Comparison of Frontozygomatic versus Sigmoid Notch Approach for Extraoral Maxillary Nerve Block Anesthesia: A Prospective Clinical Trial

Kiran Radder¹ · Ashwin Shah² · Chaitanya Kothari² · Girish Giraddi³ · Dinesh Sharma⁴ · Ranganath Nayak⁵

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Abstract

Background With definitive indications, extraoral techniques of achieving regional nerve blocks are a boon to oral and maxillofacial surgical practice. Though less commonly practiced, since general anesthesia is more favored, certain medical conditions favor the use of regional nerve blocks over general anesthesia. To block the maxillary nerve extraorally, sigmoid notch approach and frontozygomatic approach have been previously described in the literature, but a clinical trial comparing these techniques is sparse. This study attempts to compare both the approaches for

their efficacies while paying an equal attention to the associated complications.

Materials and Methods Two hundred patients aged between 40–90 years of ASA 1 and 2 category were equally divided into two groups and underwent extraction of maxillary teeth under local anesthesia using 2% lignocaine with 1:80,000 adrenaline. Frontozygomatic approach to reach the foramen rotundum was employed in group A ($n = 100$) and sigmoid notch approach in group B ($n = 100$). Pain during injection, time required for onset of subjective and objective symptoms of anesthesia and duration of anesthesia were the study parameters. Associated complications were documented and discussed. Student's unpaired t test was used for statistical evaluation.

Results Although both the techniques were found to be feasible, statistical evaluations favored the frontozygomatic approach with respect to faster onset and a longer duration of the anesthetic effect. The anatomical considerations in either techniques suggested that the incidence of potential complications of accidental entry of the needle into the orbit, skull and vessel injuries was higher when using sigmoid notch approach as against the frontozygomatic approach.

Conclusion Though sigmoid notch approach, described widely in the literature, can be employed successfully, certain anatomical considerations and technical modifications in the frontozygomatic approach have made the latter a more practical and feasible approach. When both the maxillary and the mandibular nerves need to be blocked simultaneously, sigmoid notch may be employed, but isolated maxillary nerve block is better achieved using frontozygomatic approach.

Keywords Extraoral maxillary nerve block · Suprazygomatic approach · Sigmoid notch approach

✉ Kiran Radder
drkiranradder@gmail.com
Ashwin Shah
drashwinshah1981@gmail.com
Chaitanya Kothari
chaitanya.kothari@gmail.com
Girish Giraddi
girishgiraddi@hotmail.com
Dinesh Sharma
drdineshsharmak_20@yahoo.com
Ranganath Nayak
drnayakrn@rediffmail.com

¹ Department of OMFS, SDM College of Dental Sciences, Suttur Dharwad, Karnataka, India
² Department of OMFS, Al-Badar Dental College and Hospital, Gulbarga, Karnataka, India
³ Department of OMFS, Government Dental College and Hospital, Bangalore, Karnataka, India
⁴ Department of OMFS, SB Patil Dental College and Hospital, Bidar, India
⁵ Department of OMFS, Maratha Mandal Dental College and Hospital, Belagavi, Karnataka, India

Introduction

A wide array of indications for extraoral nerve block of the second/third division of trigeminal nerve at the foramen rotundum and foramen ovale, respectively, have prompted a number of clinical trials in an attempt to describe the techniques more exhaustively. Indications include a need to anesthetize the entire distribution of the maxillary nerve for extensive surgery where in general anesthesia is contraindicated, presence of local infection intraorally, trismus, other conditions which make blocks of the more terminal branches of the maxillary/mandibular nerve difficult or impossible, when control of postoperative pain after osteotomies or reduction of facial fractures is desired and diagnostic or therapeutic purposes as in trigeminal neuralgias [1]. Maxillary nerve block can be extraorally achieved using suprazygomatic (frontozygomatic angle) or infrazygomatic (sigmoid notch) approach. Frontozygomatic notch has been discussed in the literature previously and has been proved to be an important clinical acumen, while the same is true with the sigmoid notch approach. Since it is a well-known fact that every technique is associated with certain potential complications, the same holds true for frontozygomatic and sigmoid notch approaches. This clinical trial was undertaken to compare both these approaches for their clinical efficacies as well as to throw a light on the potential complications.

Aims and Objectives

Aim of the Study:

To compare the clinical efficacy of frontozygomatic against sigmoid notch of the mandible approach for extraoral maxillary nerve block anesthesia in minor oral surgery.

Objectives of the study:

To compare the clinical efficacy of frontozygomatic against sigmoid notch of the mandible approach for extraoral maxillary nerve block anesthesia with respect to:

1. Pain experienced during injection
2. Time required for the onset of subjective symptoms of anesthesia
3. Time required for the onset of objective symptoms of anesthesia
4. Duration of anesthesia

Materials and Methods

This comparative clinical trial was conducted between April 2001 to March 2002 at PMNM Dental College and Hospital, Bagalkot, Karnataka. Two hundred patients of ASA 1 and ASA 2 category, requiring extraction of

maxillary teeth under local anesthesia using extraoral maxillary nerve block, were divided equally into two groups as group A (frontozygomatic approach) and group B (sigmoid notch of mandible approach), and both the techniques were compared with respect to clinical efficacy as well as associated complications. All the patients were within the age group of 40–90 years. Informed/written consent was sought from all the patients.

Inclusion criteria:

1. All patients within the age group of 40 to 90 years
2. Patients of ASA 1 and ASA 2 category
3. Patients requiring extraction of a minimum of four teeth (irrespective of the indication for extraction) in either the first or the second quadrant in a single sitting

Exclusion criteria:

1. Patients with a history of allergy to 2% lignocaine with 1: 80,000 adrenaline
2. Preexisting visual disturbance, mandibular deviation
3. Patients of less than 40 years or more than 90 years
4. Patients with blood dyscrasias

Following a detailed case history and routine blood investigations, maximal inter incisal opening and mandibular jaw deviation if any were documented. Facial skin preparation was done with Nirlon (cetrimide 0.6% and chlorhexidine gluconate 0.3%) and Ramadine solution (povidone iodine 5%) followed by standard draping procedure. A 21-gauge 89-mm-long spinal needle with a rubber stopper at 50-mm mark from the needle tip was used, fitted to a 5-ml disposable syringe (Fig. 1). Three ml of 2% lignocaine with 1:80000 adrenaline was used for a single block. In group A, frontozygomatic approach and in group B sigmoid notch of mandible approach were employed.

Technique for Frontozygomatic Approach

The needle entry point was situated at the skin projection of the frontozygomatic angle—at the angle formed by the

Fig. 1 Armamentarium

Fig. 2 Entry point for frontozygomatic approach

superior edge of zygomatic arch below and the posterior orbital rim forward to the skin and advanced to reach the greater wing of sphenoid bone. This region was anesthetised with 0.5 ml of local anesthetic. The injection needle was inserted until its tip made contact with the bone. After confirming that the needle was in contact with the greater wing of sphenoid bone, it was advanced through the infratemporal fossa angulated at approximately 60° and 10° toward the sagittal and the horizontal planes, respectively. To avoid pain, 0.2–0.3 ml of local anesthetic solution was injected each time before the needle was advanced about 5–8 mm at each attempt. When the rubber marker approached the surface of the skin, patients were instructed to warn the operator when they felt local anesthetic dropping in their nose or throat. This meant that the tip of the needle had reached the posterior wall of the pterygopalatine fossa and penetrated the nasal mucosa. The needle was then withdrawn for 3–5 mm to avoid intranasal injection, and after careful aspiration in at least two different planes, about 30°–40° apart, the remaining drug was slowly deposited into the vicinity of the foramen rotundum where the maxillary nerve leaves the base of the skull to enter the pterygopalatine fossa (Figs. 2, 3).

Fig. 3 Line diagram for frontozygomatic approach

Technique for Sigmoid Notch Approach

The midpoint of the zygomatic process was located, and the depression in its inferior surface was marked with a 25-gauge hypodermic needle. A skin wheal was raised just below the mark in the depression which the operator identified by having the patient open and close the jaw. A 21-gauge 89-mm-long spinal needle with a rubber stopper at 50-mm mark from the needle tip was used, fitted to a 5-ml disposable syringe. The needle was inserted through the skin wheal perpendicular to the median sagittal plane until the needle point gently made contact with the lateral pterygoid plate. The needle was withdrawn with only the point left in the tissue and redirected in a slight forward and upward direction until the needle was inserted into the depth of the marker. As in the frontozygomatic approach, 0.2–0.3 ml of local anesthetic solution was injected each time before the needle was advanced about 5–8 mm at each attempt. After careful aspiration in at least two different planes about 30°–40° apart, the remaining solution was slowly injected (Figs. 4, 5).

The study parameters included: pain experienced during the injection of the local anesthetic quantified using visual analog scale (VAS) and the scale used was: 0 to 2—no pain, 3–5 mild pain, 6–8 moderate pain and 8–10 severe pain; time required for the onset of anesthesia (subjective symptoms) was recorded in seconds when the patients reported of a feeling of numbness in the respective anatomical area, i.e., palate and the infraorbital region; time needed for the onset of peak effect of anesthesia

Fig. 4 Entry point for sigmoid notch approach

Fig. 5 Line diagram for sigmoid notch approach

referred to as the objective symptoms was also recorded in seconds and was assessed by the operator by probing the mucosa with a blunt instrument after the onset of subjective symptoms; and duration of anesthesia was assessed in hours and was recorded when the patients reported of return of the sensory function. All the parameters were subjected to statistical evaluation using unpaired t test, and

a $P < 0.05$ was considered as significant and $P < 0.001$ was highly significant. Complications like hematoma, ecchymosis, visual disturbance, limitation of mouth opening, deviation of the lower jaw or any other, immediately following the injection were assessed.

Results

Mean age of patients was 71.9 years with 56 male and 44 female patients in group A, while the mean age was 72.1 years with 61 male and 39 female patients in group B (Tables 1, 2). Two patients in group A and three patients in group B were excluded from the study since anesthesia was not secured in the first attempt.

On comparison, 71 patients in group A reported of no pain during injection as against 38 in group B and over all pain scores were better among the patients in group A, justified statistically with a $P < 0.001$ (Table 3).

Of the total sample, two patients in group A and three patients in group B reported of failure of subjective symptoms up to 100 s following the injection and the nerve block was repeated. Mean values of time needed for the onset of subjective symptoms (seconds) in palate (21.3—group A, 31.2—group B) as well as infraorbital region (25.1—group A, 36.3—group B) favored frontozygomatic approach (group A) over the sigmoid notch approach (group B) ($P < 0.01$, Table 4).

Table 1 Mean age of patients in two groups

Groups	No. of patients	Age in years		
		Range	Mean	SD
Group A	100	40–90	71.9	12.8
Group B	100	40–90	72.1	12.6

No significant difference between group A and group B

Table 2 Sex-wise distribution

Groups	Male	Females	Total
Group A	56	44	100
Group B	61	39	100
Total	117	83	200

Table 3 Incidence of pain during injection

Groups	No pain	Mild pain	Moderate pain	Total
Group A	71	27	2	100
Group B	38	50	12	100
Total	109	77	14	200

$P < 0.001$ highly significant

Table 4 Onset of anesthesia (subjective symptoms)

Area (region)	Groups	No. of subjects	Onset of anesthesia (Sec.)			<i>t</i> value	Significance
			Range	Mean	SD		
Palate	Group A	98	0–90	21.3	24.6	2.96	$P < 0.01$ Sig.
	Group B	97	0–100	31.2	23.2		
IOF	Group A	98	0–90	25.1	25.7	3.13	$P < 0.01$ Sig.
	Group B	97	0–90	36.3	25.4		

Unpaired *t* test
 IOF infraorbital fossa
 $P < 0.01$ significant

Table 5 Peak effect (objective symptoms)

Area (Region)	Groups	No. of subjects	Onset of anesthesia (Sec.)			t-value	Significance
			Range	Mean	SD		
Palate	Group A	98	90–180	106.1	24.8	1.07	NS
	Group B	97	90–300	110.4	32.0		
IOF	Group A	98	90–180	108.14	25.7	1.05	NS
	Group B	97	90–300	112.7	32.3		
PSA	Group A	98	90–180	104.6	26.6	0.75	NS
	Group B	97	90–330	107.8	33.9		

Unpaired *t* test
 IOF infraorbital fossa, PSA posterior superior alveolar area, NS not significant

Table 6 Duration of anesthesia

Groups	No. of subjects	Duration of anesthesia (h)			<i>t</i> value	Significance
		Range	Mean	SD		
Group A	98	2.81–5.03	3.48	0.61	5.07	$P < 0.001$ HS
Group B	97	1.47–5.03	3.04	0.63		

Unpaired t-test
 $P < 0.001$ highly significant

Peak anesthetic effect was assessed objectively by the operator, in the palate, infraorbital and the posterior superior alveolar regions separately. Although the mean of the time required for the peak effect quantified in seconds favored the frontozygomatic approach over the sigmoid notch approach, the difference was statistically insignificant (Table 5).

A highly significant difference with a $P < 0.001$ was noted between both groups when the total duration of anesthesia was evaluated in hours with mean values of 3.48 and 3.04 h, respectively, in group A and group B, as evident in Table 6.

Ipsilateral transient diplopia occurred in two patients in group A and seven patients in group B immediately after the injection, while the same subsided in all the cases within 3 h. Positive aspiration was encountered in eight out of 100 patients in group B, while the incidence was zero in

group A. None of the cases had any episode of sudden attack of headache or any other complication.

Discussion

Extraoral techniques of blocking the maxillary nerve at the foramen rotundum have been described, but literature comparing the subsigmoid versus frontozygomatic approaches for the same is sparse. The subsigmoid approach, though useful, has inherent potential complications like penetration of the orbit, or the skull and accidental maxillary artery puncture [1, 2]. As observed by Okuda et al. and Captier et al., the risk of vascular injury in the subsigmoid approach is more owing to the vicinity of the inframaxillary artery. In contrast, penetration of the orbit or the skull is not possible when using

frontozygomatic approach [3], probably because in this approach, the needle right from its entry point to the final position is parallel to the sagittal plane and the maxillary artery in the pterygopalatine fossa lies ventrally and inferiorly to the maxillary nerve and is thus devoid of potential injuries. [2]. In suprazygomatic route, even if any blood vessel is injured, the collected blood is limited since the infratemporal fossa is filled with temporalis muscle and it does not need any treatment apart from antibiotic cover [1].

Another advantage of the suprazygomatic approach is that this trajectory limits the needle insertion in the anterior portion of the foramen rotundum avoiding inadvertent puncture of the intra orbital contents through the infraorbital fissure, and to justify the same, Sola et al. [4] attempted to study the ultrasound guided characteristics and efficiency of suprazygomatic maxillary nerve blocks in infants and observed that, as per ultrasonographic evaluation, 70% of the local anesthetic solution was found to be deposited in the intermediate portion of the pterygopalatine fossa. The anatomical location of the internal maxillary artery in the anterior part of the pterygopalatine fossa makes its accidental puncture unlikely because of the caudal inclination of the needle during the puncture. This hypothesis was confirmed by the fact that the authors never observed the needle movements close to the internal maxillary artery or any blood reflux through the needle during aspiration tests [4]. Similarly, in our study, positive aspiration was not seen in any of the cases in group A, while it was observed in seven cases in group B.

In the sigmoid notch approach, the needle after contacting the lateral pterygoid plate has to be withdrawn and redirected anteriorly and superiorly to pass anterior to the lateral pterygoid plate into the pterygopalatine fossa.

Baljit Singh et al. conducted a study on patients as well as on the skull models to determine the length of the needle that needs to be used to reach the maxillary nerve after contacting the lateral pterygoid plate in the sigmoid notch approach. Authors noted that the maxillary nerve disappears into the inferior orbital fissure after a short distance following the emergence from behind the anterior border of the lateral pterygoid plate. Thus, only a small length of the nerve is available to secure a successful anesthesia in this technique. [5] This could possibly explain why paresthesia could be elicited in only 49 out of 75 cases in this study [5]. In contrast, access to the mandibular nerve is not obstructed by any bony structure and a relatively longer length of the nerve is available for the needle-contact-produced paresthesia.

The lateral pterygoid plate is concave in the middle part, making the anterior and posterior borders nearly equidistant to the middle part where the needle directed from the midpoint of the zygomatic arch touches the lateral pterygoid plate, and because of this projecting anterior border of

the lateral pterygoid plate, which ends superiorly and laterally to form the posterior aspect of the pterygopalatine fossa, there is a mechanical shielding of the nerve at its exit from the foramen rotundum. This anatomical finding could be attributed to the observed results in this study, i.e., a faster onset and a longer duration of the anesthetic effect seen in the frontozygomatic group as against in the sigmoid notch group.

Pain experienced during injection assessed in terms of VAS was comparatively more in group B, which could probably be owing to the fact that the needle is inserted perpendicular to the sagittal plane and it passes through the structures like subcutaneous muscles, masseter muscle and lateral pterygoid muscle [6], while in the FZ approach, the needle is kept parallel to the sagittal plane causing less trauma to the intervening structures. But to substantiate this fact, further studies to ascertain the actual structures encountered during the needle penetration in FZ approach may be required.

FZ approach is associated with the complications like pain during injection, sudden attack of headache or even brain stem anesthesia. The possible explanation for this is that the volume of the pterygopalatine fossa is less than 1 cm³ which is less than total quantity of local anesthetic solution (3 ml). So this excess solution is likely to return to the infratemporal fossa via the pterygomaxillary fissure, some quantity may enter infraorbital canal or the middle cranial fossa through the foramen rotundum. Also on its route to the injection site, the tip of the needle passes close to the vital structures like peripheral branches of the facial nerve, branches of the superficial temporal artery and vein, the maxillary artery, pterygoid venous plexus and the sphenopalatine blood vessels carrying a risk of damaging these vital structures. But the aforementioned complications can be avoided because, of the total 3 ml of the anesthetic solution, 1–1.5 ml is used for painless advancement of the injection needle on its route from the frontozygomatic angle to the pterygopalatine fossa since 0.2–0.3 ml of the local anesthetic is injected each time before the needle is advanced about 5–8 mm at each attempt [7].

The technical difficulties in employing the frontozygomatic angle approach could be width of the pterygomaxillary fissure of < 2 mm, preventing the tip of the needle from entering the pterygopalatine fossa, and an enlarged sphenoidal spine obstructing the entrance to the pterygomaxillary fissure [7]. But these difficulties can be negotiated with the current injection technique of assuming a 60° and 10° toward the sagittal and horizontal planes, respectively [7].

Authors in this clinical trial made an attempt to compare the clinical feasibility and efficacy of the frontozygomatic versus sigmoid notch approaches to reach the foramen

rotundum and observed that the suprazygomatic approach is better in terms of faster onset as well as a longer duration of the anesthetic effect, while it has fewer incidences of iatrogenic complications as against the subsigmoid notch. To conclude, although the sigmoid notch is also a practically feasible approach, it is better to employ this technique for the extraoral mandibular nerve blocks, while the frontozygomatic seems to be more favorable approach for extraoral maxillary nerve blocks and the technique may be made more common in day-to-day clinical practice, and more clinical trials with the above-mentioned perspective should be encouraged.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical Standards Procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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