

Efficacy and Safety of Conventional Halstead versus Modified Infra Alveolar Block Technique for Third Molar Extraction

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ABSTRACT

Objective: To compare efficacy of block, safety profile and frequency of adverse effects after using conventional Halstead technique versus experimental modified Halstead technique for inferior nerve block in patients planned for third molar extraction

Study Design: Quasi-experimental study

Place and Duration of Study: Orthodontics department of Armed Forces Institute of Dentistry (AFID), Rawalpindi, Pakistan, from Jun 2024 to Jul 2025

Methodology: Participants were placed in Group-A (n=160) to receive conventional Halstead approach for the block and Group B (n=160) to receive modified infra alveolar block technique for a modified Halstead approach. Primary variables studied were frequency of re-anesthesia required due to persistent pain after starting the procedure, electric discharge sensation felt, local complications including swelling and bleed, mean onset of block time at the level of tongue and lower lip. Secondary variables studied were pain during injection and extraction.

Results: Median pain scores on the VAS during injection were 2.00 (2.00) versus 3.00 (2.00) ($p<0.001$) and median pain scores during extraction were 3.00 (2.00) versus 5.00 (3.00) ($p<0.001$). Re-anesthesia requirement was seen in 46(28.7%) patients in Group-A versus 72(45.0%) patients in Group-B ($p=0.003$). Complete block failure was reported in 05(3.1%) patients in Group-A versus 08(5.0%) patients in Group-B ($p=0.396$).

Conclusion: Conventional Halstead approach still offers the better patient outcomes with respect of onset of block time, frequency of local complications, median pain scores during the procedure, requirement of re-anesthesia and overall block failure.

Keywords: Conventional Halstead technique Extraction, Modified Halstead technique, Third molar extraction

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INTRODUCTION

Pain relief in the mandibular molar region remains a cornerstone of oral surgery practice, particularly in third molar extractions where deep anesthesia of the inferior alveolar nerve (IAN) is critical.¹ Despite advancements in local anesthetic agents and techniques, inadequate anesthesia remains a common clinical problem, with failure rates for inferior alveolar nerve block (IANB) reported between 15–25% globally.² This persistent issue has stimulated continuous refinement of traditional approaches, including modifications of the Halstead technique, which has been the gold standard since its introduction in the late 19th century.³

Globally, mandibular third molar extractions are among the most frequently performed oral surgeries, with pain control directly influencing patient

satisfaction, surgical efficiency, and postoperative recovery.⁴ Recent studies have shown that nearly 30% of patients undergoing third molar extraction require secondary infiltration anesthesia following conventional Halstead IANB.⁵ This has driven clinicians to explore more predictable and patient-friendly modifications.

Regionally, reports from South Asia and the Middle East echo similar concerns. Studies conducted in Pakistan and India have demonstrated failure rates up to 40% with the classical Halstead method, largely attributed to anatomical variations in the mandibular foramen and operator-dependent technique inconsistencies.⁶ Modified techniques such as inferior approaches or extra-short needle modifications – have emerged as potential solutions, offering improved accuracy in anesthetic delivery and greater patient comfort.⁷

Internationally, the shift toward precision-guided approaches, including 3D-assisted or ultrasound-

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guided nerve localization, has further highlighted the anatomical variability influencing block success.⁸ These advancements underscore the need to reassess the conventional Halstead technique and investigate modified, more inferior insertion points, which may align better with individual nerve trajectories. Such modifications could potentially reduce anesthetic failure rates, minimize discomfort, and enhance clinical outcomes in third molar surgeries.

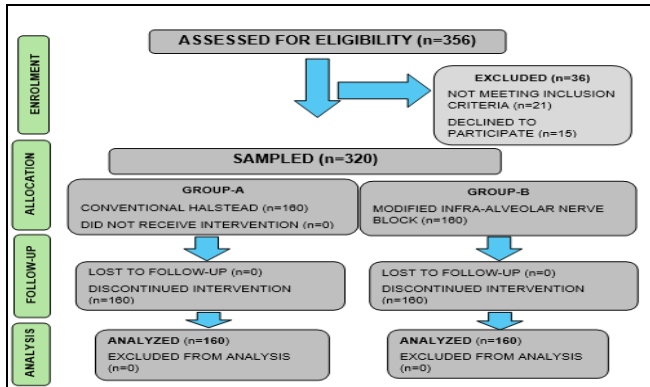


Figure: Patient Flow Diagram

METHODOLOGY

This Quasi-experimental study was carried out at the Orthodontics department of Armed Forces Institute of Dentistry (AFID), Rawalpindi, Pakistan from June 2024-July 2025 after approval from the ethical review board (vide letter no. 918/Trg/May/2024) dated 20th May 2024. Sample size was calculated using the WHO calculator keeping the confidence interval at 95%, power of test at 80% with anticipated requirement for re-anesthesia after initial block administration seen in 36.7% versus 47.9% of patients between the Halstead and modified Halstead technique.⁹ Minimum sample size using the WHO calculator came out to be 302 patients. We included a total of 320 patients in the final assessment protocol keeping margin for lost to follow-up and inconsistent results according to the inclusion criteria for the study. The study adhered to ethical guidelines and received approval from the institutional ethics committee. All participants provided informed consent and were not compensated.

Inclusion Criteria: Adults of both genders between 18 and 60 years of age who were otherwise medically stable and classified as ASA I or II according to the American Society of Anesthesiologists physical status classification planned for surgical extraction of the

lower third molar without any acute inflammatory or infectious signs at the time of recruitment.

Exclusion Criteria: Patients with significant systemic disease (ASA class III or IV). Pregnant and lactating women were not included. Individuals with known hypersensitivity to lidocaine or other amide-type local anesthetics, those with cardiovascular disease that contraindicated the use of vasoconstrictors, bleeding disorders, or those receiving anticoagulant therapy were excluded. Additional exclusion criteria included any local trauma, swelling, or infection associated with the third molar within 30 days before surgery, the use of analgesics or anti-inflammatory agents within the previous week, pathology involving adjacent teeth, and third molars in ectopic positions. Procedures that required more than 60 minutes for extraction were also excluded from the study.

Ethical approval for the study was obtained from the Research Ethics Committee of the institution. All participants were informed in detail about the purpose, expected benefits, and possible risks of the study before enrollment, and written informed consent was obtained from each individual. No financial incentives or compensations were provided for participation. The trial adhered strictly to the principles outlined in the Declaration of Helsinki.¹⁰ All participants were divided into two groups using simple random sampling once they presented in the OPD and were planned for a third molar extraction by a resident unaware of the study protocol using computer-generated chits marked X and Y with no knowledge of what they signified to ensure group allocation blinding and prevent bias. Participants were placed in Group-A (n=160) to receive conventional Halstead approach for the block and Group B (n=160) to receive modified infra alveolar block technique for a modified Halstead approach.

All surgeries were carried out by consultants in oral surgery using standardized procedures adhering to institutional guidelines. Group-A received the conventional Halsted approach. Group-B received a modified inferior alveolar nerve block (IANB) with the injection point positioned more anteriorly along the occlusal plane. Both techniques utilized the same syringe and needle type to prevent confounding. Anesthetic (2% lidocaine with 1:80,000 epinephrine), 2.0 ml was administered in two steps comprising of initial block and lingual nerve infiltration. A buccal infiltration of 1.8 ml was also applied. Group-A underwent the standard Halsted technique.¹¹ Patients

in Group-B received a modified inferior alveolar nerve block (IANB), with the injection placed at the occlusal plane, approximately three-quarters along the distance from the anterior border of the mandibular ramus. In both protocols, once the needle contacted the bone, it was slightly retracted (approx. 1 mm), aspiration was conducted, and if no blood appeared, the anesthetic was slowly injected. Roughly 1.3 ml of solution was delivered to the IANB site, and 0.5 ml was deposited during needle withdrawal to anesthetize the lingual nerve. To ensure buccal nerve anesthesia for molar extraction, an additional 1.8 ml infiltration was administered in the buccal area. Thermal sensitivity of the lower first molar on the same side was assessed every 30 seconds using a cotton pellet soaked in tetrafluoroethene until no response was noted. All surgeries were conducted under sterile conditions. A full thickness mucoperiosteal flap was raised and protected with a Minnesota retractor. Lingual flap retraction was selectively performed using a Freer elevator, based on surgical need. When necessary, bone removal and tooth sectioning were carried out using a sterile low-speed handpiece (20,000 rpm) and sterile saline. Wounds were closed with 3-0 silk sutures.

Primary variables studied were frequency of re-anesthesia required due to persistent pain after starting the procedure, electric discharge sensation felt at the level of tongue and lower lip, local complications including swelling and bleed, mean onset of block time at the level of tongue and lower lip. Secondary variables studied were pain during injection and extraction.

All statistical calculations were performed using Statistical Package for Social Sciences 26.00. Demographic and clinical variables including age, weight, and extraction time were expressed as Mean±Sd and compared using the independent samples t-test. Normality of the data was checked for continuous variables and was normally distributed. Variables including re-anesthesia, electric discharge sensations at the lower lip and tongue, local complications, flap acquisition, bone removal and tooth suctioning were expressed as frequency and percentage and compared using the Chi-square and Fisher-exact test as appropriate. Time to block onset at the level of lower lip and tongue were expressed as Mean±Sd and compared using the independent samples t-test. Pain scores during injection and extraction were expressed as median and interquartile

range and compared using the Mann-Whitney U test. A p value of ≤ 0.05 was considered statistically significant.

RESULTS

A total of 320 patients were analyzed in the final assessment protocol divided into Group-A (n=160) receiving the block through Halstead approach and Group-B (n=160) to receive the modified infra-alveolar nerve block technique (IANB). Mean age of patient was 27.56 ± 3.27 years versus 29.29 ± 3.65 years ($p < 0.001$). Gender distribution revealed 88(55.0%) males and 72(45.0%) females in Group-A versus 87(55.4%) males and 73(45.6%) females in Group-B ($p = 0.911$). Procedure was done on the right side in 85(53.1%) versus 74(46.3%) males in Group-A versus left side in 75(46.9%) males and 86(53.8%) females ($p = 0.219$). Mean tooth extraction time was 15.02 ± 2.08 minutes versus 16.09 ± 2.11 between both groups ($p < 0.001$). Flap lift was done in 72(45.0%) versus 74 (46.3%) patients ($p = 0.822$), bone removal in 61(38.1%) versus 92(57.5%) patients ($p < 0.001$) and tooth suctioning was done in 67(41.9%) versus 68(42.5%) patients ($p = 1.000$) (Table-I).

Block characteristics and patient outcomes showed that electric discharge sensation in the tongue was reported in 08(5.0%) versus 13(8.1%) patients ($p = 0.259$) while in the lower lip was reported in 11(6.9%) versus 18(11.3%) patients ($p = 0.173$). Local complications were seen in 14(8.8%) versus 19(11.9%) patients ($p = 0.358$). Block onset time for blocking the tongue was 36.01 ± 5.41 seconds in Group-A versus 54.96 ± 9.22 seconds in Group-B ($p < 0.001$) while block onset time for lower lip was 38.96 ± 6.11 seconds versus 90.00 ± 17.63 seconds between both groups ($p < 0.001$). Median pain scores on the VAS during injection were 2.00 (2.00) versus 3.00(2.00) ($p < 0.001$) and median pain scores during extraction were 3.00 (2.00) versus 5.00(3.00) ($p < 0.001$). Re-anesthesia requirement was seen in 46(28.7%) patients in Group-A versus 72(45.0%) patients in Group-B ($p = 0.003$). Complete block failure was reported in 05(3.1%) patients in Group-A versus 08(5.0%) patients in Group-B ($p = 0.396$) (Table-II).

DISCUSSION

The study concluded that conventional Halstead approach still offers the better patient outcomes with respect of onset of block time, frequency of local complications, median pain scores during the procedure, requirement of re-anesthesia and overall block failure. Krishna *et al.* (2024) conducted a prospective comparative study evaluating five inferior

alveolar nerve block (IANB) methods, including the Halstead approach, in mandibular third molar extractions. They found that while the Halstead block achieved moderate anesthesia onset and success, alternative approaches like the Kurt-Thoma technique exhibited faster onset but greater complications such as trismus and transient paresthesia. This highlights that although the Halstead method remains reliable, newer methods may improve onset at the expense of complication risk.³ Khalifah *et al.* (2021) compared a novel extra-oral infra-alveolar block to the conventional Halstead IANB and found that the novel method achieved a significantly higher success rate (98.68% vs 88.16%) with similar onset time and anesthetic depth. The study demonstrated that modified external landmark approaches could enhance consistency in anesthesia delivery, especially in patients with challenging mandibular anatomy, suggesting potential for improved clinical outcomes.¹² The authors further observed that pain during injection and intra-operative pain scores showed no significant difference between the Halstead and novel infra-alveolar approaches. However, the newer technique required fewer supplemental injections, indicating better predictability and operator satisfaction. The comparable pain outcomes suggest that success may depend more on operator proficiency than the choice of technique alone.

Table-I Demographic and Clinical Characteristics Between Both Groups (n=320)

Variables	Group A (n=160)	Group B (n=160)	p-value
Mean Age (years)	27.56±3.27	29.29±3.65	<0.001*
Mean Weight (kg)	68.91±9.94	67.77±9.55	0.295*
Gender			
Male	88 (55.0%)	87 (54.4%)	0.911**
Female	72 (45.0%)	73 (45.6%)	
Operated Side			
Right	85 (53.1%)	74 (46.3%)	0.219**
Left	75 (46.9%)	86 (53.8%)	
Extraction Time (Minutes)	15.02±2.08	16.09±2.11	<0.001*
Flap Lift	72 (45.0%)	74 (46.3%)	0.822*
Bone Removal	61 (38.1%)	92 (57.5%)	0.001*
Tooth Suctioning	67 (41.9%)	68 (42.5%)	1.000*

*Independent samples t-test, **Chi-square test.

Brizuela *et al.*, reported that the Halstead IANB has a failure rate of 15–20% even in skilled hands, primarily due to anatomical variability of the mandibular foramen. This emphasizes the inherent limitation of intra-oral techniques relying on soft tissue landmarks, which may vary significantly among

populations. The authors advocated for refining landmark recognition and considering newer blocks to minimize such variability and improve reliability.¹³ Abbasi *et al.*, in a randomized controlled trial in Islamabad compared the conventional Halstead IANB with the Gow-Gates mandibular block for molars with irreversible pulpitis. Their findings indicated higher success (84% vs 69%) for the Gow-Gates block, with improved pulpal anesthesia and fewer reinjections. While not a direct comparison of infra-alveolar and Halstead, this Pakistani study reinforces the trend that broader mandibular coverage blocks outperform traditional Halstead techniques in success rate and anesthetic reliability.¹⁴

Table-II Block Characteristics And Complications (n=320)

Variables	Group A (n=160)	Group B (n=160)	p value
Electric Discharge Sensation Tongue	08(5.0%)	13(8.1%)	0.259**
Electric Discharge Sensation Lower Lip	11(6.9%)	18(11.3%)	0.173**
Local Complications	14(8.8%)	19(11.9%)	0.358**
Block Onset Time Tongue (SEC)	36.01±5.41	54.96±9.22	<0.001*
Block Onset Time Lower Lip (SEC)	38.96±6.11	90.00±17.63	<0.001*
Median Pain Scores During Injection (Visual Analog Scale)	2.00(2.00)	3.00(2.00)	<0.001***
Median Pains Scores During Extraction (Visual Analog Scale)	3.00(2.00)	5.00(3.00)	<0.001***
Frequency Of Re-Anesthesia Requirement	46(28.7%)	72(45.0%)	0.003*
Complete Block Failure	05(3.1%)	08(5.0%)	0.396*

*Independent samples t-test, **Chi-square test, ***Mann-Whitney U test

Rehman *et al.* (2024) compared the Gow-Gates mandibular block with the Halstead IANB specifically for third molar extraction in Pakistan. The Gow-Gates technique demonstrated faster onset of anesthesia ($p < 0.001$) but a slightly higher mean pain score (1.59 ± 2.02) than the Halstead block (1.43 ± 1.19). This suggests that, while newer methods yield quicker anesthesia, patient comfort may still favor the traditional technique, likely due to operator familiarity and experience with intra-oral approaches.¹⁵

Bicsák *et al.* (2025) reported in a recent in-silico comparison of five inferior alveolar nerve block methods – including the classic Halstead approach (Halsted approach and other variants that while

computational success-rate modelling favored newer techniques e.g., the Gow-Gates technique), the Halstead method still performed acceptably in many anatomical scenarios, particularly where surgeon familiarity was high. This suggests that even as novel infra-alveolar or alternative landmarks gain promise, the Halstead method retains value, especially where operator expertise is well-established.¹⁶ Oiwa *et al.* evaluated an ultrasound-guided inferior alveolar nerve block (UGIANB) for impacted mandibular third molar extraction and found that patients who received UGIANB had significantly longer time to first postoperative rescue analgesic compared to controls (median 461 vs. 266 minutes; $p = 0.049$). While this study did not directly compare Halstead versus infra-alveolar blocks, the findings emphasize the potential of image-guided techniques in improving pain control and lowering complications in third molar surgery.¹⁷

Ahmed *et al.*, in a systematic review of IANB failure modes highlighted that the Halstead approach remains susceptible to failure due to anatomical variation (e.g., mandibular foramen position, ramus thickness) and that newer infra-alveolar techniques by utilizing extra-oral or ultrasound landmarks – may reduce supplemental injection rates and improve onset consistency. The authors caution, however, that operator training and standardization of technique remain major hurdles.¹⁸

While certain studies recommend the inferior block approaches, it is pertinent to mention that the degree of inferior block done is associated with the time of anesthesia and the chances of complications. The conventional approach still offers the best advantage of achieving a balance between block time, failure rates and complications and is still recommended as the recommended approach in majority of patients unless not feasible due to anatomical location of complicated dental access.

LIMITATIONS OF STUDY

The limitations are that the study is a single center study. The Halstead block remains limited by anatomical variability and a moderate failure rate (15–20%), along with possible complications like vascular injury and incomplete nerve coverage. Novel infra-alveolar blocks, despite higher success rates, require advanced training, exhibit inconsistent onset improvements, and lack large-scale randomized evidence. Furthermore, extra-oral variants may introduce complexity and require specialized equipment, limiting applicability in resource-constrained settings. Overall, evidence suggests both techniques remain viable, with

future studies needed to establish standardized guidelines for mandibular third molar anesthesia across populations.

CONCLUSION

The study concluded that conventional Halstead approach still offers the better patient outcomes with respect of onset of block time, frequency of local complications, median pain scores during the procedure, requirement of re-anesthesia and overall block failure.

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Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

SU & MJ: Data acquisition, data analysis, critical review, approval of the final version to be published.

AA & SJHB: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

AW & FA: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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