EVALUATION OF PAIN OUTCOMES WITH ARTICAINE VERSUS LIGNOCAINE IN THE ENDODONTIC AND SURGICAL MANAGEMENT OF IRREVERSIBLE PULPITIS IN MAXILLARY FIRST MOLARS

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ABSTRACT

Background: Untreated caries leading to cavity formation was one of the most common dental diseases internationally affecting 2.4 billion people in the year 2010. Irreversible pulpitis is one of the most common dental diseases in Pakistan with a prevalence of 19.4 percent according to one study. Maxillary molars are one of the most commonly affected teeth by irreversible pulpitis. They are also considered the cornerstone of occlusion and the tooth with the most stable anatomy. The management of irreversible pulpitis involves pulp extirpation and exodontia.

Objectives: Assessment of Pain Levels in Root Canal and Extraction Procedures Using Articaine and Lignocaine Buccal Infiltration in Maxillary First Molars with Irreversible Pulpitis

Methods: It is randomized clinical study conducted at Pharmacology department, Islamic International Medical College Rawalpindi with support Margalla Institute of Health Sciences. The duration of study was one year. 240 patients who were being treated for irreversible pulpitis in first upper molars randomly divided into two Groups, Group 1 and 2. Group 1 were the patients given the specific local anesthesia for pulp extirpation (root canal treatment). Group 2 were the patients given the local anesthetic for exodontia (dental extractions). These groups were divided further into four groups. Group A and Group B were managed by pulp extirpation (root canal) and were given Lignocaine and Articaine respectively. Group C and Group D were managed by exodontia (dental extraction) and were anesthetized using Lignocaine and Articaine respectively. The intensity of pain reported by the patient during injection and the pain felt during the procedure was determined by the VAS.

Results: Significantly less pain was experienced by the Group B and Group D patients as compared to Group A and C during the procedure. There was no statically significant difference in the pain experienced by the patients during the injection.

Conclusion: Articaine causes marked decrease in the pain experienced during the procedure and it can be used in the management of irreversible pulpitis.

Keywords: Articaine, Lignocaine, Irreversible Pulpitis, Maxillary First molars, Pain

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INTRODUCTION

Untreated caries leading to cavity formation was one of the most common dental diseases internationally affecting 2.4 billion people in the year 2010.[1] Irreversible pulpitis is one of the most common dental diseases in Pakistan with a prevalence of 19.4 percent according to one study.[2] Maxillary molars are one of the most commonly affected teeth by irreversible pulpitis.[3] They are also considered the cornerstone of occlusion

and the tooth with the most stable anatomy. The management of irreversible pulpitis involves pulp extirpation and exodontia. Both these treatment modalities require the use of anesthesia intraoperatively.
The most commonly used dental anesthetic in Pakistan is lignocaine. However, articaine has been used as a dental anesthetic and has yielded better results than lignocaine. Due to its structural difference from lignocaine articaine has better lipid solubility than lignocaine. This improved lipid solubility results in a more potent drug and a lesser risk of overdosage. Since it is used in a lesser dose than lignocaine articaine can also prove to be a cost-effective agent.
There is limited data that measures the therapeutic effect of lignocaine and articaine in the management of irreversible pulpitis in maxillary first molar. Since the maxillary molar is the most commonly affected maxillary tooth for irreversible pulpitis hence a study is designed to compare the effect of lignocaine and articaine in the treatment of irreversible pulpitis in maxillary first molar teeth.

METHODS

It was a randomized double blind clinical study which was carried out in Pharmacology department, Islamic International Medical College Rawalpindi together with Margalla Institute of Health Sciences. Study duration was one year.A total of 240 adult patients of irreversible pulpitis were made a part of the study who were divided into 4 groups each having 60 patients in the group[4]
The sample size was determined using the formula

$$\frac{Z^2pq}{E^2}$$

Confidence level= 95%, Precision =5%
Simple Random Sampling was done using a randomization software to generate codes for allotment of patients to groups. The codes were known to the principal researcher only.
The study was conducted after approval by the Ethics Review Committee (ERC), Islamic International Medical College Rawalpindi (IIMC) and ethical review Committee of Margalla Institute of Health Sciences (MIHS) Rawalpindi. Only the patients fulfilling the inclusion criteria were included in the study. To ensure blinding, anesthetic cartridges were labeled with either black or red tape, with the allocation code known exclusively to the principal investigator.[5]

The inclusion criteria included

- Prolonged response to an electric pulp tester
- Radiographs show no periapical radiolucency on radiographs, except for the widening of periodontal Ligament
- Permanent upper first molar[6]

The exclusion criteria included

- The presence of suspected allergy to either lignocaine or articaine
- H/O significant medical conditions such as diabetes mellitus, hypertension, known cardiac disease etc.
- Presence of abscess, sinus opening
- Pregnant female[s7]

The patients were allocated into the 2 main groups
Group 1: Local anesthetic used for patients undergoing root canal (pulp extirpation) of the maxillary first molar
Group 2: Local anesthetic used for patients undergoing extraction of the first upper molar
Subgroups: These groups were further subdivided into four groups A, B, C and D as follows
Group A (N=60 patients): Patient undergoing Root canal (pulp extirpation) of the upper first molar tooth under lignocaine
Group B (N=60 patients): Patient undergoing Root canal (pulp extirpation) of the upper first molar tooth under articaine
Group C (N=60 patients): Patients undergoing upper first molar extraction under lignocaine
Group D (N=60 patients): Patient undergoing upper first molar extraction under articaine
Baseline pulpal response of teeth diagnosed with irreversible pulpitis was recorded using an electronic pulp tester prior to the administration of local anestthetics. To validate the accuracy of the readings, a contralateral, non-anesthetized maxillary tooth was selected as a control and subjected to a single pulp sensitivity test before anesthetic injection. Base line pulp testing was done to ensure that the pulp is only inflamed and not necrotic. Once the baseline pulp testing was done and it was determined that the pulp is only inflamed the anesthesia was given.
Groups 1 and 3 received lignocaine while groups 2 and 4 were given articaine under the standard technique.
The discomfort associated with each injection was recorded using a standardized 100-mm visual analog scale (VAS), with anchors defined as 0 mm for "no pain" and 100 mm for "unbearable pain.[8]
VAS scale used by the Department of Anesthesiology and Pain Medicine, Yonsei University Wonju College of Medicine, Wonju, Korea.[9]
Treatment was classified as pain-free when the procedure, whether extraction or pulp extirpation, was completed without the patient experiencing or reporting any pain. Patients who felt any pain during treatment were considered as unsuccessful pain-free treatment and managed according to the best local treatment protocols while giving them further injections as needed.[10]
Data was entered and analyzed in statistical package for social sciences (SPSS version 21). Chi-square test was used to compare groups for pain parameter.

RESULTS

For Group A, 36.7 % of the patients experienced Grade 2 pain during the injection of the local anesthetic whereas 45% patients experienced Grade 3 pain. 33.3% of the Group B patients experienced Grade 2 pain, 33.3 % experienced Grade 3 pain and 25 % patients experienced Grade 4 pain respectively. The difference between the value of the pain experienced by the Group A and B was determined using chi-square test and a p- value of 0.24 showed that the difference between the two groups was statically not significant. Similarly for Group C patients 55% of the Group C patients experienced Grade 3 pain whereas 40 % of the patients in this group experienced Grade 4 pain. Amongst the Group D patients 43.3 % experienced Grade 3 pain and 45% of the patients experienced Grade 4 pain respectively. The difference was statistically not significant as shown by the p value of 0.39 which was determined from chi square test.

The pain experienced during the injection of the local anesthetic as determined by the VAS scale

	Anesthesia used for pulp extirpation (Group 1)		Anesthesia used for dental extraction (Group 2)	
Grading	Group A	Group B	Group C	Group D
0mm (No pain)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
1-10mm (Grade 1)	1 (1.7%)	2 (3.3 %)	1 (1.7%)	4 (6.7%)
11-20mm (Grade 2)	22 (36.7%)	20 (33.3%)	2 (3.3%)	3 (5.0%)
21-50mm (Grade 3)	27 (45%)	20 (33.3%)	23 (55%)	26 (43.3%)
51-80mm (Grade 4)	10 (16.7%)	15 (25 %)	24 (40%)	27 (45.0%)
81-100mm (Grade 5)	0 (0%)	3 (5%)	0 (0%)	0 (0%)
p value	0.24		0.39	

p- value ≤ 0.05 Significant*
p- value < 0.001 Highly significant**

For Group A, 33.3 % of the patients experienced Grade 1 pain during the procedure, whereas 41.7% patients experienced Grade 2 pain and 23.3% of Group A experienced Grade 3 pain respectively. For Group B patients 55% experienced Grade 1 pain and 35% patients experienced Grade 2 pain respectively. The difference between the value of the pain experienced by the Group A and B was analyzed using chi-square test and a p- value of 0.02 showed that the difference between the two groups was statically significant.

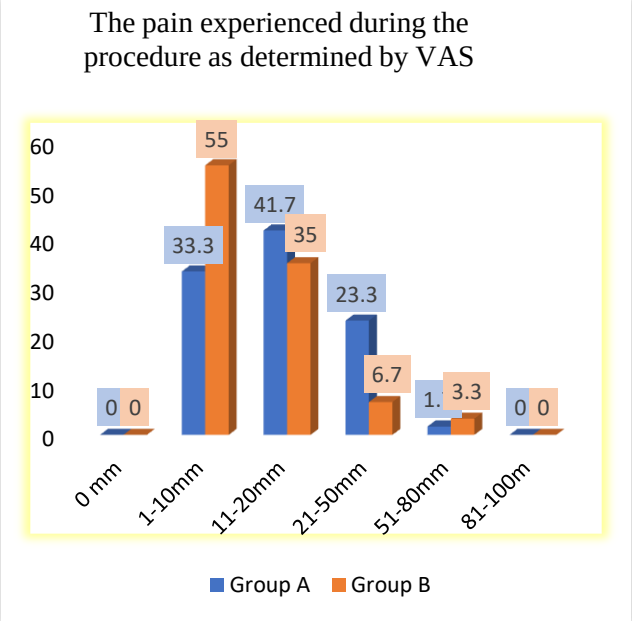
Similarly for Group C patients 51.7% of the Group C patients reported Grade 3 pain on the standardized pain assessment scale whereas 41.7 % of the patients in this group reported Grade 4 pain on the standardized pain assessment scale. Amongst the Group D patients 80 % experienced Grade 3 pain during the procedure of extraction. The difference between the two groups was statistically significant as shown by the p value of 0.001 which was determined from chi square test.

The comparison between the pain experienced during the procedure for groups A, B and Groups C, D

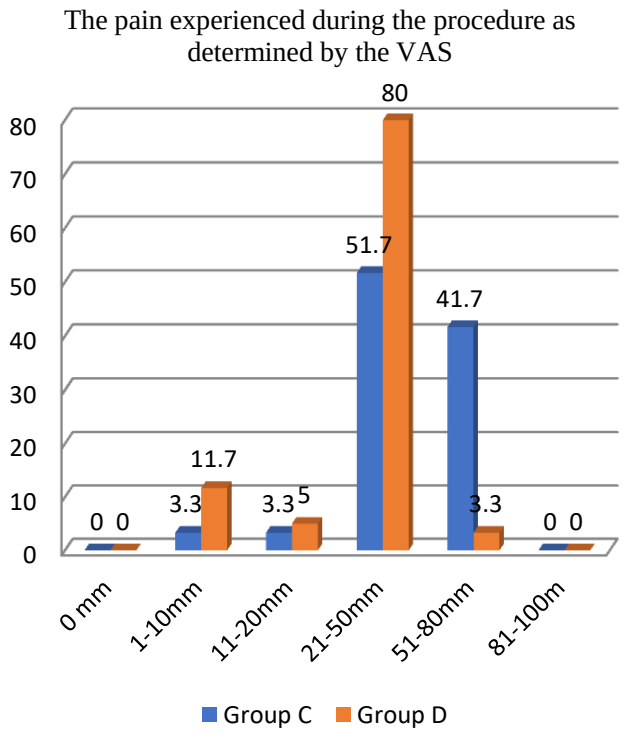
Pain experienced during the procedure as determined by the VAS

	Anesthesia used for pulp extirpation (Group 1)		Anesthesia used for extraction (Group 2)	
Grading	Group A	Group B	Group C	Group D
0 mm (No pain)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
1-10mm (Grade 1)	20 (33.3%)	33(55.0 %)	2(3.3%)	7 (1.7%)
11-20mm (Grade 2)	25 (41.7%)	21(35.0 %)	2 (3.3%)	3 (5.0%)
21-50mm (Grade 3)	14 (23.3%)	4 (6.7%)	21 (51.7%)	48 (80.0%)
51-80mm (Grade 4)	1 (1.7%)	2 (3.3%)	35 (41.7%)	2 (3.3%)
81-100mm (Grade 5)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
P value	0.02*		0.001**	

p- value ≤ 0.05 Significant*
p- value < 0.001 Highly significant**



The pain experienced during the procedure by the patients of group A and B expressed as percentage and determined by the VAS



The pain experienced during the procedure by the patients of group C and D expressed as percentage and determined by the VAS

DISCUSSION

The study showed lesser pain during the procedure in Group B as compared to Group A, hence articaine ensured lesser pain during the procedure of root canal and greater number of successful procedures. Similar results were also observed where Group D patients experienced lesser pain than Group C. Hence articaine proved to be more efficient than lignocaine in this study for the management of maxillary molar teeth in both root canal treatment as well as extractions.

Results of current study were found to be similar to the study of Jain and Jadhav et al. according to which Articaine is clinically better to Lidocaine in anesthetic efficacy.[11] This endorsed our study.

There was no significant difference in the pain on injection in Group A and Group B. Results for Group C and Group D were also statistically not significant also. Hence no difference was observed in the pain experienced by the root canal patients during the administration of either of the local anesthetic. Similarly, no difference was observed in the pain reported by the extraction patients during the injection of either of the local anesthetic Hence there was no significant difference in pain on administration of injection for articaine and lignocaine in root canal and extraction patients in our study. This was similar to the results achieved by Ei Phyo et al where no marked difference existed between pain on injection for lignocaine and articaine for maxillary infiltration anesthesia in impacted third molars.[12.]

Similarly in another study carried out by Maljaei et al, the pain on injection reported by patients who were given articaine and lignocaine for the management of upper second molars did not have any significant difference.[13].

Erfanparast et al compared the pain perception on injection for articaine and lignocaine for the management of mandibular molars. No statistically significant difference was obtained in this study further endorsing my study.[14.]

5% of dental patients avoid dental procedures due to the fear of injection pain.[15] The intensity of pain in dentistry patients is affected by multiple factors such as needle gauge, anesthesia type and temperature and injection site pH.[16] Modern dentistry has employed multiple techniques to reduce the pain during anesthetic injection such as topical anesthetic application,[17] topical cooling of the injection site, computerized injection systems,18 pressure administration and transcutaneous electronic nerve stimulation (TENS).[19]

A study performed by Gurucharan et al showed that patients reported much less pain than the control group when the anesthetic solution was precooled and ice was applied to the injection site..[20] Cold by itself possesses analgesic effect. In addition, when there is a fall in temperature of less than 7°C, it causes a deactivation of the Aδ nerve fibers which are responsible for the sharp pain caused by the dental injection.[21] Mohiuddin et al demonstrated that application of ice at the injection site could also result in marked decrease in injection pain.[22] Similar results were also observed by Ghaderi et al.[23] Thus, precooled anesthetic and the topical application of ice can provide significant relief to the patients during injection. Topical gels might provide relief too but topical gels result in altered taste sensation and slow down the onset of anesthesia. However topical anesthesia does provide significant reduction in both the pain of insertion and injection during infiltration anesthesia. The pain reduction is significantly marked in anxious dental patients as compared to non-anxious patients as determined in a study by Sin-Yeon Cho et al.[24]

Although using intraoperative pain to assess anesthetic success seems simple, the subjective and multifactorial nature of pain makes it an unreliable indicator of anesthesia failure at times. Topazian et al. stated that although the perception of pain is a significant component of the pain experience, it is only uniform and reproducible when other elements like mood, tiredness, and distraction are not considered. Pain perception is shaped by emotional, psychological, cultural, and interpersonal factors, including the clinician's ability to manage patient expectations.[25]

Achieving effective anesthesia in symptomatic irreversible pulpitis can be difficult, despite its importance for patient

comfort and anxiety reduction. Several contributing factors have been proposed, including central sensitization, prostaglandin-mediated peripheral nociceptor sensitization, acute tachyphylaxis, and local inflammatory changes that alter tissue pH and blood flow. Psychological factors may also influence anesthetic outcomes .[26]

The failure of local anesthesia in endodontic procedures, particularly in cases of pulpitis or apical periodontitis, is often multifactorial. Inflammatory and infectious processes can alter local tissue pH and neural response, reducing anesthetic efficacy. From a pharmacological standpoint, factors such as the use of expired agents, improper storage conditions—especially exposure to temperatures exceeding 37°C—and the use of compromised or rarely utilized anesthetic batches may contribute to inadequate anesthesia. Moreover, technical aspects such as insufficient injection pressure or degradation of anesthetic solutions in plastic cartridges can further compromise clinical outcomes, even when standard techniques are properly executed. These considerations highlight the importance of both clinical precision and pharmaceutical integrity in achieving effective pain control.[27]

The anesthesia cartridges were maintained in optimum environmental conditions, the expiry date and the quality of anesthetic cartridges were thoroughly monitored throughout the study. It was also ensured that patients were guided about all the steps of the procedure being performed and maximum level of comfort was available to them to reduce anxiety.

According to another study the anesthesia given by general dentists is more likely to end in failure.[29] To ensure this factor was removed the anesthesia in this study was administered by an endodontist for root canal patients and an oral and maxillofacial surgeon for extraction patients.

CONCLUSION

The pain experienced during the procedure may be significantly reduced hence reducing anxiety in dental patients. Hence articaine can prove to be a good tool in dentists' armamentarium for the management of maxillary molars which are the most common teeth affected by irreversible pulpitis.

ETHICAL APPROVAL

Ethical approval of article was granted by the Institutional Review Committee of Islamic International Medical College vide reference No. Appl. # Riphah /IRC/ 21/62 dated 12 October, 2021.

CONFLICT OF INTEREST

Authors declare no conflict of interest.

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AUTHOR'S CONTRIBUTIONS

AR: Conception of study, data analysis & Interpretation Manuscript Writing, critical review

AIM, AR, AC: Material analysis, Data analysis, review of manuscript

SJH, TK: Manuscript writing, critical review,

TK: concept and design, manuscript writing

All Authors: Approval of the final version of the manuscript to be published

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