Usefulness of Curved-Shaft Needles for Infiltrating the Sphenopalatine Area

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Abstract The objective of this study is to evaluate what types of needles are optimal and efficient for infiltrating the sphenopalatine area during endoscopic sinus surgery. Prospective, randomized, open-labeled study was designed. Sixty-three sides of nasal cavities of 45 patients were randomly assigned to three groups with different needle shapes. The group 1 needles had a straight shaft, the group 2 had an obtuse curved shaft, and the group 3 had an arch-shape shaft. The infiltration time for group 1 was longer than that for group 2 and group 3. There was significant difference in the secondary infiltration time between group 1 and group 3 ($p = 0.005$). We devised new curved-shaft needles that can utilize the ‘lever effect’ and showed that they are more efficient than straight shaft needles for infiltrating the sphenopalatine area.

Keywords Endoscopic sinus surgery · Bleeding · Sphenopalatine foramen · Needle

Introduction

Endoscopic sinus surgery (ESS) is one of the most widely carried out surgeries of the otorhinologic field. Intraoperative bleeding can impair the visualization of the surgical field and affect surgical outcome [1]. Thus, controlling bleeding is one of the most important factors for the success of ESS [1].

The sphenopalatine artery, which supplies most of the mid and posterior nasal area, is located in the posterior lateral area of the nasal cavity [2]. Injecting a diluted adrenaline solution with an anesthetic can induce vasoconstriction in the operative field [3]. When operators encounter a severely deviated nasal septum, hypertrophied turbinate, or nasal polyps, they may have difficulty placing a long needle in a desired area. Inaccurate or insufficient infiltration results in increased bleeding during the operation and can negatively affect surgical outcomes [1]. However, there have been no reports on the appropriate shape of needles used for this procedure. Thus, the aim of this study was to evaluate what types of needles are optimal and efficient for the infiltration of the sphenopalatine area in a variety of nasal conditions.

Materials and Methods

Forty-five patients (range: 13–70 years of age) who were undergoing elective ESS were enrolled in this study from December, 2013 to May, 2014. Sixty-three sides of the nasal cavities of 45 patients were randomly assigned to three groups with needles of three different shapes. This study was approved by the Ethics Committee and informed consent was obtained from all patients (File number: 2013-10-009-002). Patients with a physical status of I or II

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by the American Society of Anesthesiologist (ASA) guidelines were included in the study. Patients who had a previous history of side effects from the administration of adrenaline or lidocaine solutions and patients with unstable hemodynamics were excluded from the study.

Random numbers were obtained from the Internet site: www.graphpad.com/quickcalcs.

All patients were randomly assigned to 1 of 3 groups with different injection needle shapes (Fig. 1). A 24 gauge spinal needle was used for all three groups. The group 1 needles had a straight shaft with 1 cm of the tip bent at a 45-degree angle. The group 2 needles had an obtuse curved shaft with 0.5 cm of the tip bent at a 15-degree angle. The group 3 needles had an arch-shape curved shaft with 0.5 cm of the tip bent at a 15-degree angle.

One otolaryngologist with 10 years of experience who did not participate in this study carried out submucosal infiltration with randomly assigned needles. The primary infiltration time (1° time) for the sphenopalatine area with 1 % lidocaine and a 1:100,000 diluted adrenaline solution under endoscope was recorded from the moment needle passing the nostril till injecting 1 ml of the solution after finishing endotracheal intubation. Unless the sphenopalatine area was infiltrated with an assigned needle, additional procedures were performed to widen the nasal passage, such as tubinate outfracture, septoplasty, and polyp debulking. And, the time of secondary infiltration (2° time) to the sphenopalatine area was recorded after finishing the additional procedures.

Fig. 1 Three different needles for infiltration of the sphenopalatine area via a transnasal approach. **a** Shaft is straight and 1 cm of the tip was bent at a 45-degree angle. **b** Shaft is bent at its mid-portion at an obtuse angle and 0.5 cm of the tip was bent at a 15-degree angle. **c** Shaft has an arched shape and 0.5 cm of the tip was bent at a 15-degree angle

We adapted the Johansson grading system for nasal polyp classification: 0 = no polyps, 1 = small polyps not reaching the upper edge of the inferior turbinate, 2 = medium-sized polyps reaching between the upper and lower edge of the inferior, 3 = large polyps reaching below the lower edge of the inferior turbinate [4]. The severity of the septal deviation was described as follows: mild—deviation less than half the total distance to the lateral nasal wall, moderate—deviation more than half but not touching the lateral nasal wall, severe—touching the lateral nasal wall. The classification of the nasal septum was as follows: concave, straight, or convex with/without local spur.

Fig. 2 Scatter plots of infiltration times for the three groups using three different needles. **a** Primary infiltration time was significantly reduced in groups 2 and 3 compared to group 1. **b** Secondary infiltration time after additional procedures was significantly reduced in group 3 compared to group 1. 1°: primary, s: seconds, 2°: secondary

Table 1 Primary successful infiltration rates according to septal deviation classification and polyp grade

Class.	Polyp gr.	Success/trials	Rate (%)
Concave	0	4/5	80
	1	0/2	0
	2	3/6	50
	3	0/5	0
		7/18	39
Straight	0	10/11	98
	1	7/9	78
	2	3/6	50
	3	0/3	0
		10/18	56
Convex	0	1/6	17
	1	0/2	0
	2	0/3	0
	3	0/5	0
		1/16	6

Class Classification, *gr* Grade

Statistical analysis

The statistical analysis was performed using SPSS 12.0 (SPSS, Inc., Chicago, IL, USA). The statistical significance of the infiltration time among the groups was analyzed using the Kruskal–Wallis test. The multiple regression analysis of the factors affecting the 1° time was performed. A value of $p < 0.05$ was accepted as statistically significant.

Results

A total of 45 patients with unilateral and bilateral sinus diseases were enrolled in the study. We performed ESS on 63 sides (27 left, 36 right) of the sinus cavities of 45 patients diagnosed with chronic sinusitis. Ten patients had fungal sinusitis, three had antrochoanal polyps, three had postoperative cheek cysts, and two had a benign nasal cavity mass. The age of the subjects ranged from 13 to 74 years old with a mean of 45 years old. There were 35 (77.8 %) male subjects and 10 (22.2 %) female subjects.

In this preliminary study, there was no significant difference in the infiltration time to the sphenopalatine area for the right and left side of nasal cavity for patients with the same nasal conditions. The 1° time of the sphenopalatine area for each group is shown in Fig. 2. The mean times for each group were as follows: group 1 = 66.6 s, group 2 = 38.4 s, group 3 = 34.3 s. There were significant differences between the 1° time for groups 1 and 2 ($p = 0.005$) and groups 1 and 3 ($p = 0.004$). However,

Fig. 3 Schematic drawings of transnasal infiltration to the sphenopalatine area via transnasal approach. **a** A long-sized tip and straight shaft needle can reach the sphenopalatine area unless it touches the surrounding structure. **b** An obtuse angle shaft can utilize the lever effect against nasal septum, which acts as a fulcrum. **c** An arched shape shaft can utilize the lever effect through its entire length. * Middle turbinate, † Sphenopalatine foramen (area)

there was no significant difference between the 1° time for groups 2 and 3 ($p = 0.445$). The 2° time for each group after all additional procedures is shown in Fig. 2. There was a significant difference between the 2° time for groups 1 and 3 ($p = 0.005$).

A multiple regression analysis was performed for the 28 cases with successful primary infiltration (without needing additional procedures) to evaluate which factors affected the 1° time. Of the various factors analyzed, only needle

type significantly affected the 1° time ($p = 0.014$, $R^2 = 0.407$).

The numbers of primary successful infiltrations according to the severity of septal deviation were counted; there were 27 successful infiltrations in 53 trials (50.9 %) of patients with mild septal deviation severity, 1 in 7 trials (14.3 %) of patients with moderate septal deviation severity, and 0 in 3 trials (0 %) of patients with severe septal deviation severity. The primary successful infiltration rates according to septal deviation classification and polyp grade are shown in Table 1.

Additional procedures were performed in 34 cases (54 %). Turbinate outfracture (25.8 %) and polyp debulking (25.8 %) were the most commonly performed procedures. A septoplasty was performed in three cases (4.5 %) with severe septal deviations.

Discussion

The sphenopalatine artery, an end artery of the internal maxillary artery, enters the nasal cavity through the sphenopalatine foramen from the pterygopalatine fossa. There are two main routes to approach the sphenopalatine area. The transnasal route is widely used; it is easy but can be influenced by various nasal conditions. A transpalatal greater palatine canal injection is an alternative route for reaching the sphenopalatine artery via the pterygopalatine fossa. It has the advantages of not being affected by nasal conditions. However, the pterygopalatine fossa is directly connected to the infraorbital fissure; thus, orbital contents can be directly injured by transpalatal greater palatine canal injection. Possible complications include the following: infraorbital nerve injury, blindness due to the vasoconstriction of the ophthalmic artery, and cardiovascular side effects due to intravascular injection [5]. Thus, transpalatal greater palatine canal injection is not routinely used for preoperative sinonasal surgery due to the risk of complications.

The nasal passage is not straight but, rather, is snaky due to the turbinates of the lateral wall and the septum of the medial side. Without touching for a needle to the surrounding turbinates and septum, an operator can introduce and place the needle in the desired area in the posterior nasal cavity. Curved-shaft needles can be passed through more passage routes than straight needles by facing the concave side of the shaft toward a turbinate and the convex side of the shaft toward the septum. Another advantage of curved shaft needles is the lever effect. The tip of the curved-shaft needle can easily reach the sphenopalatine area using the lever effect obtained by placing the convex side of shaft against the septum (Fig. 3). The degree of bending can be controlled by using the septum as a

fulcrum. As the tip of the needle enters the mucosa, delicate power must be used for the tip to engage the mucosa. Without that delicate power, the needle cannot engage and the shaft of the needle may bend away.

There were some differences between groups 2 and 3. The group 2 needle has a constant fulcrum length, which determines where the needle bends; thus, only the bent portion of the needle can be used for the lever effect. However, the whole length of the group 3 needle can be used for the lever effect due to its arched shape.

The primary successful infiltration numbers were different for various conditions. When the effect of the nasal septum was relatively low, as in patients with a concave or straight septum, the rate of primary successful infiltration depended on polyp grade. In contrast, when the septal deviation was more severe, such as a convex septum, the rate of primary successful infiltration was not dependent on polyp grade but, rather, depended on the convexity itself.

The most common additional procedure performed when polyposis was not severe was the turbinate outfracture. It is an easy procedure that causes little bleeding and does not take much time; it can effectively widen a nasal passage when topical decongestion cannot. Only when a 4 mm-sized rigid endoscope could not enter the middle meatus, a septoplasty was necessary for the injection and the initiation of ESS.

In this study, we devised new curved-shaft needles that can utilize the ‘lever effect’ and utilize more passages in the nasal cavity because of their shape. Also, we showed that these needles are more efficient than straight-shaft needles for infiltrating the sphenopalatine area.

Conflict of interest No potential conflict of interest relevant to this article was reported.

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