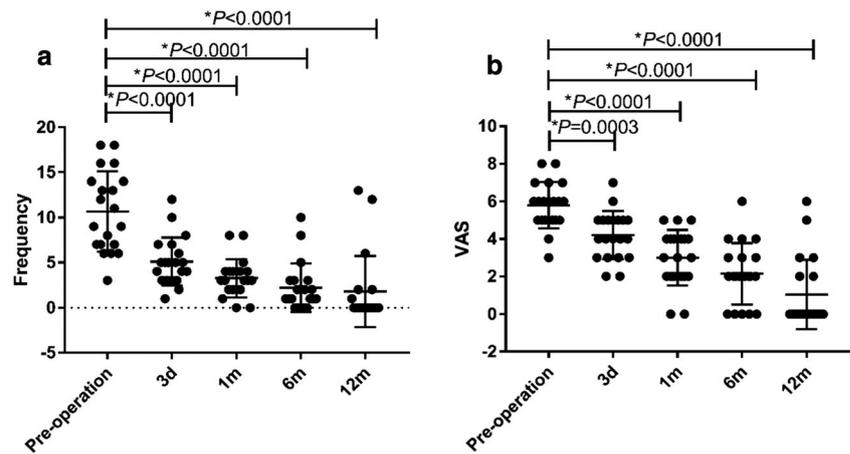
One independent assessor had carried out all statistical analyses through *t* test and Fisher’s exact test. Different descriptive statistical parameters, such as patient age, gender, disease course, side of pain, history of hypertension, and history of diabetes, had been collected, so as to detect the correlation of clinicopathological factors of patients with the long-term efficacy. All results had been expressed in the form of mean ± standard deviation (mean ± SD), and the results 3 days, as well as 1, 6, and 12 months, after surgery were compared with those before surgery (in the form of mean ± SD). A difference of *P* < 0.05 was deemed as statistically significant.

**Results**

Twenty TCH patients had been recruited into our final analysis. Demographical data of all objects of study are shown in Table 1. As for the pain side, 11 patients were on the left and 9 were on the right. The age of TCH patients, including 12 males (60%) and 8 females (40%), lay within the range of 8–19 years (median, 11.5 years). Meanwhile, the average duration from symptom onset to operation was 33.5 months. The pain-free rates were 2.00%, 10.00%, 25.00%, and 70.00%, respectively, 3 days, as well as 1, 6, and 12 months, after SLAT surgery (Fig. 2).

The preoperative TCH attack frequency per day (10.65 ± 0.99) was reduced to 5.1 ± 0.59 (*P* < 0.0001) on day 3 after surgery, to 3.25 ± 0.47 (*P* < 0.0001) at 1 month, to 2.2 ± 0.60 (*P* < 0.0001) at 6 months and to 1.8 ± 0.87 (*P* < 0.0001) at 12 months (Table 2, Fig. 3a). Besides, the preoperative VAS pain grade (5.8 ± 0.28) was reduced to 4.2 ± 0.29 (*P* = 0.0003) 3 days after surgery, to 3 ± 0.33 (*P* < 0.0001) at 1 month, to 2.15 ± 0.36 (*P* < 0.0001) at 6 months, and to 1.05 ± 0.41 (*P* < 0.0001) at 12 months (Table 3, Fig. 3b).

**Fig. 3** Comparison of frequency of pain and VAS pain grade between pre-operation and multiple time points of follow-up. d, day; m, month



The other complication after surgery was facial numbness reported among 8 cases, which was alleviated during follow-up after surgery and would not affect the patient life quality. Typically, no mortality or permanent cranial nerve deficit had been reported from all patients.

## Discussion

Adolescent headaches have been a growing concern in recent years. CH is one of the most prevalent chronic pain manifestations of teenager. Despite the multitude of available treatments, parents are often concerned about chronic therapies and pediatricians have insufficient confidence in prescribing prophylactic drugs. Therefore, there is now growing interest in surgical treatment used to cure CH.

CH is linked with complicated pathogenesis, and its potential mechanism remains largely unknown. CH, a kind of neurovascular and chronobiological headache disorder, is featured by the brain vascular changes triggered by activating the trigeminal-autonomic reflex [16, 17]. As is indicated, the CH autonomic symptoms may be ascribed to the external cephalic artery vasodilation as well as perivascular edema, since the overreacted trigeminal parasympathetic nerve during disease attack would compromise the artery as well as the traverse sympathetic fibers. Alternatively, those symptoms may take place following trigeminal discharge [18–20]. Therefore, treatment for the trigeminal branch may be effective.

**Table 3** The VAS pain grade at multiple time points

Follow-up	VAS pain grade	<i>P</i> value
Pre-operation	5.8 ± 0.28	
3 days	4.2 ± 0.29	0.0003
1 month	3 ± 0.33	< 0.0001
6 months	2.15 ± 0.36	< 0.0001
12 months	1.05 ± 0.41	< 0.0001

ATN, a trigeminal nerve branch in the mandibular division, is implicated in numerous branches to the temporomandibular joint, the parotid gland, the external acoustic meatus, the anterior auricle, the zygoma, as well as the superficial temporal area. Specifically, branch in the superficial temporal area represents the terminal innervating skin in the temporal area. Sometimes, it may serve as the root of TCH as well as neuralgia in the auriculotemporal area [21–23]. Notably, correlation of the abovementioned peripheral nerves with adjacent arteries should be paid attention, since the latter can intersect or intertwine with the former to induce irritation, thereby triggering the attack of headache [24, 25]. Furthermore, it is speculated that STA may intersect with ATN in these patients to cause irritation, and the close relationship between these two has been proposed previously and verified in numerous anatomic studies [26–28]. Therefore, it may be necessary to ligate the STA while severing the ATN for temporal pain treatment.

Recent years, nerve blockade has shown efficacy as transitional and even preventive maintenance therapy for CH [23, 29]. However, a large number of studies have shown that nerve block requires repeated long-term injection of lidocaine and triamcinolone to maintain efficacy. In addition to the side effects of anesthetics and corticosteroid on patients, the lengthy treatment process also greatly affects the quality of life of patients. As a local anesthesia operation, SLAT can achieve satisfactory results in a single operation, safe and simple. This may be the reason why SLAT is more recommended than nerve block.

In our study, the risk of facial numbness is the main complication of SLAT. The auriculotemporal nerve is a sensory nerve distributed in the skin of the temporal. If the nerve is transected, the feeling of the dominant area is impaired. Fortunately, the facial numbness reported among 8 cases, which was alleviated during follow-up after surgery, would not affect the patient life quality. For this complication, longer-term follow-up and larger sample size studies are needed.

Nonetheless, our study was also associated with certain limitations. Specifically, due to the small sample size and

uncontrolled design, follow-up research findings must be interpreted cautiously as a result of the small sample size as well as uncontrolled nature in design.

## Conclusions

The techniques together with results described in this article demonstrate that SLAT can serve as a safe, simple, and effective treatment for TCH in adolescent; more importantly, the benefit derived from SLAT seems to be durable.

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**Compliance with ethical standards** The study protocol was approved by the Institutional Ethics Committee of the Xinhua hospital.

**Conflict of interest** The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

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