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Impact of age on the anatomy of the pediatric pterygopalatine fossa and its relationship to the suprazygomatic maxillary nerve block

Alexander P. Marston[a,*], Glenn Merritt[b], Jonathan M. Morris[c], Shelagh A. Cofer[a]

[a] Department of Otorhinolaryngology, Mayo Clinic, 200 1st St SW, Rochester, MN, 55905, USA
[b] Department of Anesthesiology, School of Medicine, University of Colorado, 13001 E 17th Pl, Aurora, 80045, CO, USA
[c] Department of Radiology, Mayo Clinic, 200 1st St SW, Rochester, MN, 55905, USA

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ABSTRACT

Objectives: The suprazygomatic maxillary nerve block is associated with improved post-operative pain management after select craniofacial surgical procedures. This study's objective is to better define the impact of pediatric facial skeletal growth on techniques for accessing the pterygopalatine fossa (PPF).

Methods: Pediatric patients with prior thin-slice maxillofacial computed tomography imaging were identified in an institutional radiology database. Aquarius image-processing software (Ver. 4.4.11, TeraRecon, Inc., Foster City, CA) was used to measure from the suprazygomatic skin to the greater wing of the sphenoid where the needle is then re-oriented in an anterior and inferior trajectory allowing it to advance into the PPF.

Results: A total of 90 patients ranging from 0 to ≤18 years of age were included in the study. The mean distance from the suprazygomatic skin to the foramen rotundum in patients 0 to ≤12 months of age and > 13 to ≤18 years of age was 38.6 (SD ± 4.7) and 47.1 (SD ± 3.2) mm, respectively ($p < .0001$). The statistical analysis demonstrated a positive correlation between age in years and all of the measured distances ($p = .0001$). With respect to the plane of the needle entry site, the anterior and inferior angles required for passage into the PPF in the 0 to ≤12 months age group were 11 (SD ± 2.1) and 9.0 (SD ± 2.5) degrees, respectively, compared to those in the > 13 to ≤18 years of age group at 12.4 (SD ± 1.9) and 12.1 (SD ± 3.2) degrees, respectively. These data reveal that patients in the oldest compared to the youngest pediatric age groups require significantly greater needle insertion, yet the angles of needle re-orientation are clinically similar between these two pediatric age groups varying by up to only 3°.

Conclusion: As expected, the distance from the skin to the foramen rotundum increases significantly with age; however, the angles of re-orientation with respect to the original needle entry site demonstrated up to only 3° of variability between the youngest and oldest age groups evaluated in this pediatric cohort.

1. Introduction

Effective post-operative pain management following cleft lip and palate surgery is important for maintaining a safe airway, facilitating adequate hydration and nutritional intake, and ensuring integrity of the surgical repair [1–3]. Additionally, post-operative opioid use can increase the risk of airway obstruction, decrease respiratory drive and may prolong intensive care unit monitoring [4]. For these reasons, optimization of pain management protocols following cleft lip and palate surgery has led to the development of novel truncal anesthesia nerve block techniques.

The second division of the trigeminal nerve, or maxillary nerve, is the primary nerve that supplies the lip and palate structures. Specifically, the maxillary nerve provides sensation for the midfacial and nasal skin, lower eyelid, upper lip, intranasal mucosa, and the hard and soft palate. The maxillary nerve exits the skull base through the foramen rotundum (FR) where it then enters the medial aspect of the pterygopalatine fossa (PPF). Within the PPF, the maxillary nerve travels anteriorly and laterally where it enters the orbit through the inferior orbital fissure and becomes the infraorbital nerve [5]. Ganglionic branches from the maxillary nerve travel through the pterygopalatine ganglion to become the greater and lesser palatine nerves providing sensation to the hard and soft palate. Additionally, the zygomatic and posterior superior alveolar nerves branch off of the maxillary nerve within the PPF.

Although an infraorbital nerve block offers anesthesia for isolated cleft lip procedures, this technique does not provide anesthesia of the palate [6]. When palate anesthesia is desired, a truncal block of the

* Corresponding author.
E-mail addresses: marston.alex@gmail.com (A.P. Marston), merrittmd@aol.com (G. Merritt), morris.jonathan@mayo.edu (J.M. Morris), cofer.shelagh@mayo.edu (S.A. Cofer).

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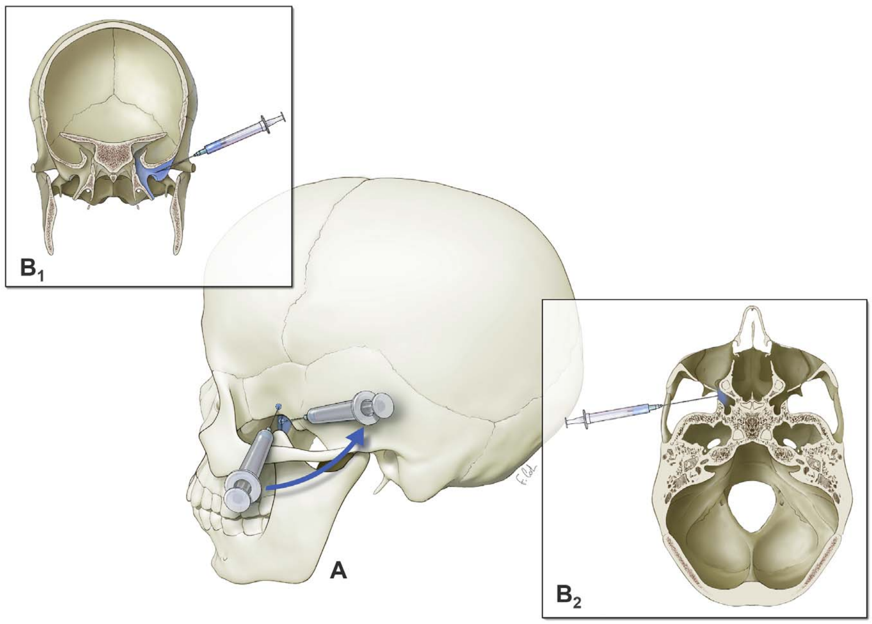

Fig. 1. Illustration depicting the technique and course of the needle when performing a transcutaneous, suprazygomatic maxillary nerve block. The needle is inserted perpendicular to the skin at the frontozygomatic angle, advanced until it contacts the greater wing of the sphenoid, and then reoriented anteriorly and inferiorly until passing into the pterygopalatine fossa (image A). B_1 shows a coronal image and B_2 an axial image of the anesthetic needle within the pterygopalatine fossa. (Illustration by Frank Corl, Mayo Clinic, Rochester, MN).

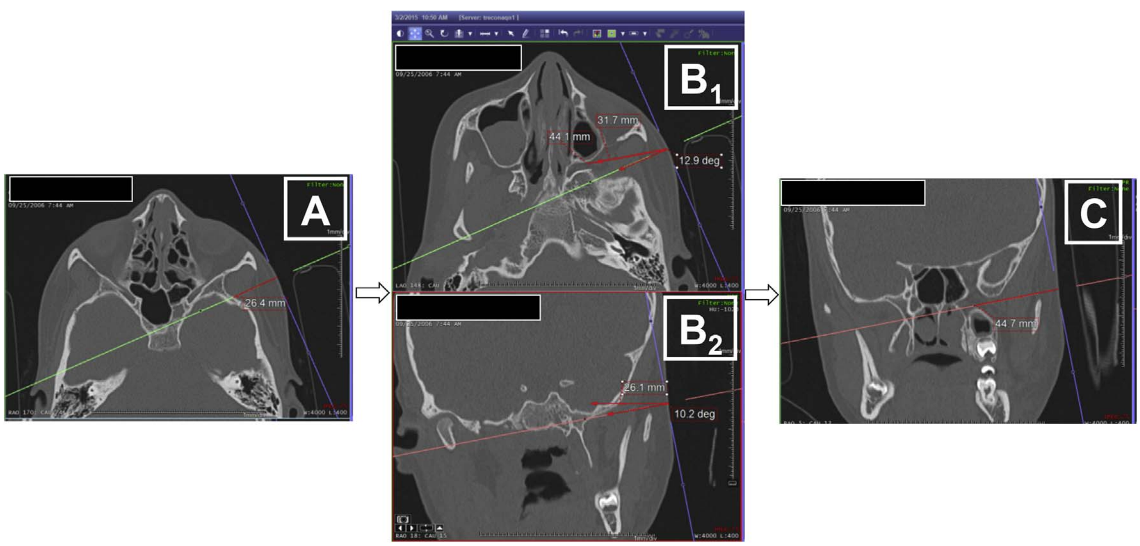

Fig. 2. Screen shots from Aquarius iNtuition (Ver. 4.4.11, TeraRecon, Inc., Foster City, CA) image-processing software showing measurements from the skin at the frontozygomatic angle to the greater wing of the sphenoid on an axial CT image (A), the angle of anterior re-orientation on an axial CT image (B_1), the angle of inferior re-orientation on a coronal CT image (B_2), and the final needle trajectory passing through the pterygopalatine fossa to the foramen rotundum on a coronal CT image (C).

maxillary nerve via a transcutaneous approach can be utilized. Transcutaneous approaches to the PPF to achieve a maxillary nerve block can be accessed via either an infrazygomatic or suprazygomatic approach [5,7]. Although the infrazygomatic approach has shown to provide an efficacious treatment for trigeminal neuralgia, it is associated with an increased risk of injury to the eye and skull base in the adult population [8]. Due to the adult literature demonstrating an increased risk of orbital injury via an infrazygomatic approach, the suprazygomatic approach is favored in children (Fig. 1). The suprazygomatic approach has been shown to produce reliable pain control results in the pediatric population following cleft palate surgery. A randomized, prospective, double-blind study by Chiono et al. published in 2013 found that the post-operative 48 h cumulative intravenous morphine dose required after cleft palate surgery was significantly less in patients who received a bilateral suprazygomatic maxillary nerve block with ropivacaine versus the isotonic saline placebo [9].

Previously published anatomic studies describe the dimensions of the PPF and maxillary nerve with respect to the suprazygomatic skin in a pediatric population [10]. However, the relationship of the anatomic distances with respect to the pediatric patient's age has not yet been described. The aim of the proposed study is to evaluate PPF anatomy with respect to age to better describe the differences in technique required for effective administration of transcutaneous suprazygomatic maxillary nerve blocks in the pediatric patient population.

2. Methods

After institutional review board approval, infants and children aged 1 week to 18 years of age with a prior head CT scan either with or without contrast between January 1, 1990 and October 1, 2014 were identified within a single institutional database. Subjects with a history of prematurity, craniofacial dysmorphisms or fractures were excluded. The CT scan thickness was less than or equal to 1 mm in all patients. The patients were divided into 6 age groups: 0 to ≤ 12 months, > 1 to ≤ 2 years, > 2 to ≤ 5 years, > 5 to ≤ 8 years, > 8 to ≤ 13 years, and > 13 to ≤ 18 years of age.