

# Changes in facial temperature measured by digital infrared thermal imaging in patients after transnasal sphenopalatine ganglion block

## Retrospective observational study

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### Abstract

Sphenopalatine ganglion block (SPGB) is a technique developed in the 1990s for the management of head and neck pain patients. Recently, transnasal sphenopalatine ganglion block (TN-SPGB) has been widely used for these patients; however, no objective methods exist for validating the success of TN-SPGB. In this study, we measured the changes in facial temperature before and 30 minutes after TN-SPGB by using digital infrared thermal imaging (DITI) to validate its success.

The medical records of patients, who underwent TN-SPGB and facial DITI between January 2016 and December 2017, were reviewed. TN-SPGB and facial DITI were performed 36 times in 32 patients. The changes in facial temperatures measured at the forehead (V1), maxillary area (V2), and mandibular area (V3) by using DITI before and 30 minutes after TN-SPGB were recorded and compared. The temperatures on the ipsilateral and contralateral sides of these areas were also compared. The comparison between pain relief group and pain maintenance group was analyzed.

After TN-SPGB, the temperature decreased significantly on both sides of V1 ( $P = .0208$ ,  $0.0181$ ). No significant differences were observed between the ipsilateral and contralateral sides ( $P > .05$ ). There was no correlation between changes in temperature and changes in pain score in the pain regions after the procedure ( $P > .05$ ).

The temperature decreased significantly in V1 area at 30 minutes after TN-SPGB compared with the temperature before TN-SPGB. Based on these results, we propose using DITI to measure temperature changes as an objective method for verifying the success of TN-SPGB.

**Abbreviations:** DITI = digital infrared thermal imaging, SD = standard deviation, SGB = stellate ganglion block, SPG = sphenopalatine ganglion, SPGB = sphenopalatine ganglion block, TN-SPGB = transnasal sphenopalatine ganglion block, V1 = forehead, V2 = maxillary area, V3 = mandibular area.

**Keywords:** face, pain management, sphenopalatine ganglion block, temperature

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## 1. Introduction

The sphenopalatine ganglion (SPG) is located in the inner space of the pterygomaxillary fissure and is surrounded by the palatine bone.<sup>[1]</sup> The SPG is a ganglion that innervates sympathetic, parasympathetic, and sensory nerves, and is known to be the predominant ganglion with parasympathetic nerves (Fig. 1).<sup>[2]</sup>

Various blocks have been performed since the 1990s to control head and neck pain.<sup>[3]</sup> Most blocks (sphenopalatine ganglion blocks [SPGBs]) are performed for radiofrequency ablation, and SPG interventions have been reported to destroy or modulate SPG cells, incurring risks such as bradycardia, infection, hemorrhage, nerve injury, and rarely death.<sup>[4]</sup>

Transnasal sphenopalatine ganglion block (TN-SPGB) was first introduced in 1998 and has been performed using the Tx360 (Tian Medical, Libertyville, IL) and Sphenocath (Dolor Technologies, Scottsdale, AZ) devices since 2000.<sup>[4]</sup> Many studies have been conducted on TN-SPGB in patients with head and neck pain, including cluster headache. Recently, studies have been conducted on migraine, nicotine addiction, facial hyperhidrosis, and postdural puncture headache, and the indications for this treatment are gradually expanding.<sup>[2]</sup>

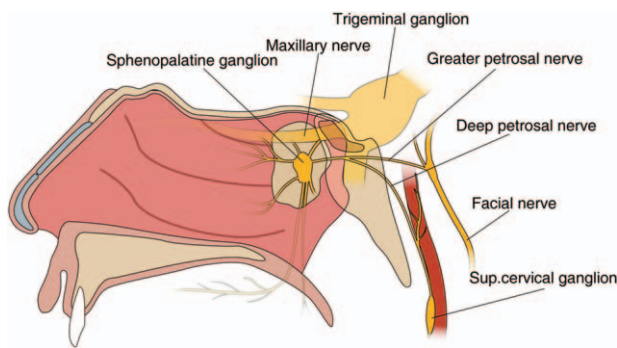


Figure 1. Sphenopalatine ganglion nerve innervation.

No objective methods exist for validating the success of SPGB despite many attempts having been made since the introduction of the transnasal approach. The effect of the TN-SPGB is determined by the degree of pain relief, which is based on the patient’s subjective description. In cases where TN-SPGB has no effect on patients with head and neck pain, no method exists to confirm whether the SPGB was ineffective or the treatment was poorly implemented.

Meanwhile, stellate ganglion block (SGB), another nerve block for head and neck pain, was first reported in 1998 to compare temperature changes and pain relief by using infrared thermography, and currently, the success of sympathetic block is judged according to the temperature changes.<sup>[5]</sup>

Therefore, we hypothesized that because the SPG has all 3 components of sympathetic, parasympathetic, and sensory nerves, the success of SPGB can be objectively validated based on facial temperature changes, like the way the success of SGB is judged according to temperature changes. In this study, patient medical records were used to obtain digital infrared thermal imaging (DITI) data captured before and 30 minutes after SPGB to check facial temperature changes.

**2. Methods**

**2.1. Participants**

This retrospective research was approved by the Institutional Ethics Committee of Ajou Hospital, Republic of Korea (AJIRB-MED-MDB-17-345). Informed consents were not obtained

**Table 1**  
**Demographic data.**

Parameter	Numbers
Patients	32
Age, y	59.3 ± 12.0
Sex	
Male	16
Female	16
Height, cm	161.25 ± 4.82
Weight, kg	61.98 ± 3.08
Diagnosis	
Herpes zoster	
Trigeminal	
V1	14
V2	1
V3	3
Cervical	8
Migraine	2
Anosmia	3
Eagle syndrome	1
Side of symptoms	
Right	14
Left	13
Both	5
Total number of TN-SPGBs	
Right	22
Left	14

Means ± standard deviations are presented for age, height, and weight. Frequencies are presented for other variables.

TN-SPGB = transnasal sphenopalatine ganglion block, V1 = forehead, V2 = maxillary area, V3 = mandibular area.

because of retrospective study. Thirty-six TN-SPGBs performed on 32 patients who visited the Pain Clinic of Ajou University Hospital for head and neck pain were included in this study. DITI was performed before TN-SPGB and 30 minutes after TN-SPGB. Patients with herpes zoster, migraine, and anosmia were included (Table 1). There were no missing data.

**2.2. Procedures**

**2.2.1. Transnasal sphenopalatine ganglion block.** TN-SPGB was performed by one pain physician. Patients were placed in the supine position on a bed, and a cotton tip applicator soaked with 2% mepivacaine was inserted vertically into the nostril (Fig. 2). After the cotton tip applicator reached the posterior wall of the

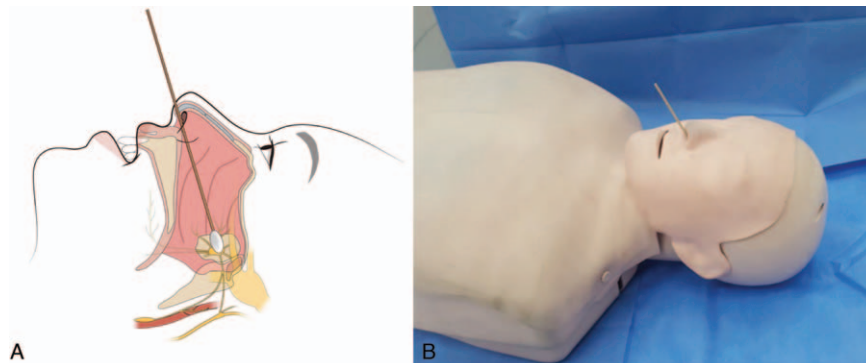
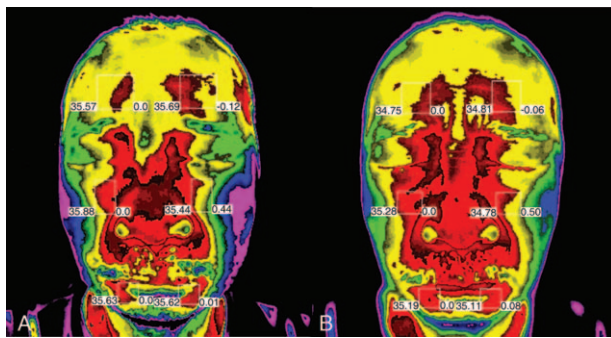


Figure 2. Transnasal sphenopalatine ganglion block procedure. (A) Cross-sectional sagittal view of SPGB; (B) TN-SPGB in mannequin of human. SPGB = sphenopalatine ganglion block, TN-SPGB = transnasal sphenopalatine ganglion block.



**Figure 3.** Digital infrared thermal imaging before and after TN-SPGB. (A) Before TN-SPGB; (B) 30 minutes after TN-SPGB. TN-SPGB=transnasal sphenopalatine ganglion block.

middle turbinate, it was fixed at this position and removed 10 minutes later.

**2.2.2. Digital infrared thermal imaging and temperature measurements.** Facial DITI was performed after 30 minutes of adaptation in an independent room at 24°C. After TN-SPGB, facial DITI was performed again under the same room conditions. DITI was performed from 3 angles to obtain a frontal view, right-side view, and left-side view. Measurements were made by using an IRIS XP (Medicore, Seoul, South Korea). IRIS XP was calibrated in Korea Measuring Instruments Research Association before this research began.

**2.3. Outcomes**

In the frontal facial DITI images, facial temperatures were measured at 6 areas, comprising the right and left sides of the forehead (V1), maxillary area (V2), and mandibular area (V3). Means and standard deviations of the facial temperatures were calculated using a range of interest based on the 6 areas (Fig. 3).

**2.4. Statistical analysis**

Data obtained from a previous study indicated that 27 patients would be required to achieve  $\alpha$  and  $\beta$  errors of 0.05 and 0.2, respectively.<sup>[6]</sup> Considering a dropout rate of 20%, a required sample size of 34 was calculated. Statistical analysis was performed using Statistical Analysis Software v. 9.4 (SAS Institute Inc., Cary, NC). All data are presented as the mean and standard deviation. Paired *t* tests were used to compare the temperature before TN-SPGB with that of 30 minutes after TN-SPGB, and to compare the temperature of the ipsilateral side with that of the contralateral side 30 minutes after TN-SPGB. The

Cochran-Armitage trend test was performed to detect trends in changes in temperature and pain.

**3. Results**

Demographic data are presented in Table 1. Comparing temperatures before TN-SPGB and 30 minutes after TN-SPGB revealed that the mean temperatures at V1 significantly decreased by 0.29°C on the right side ( $P=.0208$ ) and by 0.31°C on the left side ( $P=.0181$ ) (Table 2). In addition, TN-SPGB was performed in only one nostril according to the lesion location, but the temperatures decreased on both sides of V1 regardless of the block side (Table 3).

Comparisons between ipsilateral side and contralateral side were analyzed, but no temperature changes were showed except one area (between before and 30 minutes after TN-SPGB in left V1).

The comparison between pain relief group and pain maintenance group was analyzed in 15 TN-SPGBs (Table 4). There was no one in pain aggravation group. Herpes zoster in the nonface area, headaches, and anosmia are excluded. Pain mostly decreased after TN-SPGB in patients with head and neck pain, including those with herpes zoster, and the comparison between pain relief group and pain maintenance group was not statistically significant ( $P=.3636$ ).

**4. Discussion**

Millions of people around the world suffer headaches and facial pain which have been progressed chronically.<sup>[3]</sup> Medications are the primary treatment for many types of headache. Although invasive therapy for head and neck lesions is effective, it is not applied in most cases because of the high risk of complications in some cases.<sup>[2]</sup> TN-SPGB is known to be safe and effective and has thus been applied in clinical practice since 2000.<sup>[7]</sup> TN-SPGB has been reported to be effective in treating cluster headache, nicotine addiction, and postdural puncture headache. Indications for TN-SPGB are gradually expanding.<sup>[8]</sup>

Regarding studies on TN-SPGB, the first randomized controlled trial was conducted by Scudds et al with 61 myofascial pain syndrome and fibromyalgia patients in 1995.<sup>[9]</sup> Krasuski et al reported on patients with severe headache caused by head trauma, dental work, fibromyalgia, and pharyngitis, who were treated with SPGB with sterile cotton sticks soaked in 4% lidocaine. Pain relief was reported for 12 of 15 patients.<sup>[10]</sup>

Because of the effectiveness and low risk of complications of TN-SPGB, relevant instruments have been developed. However, a method was lacking for validating the success of TN-SPGB, with pain relief being the only measure of its effectiveness; in cases where TN-SPGB has no effect, it is unclear whether the block

**Table 2**  
Changes in facial temperatures before and 30 minutes after transnasal sphenopalatine ganglion block.

Parameters	V1	Right V2	V3	V1	Left V2	V3
Temperature before TN-SPGB, °C	34.44 ± 0.89	34.14 ± 1.24	34.36 ± 0.99	34.41 ± 0.89	34.08 ± 1.12	34.33 ± 0.99
Temperature 30 min after TN-SPGB, °C	34.15 ± 0.64	34.21 ± 0.91	34.37 ± 0.57	34.10 ± 0.65	34.17 ± 0.73	34.35 ± 0.60
Difference (mean ± SD)	-0.29 ± 0.71	0.07 ± 1.00	-0.01 ± 0.72	-0.31 ± 0.75	0.09 ± 0.84	-0.03 ± 0.79
<i>P</i> *	.0208*	.6657	.9632	.0181*	.5062	.8368

SD=standard deviation, TN-SPGB=transnasal sphenopalatine ganglion block, V1=forehead, V2=maxillary area, V3=mandibular area.  
\*Significance at  $P < .05$ .

**Table 3****Comparison of temperatures before and after transnasal sphenopalatine ganglion block on the ipsilateral and contralateral sides.**

Side of TN-SPGB	Right side (n=22)			Left side (n=14)		
	Temperature on ipsilateral side, °C	Temperature on contralateral side, °C	P	Temperature on ipsilateral side, °C	Temperature on contralateral side, °C	P
Before TN-SPGB						
V1	34.75 ± 0.71	34.71 ± 0.68	.8642	34.08 ± 0.99	34.03 ± 0.78	.5699
V2	34.57 ± 0.85	34.35 ± 0.82	.4438	33.74 ± 1.34	33.59 ± 1.36	.2411
V3	34.61 ± 1.01	34.51 ± 1.02	.7746	34.01 ± 0.98	34.00 ± 0.96	.2998
Thirty minutes after TN-SPGB						
V1	34.39 ± 0.50	34.29 ± 0.46	.8849	34.04 ± 0.87	33.94 ± 0.67	.7571
V2	34.56 ± 0.67	34.30 ± 0.66	.7845	34.03 ± 0.89	33.84 ± 0.95	.6165
V3	34.59 ± 0.44	34.42 ± 0.54	.9751	34.19 ± 0.70	34.08 ± 0.62	.6943
P value (before vs 30 min after TN-SPGB)						
V1	.0890	.0404*		.9205	.7800	
V2	.9845	.8290		.5408	.6061	
V3	.9461	.7344		.6174	.8072	

Thirty-six TN-SPGBs were performed in 32 patients on right and left sides.

TN-SPGB = transnasal sphenopalatine ganglion block, V1 = forehead, V2 = maxillary area, V3 = mandibular area.

\*Significance at  $P < 0.05$ .

failed or was ineffective. In sympathetic block, thermography after SGB was first reported to confirm its success in the 1980s<sup>[4]</sup>; temperature increases after the procedure are used to determine the effectiveness of the block.<sup>[6]</sup>

In this study, we attempted to determine the success of TN-SPGB by measuring facial temperature changes before and 30 minutes after TN-SPGB, using DITI. After TN-SPGB, the temperatures decreased significantly on both sides of V1 area.

Numerous hypotheses can be drawn from interpretations of the aforementioned results. First, the SPG can be hypothesized to have sympathetic, parasympathetic, and sensory nerve components, but not all 3 nerves would be blocked in TN-SPGB because transnasal approach of the SPG is blocked by diffusion. Second, even if all 3 nerves are blocked, the parasympathetic nerve blocks would become dominant in the SPG when the transnasal approach is used. TN-SPGB has been found to be effective in treating migraines, and migraine medications are known vasoconstrictors, which supports the aforementioned hypotheses. Hence, TN-SPGB might theoretically exert a vasoconstrictive effect of parasympathetic blocks as a compensatory effect of sympathetic nerve blocks. However, no studies have been conducted on the cranial autonomic system and temperature changes in the head and neck. Therefore, additional controlled studies are needed.

We also noted that the temperature changes at V2 and V3 areas are not clear. The reasons for this phenomenon could be that whereas the blood supply is sufficient in the front of the brain at V1, it is insufficient at V2 and V3 because of structures such as nasal cavities, oral cavities, and sinuses.

**Table 4****Comparison between pain relief group and pain maintenance group after transnasal sphenopalatine ganglion block.**

Patients (n=15)	Increase in temperature	No change in temperature	Decrease in temperature
Pain relief (n=10)	4/10	0/10	6/10
Pain maintenance (n=5)	3/5	1/5	1/5
Pain aggravation (n=0)	0	0	0
P		.3636	

At V2 area, the temperature tended to increase slightly, which may have been due to sympathetic dual innervation of the SPG. The decrease in temperature at V1 area may have been related to compensatory activity of the sympathetic nerves.

Although the lesion location was identified as being on the left or right side and SPGB was performed in only one nostril accordingly, the temperature decreased on both sides of V1 area regardless of the direction of the block. This result suggests that only one-sided TN-SPGB is necessary, even in patients with bilateral symptoms. This result could be related to the structural properties of the mucous membrane and the lack of bony structures in the SPG.

Regardless of the pain site, pain relief and temperature changes at V1 area have shown a significant correlation, suggesting that they can be a good indicator for verifying the effects of TN-SPGB.

Wasserman et al reported temperature increases of approximately 1.4°C in both zygomatic areas after TN-SPGB, contrary to our results.<sup>[6]</sup> They reported that the SPG received an additional sympathetic innervation of the maxillary artery plexus and increased in temperature after TN-SPGB because of sympathetic nerve blockade.<sup>[5]</sup> In addition, the methods differed between the aforementioned study and the present study, such as drug volume and concentration as well as the instruments used.

We concluded that TN-SPGB reduced facial temperature in the V1 area, and was effective on both sides. The limitations of this study are as follows. First, this was a retrospective study. Second, the number of patients was relatively small. Third, the participants were patients rather than healthy individuals. Fourth, we did not employ a control group. Fifth, we did not use standardized instruments for TN-SPGB because such devices (e.g., Sphenocath; Dolor Technologies, Scottsdale, AZ) are unavailable in South Korea.

### Author contributions

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**Resources:** Sunok Kim, Seryeon Lee, Hyuk Soo Chang, Hae Won Jeong, Hyungbae Park, A Ram Lee, Soohwan Ahn, Tae Kwang Kim.

**Supervision:** Sook Young Lee, Ho Young Gil, Ji Eun Kim, Jong Bum Choi.

**Writing – Original Draft:** Na Eun Kim.

**Writing – Review and Editing:** Ji Eun Kim, Jong Bum Choi.

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