Clinical Anatomy of Blockade of the Pterygopalatine Ganglion: Literature Review and Pictorial Tour Using Cadaveric Images

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Summary: Pterygopalatine ganglion block (sphenopalatine ganglion block) is a well-known procedure for treating cluster headache and for relieving cancer pain. In this review, the history and anatomy of the pterygopalatine ganglion are discussed, and images, including computed tomography and endoscopy, are presented to improve understanding of the clinical anatomy of the ganglion regarding the block procedure.

Key words cluster headache, pterygopalatine ganglion block, sphenopalatine ganglion block, anatomy, cadaver

INTRODUCTION

Pterygopalatine ganglion (PPG) block, which is also known clinically as sphenopalatine ganglion block, is a well-known procedure for treating cluster headache and for relieving cancer pain, and as such it can have a great influence on patients’ quality of life. Sluder [1] is recognized as the first physician to block the PPG with a transnasal approach in 1908. Ruskin [2] reviewed the remote effects of blocking the PPG and reported its efficacy for headaches, facial neuralgias, low back pain, temporomandibular joint dysfunction, and even hiccups. Subsequently, the classic and modified techniques and related anatomy have been well documented in numerous clinical studies [3-5] and reviews [6, 7]. Because of the anatomical complexity of the pterygopalatine fossa (PPF) and sphenopalatine foramen (SPF), depiction and clarification of the needle trajectory for PPG blockade has been challenging. Changes in terminology regarding PPG have also made understanding difficult. Our aim is to review the anatomy of the PPG and clarify the correct needle trajectory towards the SPF required to reach the PPF, with anatomical documentation and cadaveric dissection, to improve understanding of the PPG block procedure.

HISTORY OF PPG: FROM MECKEL TO SLUDER

PPG was first described in 1749 by Johann Friedrich Meckel, who eponymously named it Meckelii majus [8, 9]. Meckel contemplated the functions of the ganglia, suggesting they increased the number of nerve branches by subdividing small nerves, projected nerves in multiple directions, and bundled smaller nerves into larger ones [8].

In 1909, Sluder noted the close relationship between the PPG and the external bony wall of the nose [10, 11]. He also noted that the PPG was related to pain at the root of the nose, in and around the eye, the upper...
and lower teeth, the maxilla and mandible, the ear, occiput and neck, shoulder, axilla, and the entire arm [10]. This was the earliest description of what are now known as cluster headaches.

Sluder [1, 12] suggested a procedure that involved applying cocaine just posterior to the posterior tip of the middle turbinate over the ganglion. He also experimented with 2% silver and 0.5% formaldehyde solutions. In 1913, he reported a treatment that included phenol-alcohol injections into the region of the sphenopalatine foramen [12, 13]. These were the first accounts of any procedure intended to alleviate pain associated with what were first described as “nasal headaches” [1].

ANATOMY OF THE PPG

The PPG is the largest peripheral parasympathetic ganglia and is triangular in shape [14, 15]. It is located deep within the PPF and lies lateral to the SPF and below and slightly medial to the foramen rotundum and the maxillary nerve [15] (Figs. 1 and 2).

The dimensions and variability of the SPF are clinically significant in the procedure discussed herein. The foramen lies on the lateral nasal wall and can be oval, square, triangular, or piriform [16]. The average horizontal diameter is 5.1 mm (range: 4-7 mm) and the average vertical diameter 6.2 mm (4.5-7.5 mm) [16-18]. Typically, two nerve branches connect the maxillary nerve to the PPG [17, 19]; however, these sensory branches pass through the ganglion without synapsing [15, 20, 21]. Pre-ganglionic parasympathetic fibers of the PPG run first in the greater petrosal branch of the facial nerve, having originated in the superior salivatory nucleus as the nervus intermedius, and then reach the nerve of the pterygoid canal. The deep petrosal nerve is given off from the internal carotid plexus and carries post-ganglionic sympathetic fibers to the PPG through

![Fig. 1. Anatomy of the pterygopalatine fossa (light blue triangles). Note the pterygopalatine fossa is continuous with the foramen rotundum (arrowhead) and pterygoid canal (vidian nerve) (blue arrows). A: Sagittal CT section of the nasal cavity B: Sagittal CT section of the maxillary sinus C: Cadaveric dissection of the pterygopalatine fossa (surrounding bone removed) IC; inferior nasal concha, MS; maxillary sinus](image)

![Fig. 2. Location of the sphenopalatine foramen (circle). IC; inferior nasal concha, MC; middle nasal concha, SS; sphenoidal sinus](image)
the pterygoid canal (vidian nerve) [15, 19].

The pre-ganglionic fibers synapse with post-ganglionic fibers within the ganglion, and the latter travel along the trigeminal nerve branches, providing both vasomotor function to the surrounding vascular structures and secretomotor function to the nasal mucosa and lacrimal glands [19, 22].

The PPG gives rise to the nasopalatine nerve, the greater and lesser palatine nerves, the posterior superior and inferior lateral nasal branches and the pharyngeal branch of the maxillary nerve [19, 21]. Small orbital branches also arise from it [23, 24]. The greater palatine nerve supplies general sensation to the hard palate, gingiva, and mucosa of the buccal cavity; the lesser palatine nerve supplies sensation to the uvula, tonsils, and soft palate [19].

NEEDLE TRAJECTORY OF THE PPG BLOCKADE USING CAADVERIC IMAGES

An intranasal PPG blockade procedure allows the needle to approach the PPF relatively easily. Cocaine and lidocaine are usually placed on the nasopharyngeal mucosa just posterior to the middle nasal concha with a cotton-tipped applicator. According to Sluder [11, 25], a straight needle goes through the nostril posteriorly, superiorly and slightly laterally, approaching the lateral wall of the nasal cavity in the middle nasal meatus marked by the origin of the posterior edge of the bony middle nasal concha, and arrives almost immediately on the anterior wall of the PPF. Its point is then pushed backward 0.66 cm to enter the PPG or its immediate vicinity. The zygomatic arch serves as a parallel reference to the middle nasal concha [26], although it is not always a reliable landmark. Nose abnormalities such as deviation of the nasal septum can make this route difficult, uncertain, and sometimes dangerous [27].

The increased risk of nasal mucosa injury during needle insertion led to the development of the transnasal endoscopic technique for needle insertion under direct vision using a rigid sinuscope (Fig. 3). Transnasal endoscopic needle insertion was first described in 1993 by Prasanna and Murthy [28] focusing on the postero-superior aspect of the middle nasal concha (Fig. 4). Felisati et al. [29] approached the PPF using endoscopy via the lateral nasal wall between the middle and inferior nasal concha (Fig. 5).

At the posterior edge of the middle nasal concha there is a sharp crest called the ethmoidal crest. The sphenopalatine foramen is located immediately behind it and is oriented at an angle of 15 to 20 degrees in the sagittal plane, or is located just behind or slightly above the attachment of the posterior edge of the middle nasal concha and at the junction of the superior and lateral nasal walls, 12 mm superior and lateral to the superior border of the choana [30]. The superior nasal concha acts as a landmark for the sphenopalatine foramen located posterior and superior to the middle nasal concha. A valid landmark is the constant convergence of some of the vessels of the lateral wall towards the sphenopalatine foramen due to the disappearance of vessels into the foramen. This point is called ‘the vanishing point’ [31]. The ganglion is covered with a 1-5

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Fig. 3. Transnasal endoscopic observation.
A: Inferior nasal concha
B: Middle nasal concha
IC: inferior nasal concha, MC: middle nasal concha, S: nasal septum
mm layer of connective tissue and mucous membrane [32].

CONCLUSION: A thorough understanding of the anatomy of the PPG and related structures allows clinicians to more accurately predict correct needle placement.

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