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RESEARCH ARTICLE

COMPARATIVE EVALUATION OF ANAESTHETIC EFFICACY OF ARTICANE 4%, BUPIVACAINE 0.5% AND LIDOCAINE 2% FOR INFRAORBITAL NERVE BLOCK: A RANDOMIZED CLINICAL TRIAL

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Abstract

Aim: The aim of this clinical trial was compare of anaesthetic efficacy of articane 4%, bupivacaine 0.5% and lidocaine 2% for infraorbital nerve block.

Materials And Methods: 75 patients were randomly assigned in to 3 groups where they were injected with eitherarticane 4%, bupivacaine 0.5% and lidocaine 2% and their anaesthetic efficacy was checked . Normality testing was done using the Shapiro-Wilk test. Data for EPT failed normality and hence, non-parametric tests were used for analysis. The EPT scores for pain threshold were compared between the three groups using Kruskal-Wallis test (non-parametric ANOVA) at pre-dosing, post-dosing, 1 hour, 2 hours and 3 hours. Post-hoc Mann-Whitney 'U' test was used for pair-wise comparisons at all time periods.

Results: As per the results obtained from the present study, the post-dosing results with electronic pulp tester was highest with Articaine followed by lignocaine and was least with bupivacaine. This showed that the Articaine had early onset amongst all three and bupivacaine showed late onset.

Conclusion: This study shows that statistically significant difference was observed between lidocaine, Articaine and bupivacaine.Articaine has a faster onset and provides clinically effective anaesthesia in root canal treatment and other restorative procedures. ,

Introduction:-

A major concern of the dental practitioners towards patients is pain control. To have a successful dental treatment it is important for the patient to experience minimal pain or discomfort. [1,2]In such cases a potent anaesthesia to the involved tooth or region play an important role in relieving pain.[3]

Pain management if effective, leads to endodontic treatment without anxiety and fear. However, achieving anaesthesia is difficult in cases of acute episodes of pain. [1]

After anaesthesia, patients usually may present with lip numbness and other subjective symptoms but clinician may find difficulty in achieving successful pulpal anaesthesia.[3]

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Backbone for the pain control technique in dentistry is formed by local anaesthesia. From cocaine (1884), procaine (1904), to lidocaine (1948), dentistry has been in the forefront in providing patients with pain free treatment. There are primarily two classes of local anaesthetics and are classified as amides and esters. Most commonly used local anaesthetics are of amide type because it produces more rapid and reliable anaesthesia. In between 1930 and 1991 newer amino-ester local anaesthetics were synthesize such as tropocaine, holocaine, benzocaine and tetracaine. Between 1898 and 1972 amino amide local anaesthetics were prepared including procaine, chloroprocaine, cinchocaine, lidocaine, mepivacaine, prilocaine, bupivacaine, etidocaine, and articaine. There are still more research going on to seek more safe and effective local anaesthetics. [5,6,7.]

At present, lidocaine is most commonly used anaesthetic agent in dentistry as it is labelled as "gold standard" due to its efficacy, minimal toxicity, and low allergenicity. It has been used in clinics since 1948 after its availability .[8]

Lignocaine was synthesized and brought in use first by Lofgren in 1943. It is also known as 2-Diethylamino-N-(2,6-dimethylphenyl) acetamide hydrochloride monohydrate.

Other widely used anaesthetic agents in developed countries is "Articaine". It has a more anaesthetic efficacy and greater ability to diffuse through tissue.[9]

In 1969 Muschaneau first synthesized Articaine twenty-five years after lidocaine. It was first named as 'Carticaine' which, later in 1984 was changed to "Articaine". It has a thiophene ring in its molecule instead of usual benzene ring.

Other local anaesthetic of choice in extended operations for prolonged postoperative pain control and analgesia is "Bupivacaine"

Bupivacaine is another amide type of local anaesthesia which has a longer span of action.

Some authors also have concluded that it has ability to attain longer postoperative analgesic periods, which in turn reduces the requirement of analgesic medication to the patient where the pain intensity is highest.[10,11]

Success rate is also reduced due to complex anatomical location in anterior maxilla.

Deposition of anaesthetic solution at the infraorbital foramen achieves infra-orbital nerve block or anterior superior alveolar block which anaesthetizes maxillary anterior and premolar.[12,13]

There is reduced anaesthetic success due to anatomic variations in anterior maxilla which occasionally causes problems. In such instances to ensure adequate anaesthetic solution to the target site multiple needle penetrations may be necessary. The ideal maxillary nerve block with single injection produces pulpal anaesthesia with rapid onset for multiple teeth. The literature does not explain a single injection site that would produce pulpal anaesthesia to the majority of the maxillary teeth without collateral anaesthesia of the face, lip, and muscles of facial expression.[14]

Till date there is no comparison between Articaine, Bupivacaine and Lidocaine for infra-orbital nerve block in the same study and so this study was undertaken.

Materials And Methods:-

75 patients diagnosed with symptomatic irreversible pulpitis were selected from Out-Patient Department of Conservative dentistry and Endodontics, Bharati-Vidyapeeth Dental College and Hospital, Navi Mumbai.

Healthy subjects aged between 18 and 65 years those diagnosed with symptomatic irreversible pulpitis in anterior and premolars of maxillary teeth requiring endodontic therapy were included for the study. Patients with any systemic conditions or who had taken any medication in last 24 hours were not included in the study . Also patients exhibiting allergy to local anaesthetic agents were excluded from the study

ThisclinicaltrialwasreportedaccordingtoCONSORTguidelines 2010 and was approved Scientific Review Committee and Institutional Ethical Committee (223/2017) Bharati Vidyapeeth Deemed to be University Dental College and

Hospital, Navi Mumbai. This study was conducted in accordance to the Helsinki guidelines (1975) which was revised in the year 2013 and was approved and accepted by the ethical committee of the university.

Study Groups:
Seventy-five patients were divided in group of twenty-five each: -
GROUP I = Patients receiving Infra-orbital nerve block with Articaine.
GROUP II = Patients receiving Infra-orbital nerve block with Bupivacaine.
GROUP III = Patients receiving Infra-orbital nerve block with Lidocaine.

REFER FIG NO 1
Randomization was done with the help of envelope containing chits with the name of local anaesthetic written on it. The envelope was randomly chosen and opened only in front of the patient and treatment was assigned accordingly.

Informed consent was obtained from all the subjects. No reference was made to the smells, sounds, or feel of the methods in order to avoid creating a bias against any method. The local anaesthetic randomly allocated were not disclosed to the patient. The subjects were informed about the particular anaesthetic method which were employed.

Statistical Analysis
The sample size is not based on assumptions, calculations and estimation and it was planned to include 25 patients in each of the 3 study groups. Thus, a total of 75 teeth were included in the 3-study group. (n = 25).

All data were entered into a Microsoft Office Excel (version 2016) in a spreadsheet which was prepared and validated for the data form. Data was entered and checked for errors and discrepancies. Data analysis was done using windows based 'MedCalc Statistical Software' version 19.0.1 (MedCalc Software bvba, Ostend, Belgium; http://www.medcalc.org; 2019).

All testing was done using two-sided tests at alpha 0.05. Thus, the criteria for rejecting the null hypothesis was be a 'p' value of <0.05.
Null hypothesis (H_0): There are no differences in the EPT between three groups at 1 , 2 and 3 hours.

Results:-
Normality testing was done using the Shapiro-Wilk test. Data for EPT failed normality and hence, non-parametric tests were used for analysis. The EPT scores for pain threshold were compared between the three groups using Kruskal-Wallis test (non-parametric ANOVA) at pre-dosing, post-dosing, 1 hour, 2 hours and 3 hours.

Post-hoc Mann-Whitney 'U' test was used for pair-wise comparisons at all time periods. Similarly, the change in EPT scores from post-dosing period at 1 hour, 2 hours and 3 hours is analysed using the Kruskal-Wallis test followed by post-hoc Mann-Whitney 'U' test. Within group changes in EPT scores at different time periods in each group was analysed using the Friedman test.

Discussion:-
Local anaesthesia plays an important role in treating patients with irreversible pulpitis. However, achieving anaesthesia becomes difficult in such patients and leads to barrier in endodontics. Local anaesthesia has a potent action on uninflamed pulp or clinically normal pulp but it is difficult to achieve in inflamed pulp.

According to a study by Hargreaves & Keiser, hypothesis have been described for failure of local anaesthetic which include:
1. Anatomical Causes for Anaesthetic Failure.
2. Acute Tachyphylaxis of Local Anaesthetics.
3. Effect of Inflammation on Local Tissue ph.
4. Effect of Inflammation on Blood Flow.
5. Effect of Inflammation on Nociceptors.
6. Effect of Inflammation on Central Sensitization.
7. Psychological Factors.[37]

Also, the post-operative pain increases the pain response and make the patient apprehensive which leads to psychological distress and increases the pain sensitivity.[38]Local anaesthetics produce anaesthesia by inhibiting excitation of nerve endings or by blocking conduction in peripheral nerves.[39]Contemporary local anaesthetics contain intermediate amide chain and thus are classified as amide type of local anaesthetic agents.

Commonly used amide type of local anaesthetics are:Lidocaine, Articaine ,Bupivacaine., Mepivacaine and Prilocaine.[40]

All of these differ in their potency, speed of onset and duration of anaesthesia.Anaesthetic agents having high lipid solubility usually are much potent due to their property of increased diffusion through the nerve sheath. Agents with higher lipid solubility are anaesthetically more potent.[37]

Lidocaine have a lower lipid solubility as compared to Articaine and Bupivacaine.

Also, bupivacaine has high affinity towards proteins in the sodium channels which increases neural blockade duration and so it is known as a long acting amide type of local anaesthesia.[41]

This study was conducted to evaluate three different amide-type of local anaesthetic agents – lidocaine, Articaine, and bupivacaine in providing pulpal anaesthesia in patients with symptomatic irreversible pulpitis.

Lidocaine:
It is the most common type of local anaesthetic agent used by dentist and surgeons for local anaesthetic purpose. It is a first type of amide local anaesthetic used, which was synthesized under name of "Xylocaine" by Nils Lofgren a Swedish chemist in 1943.

Onset and Duration of anaesthesia:
Average onset of the anaesthesia is less than one to two minutes.

It provides pulpal anaesthesia of at least 60 – 90 minutes.[42]

It has proven to be efficient, of low allergenicity, and minimal toxicity through clinical use and research have confirmed the value and safety of this drug.

Thus, it became labelled the "gold standard" in local anaesthetics.[13]

Articaine:
Articaine has been widely used in dentistry. It was started to be used in dentistry around 1976 in Germany.

Articaine is intermediate acting amide local anaesthetic and has an ester group in its structure which accounts in its fast metabolism.

It has been reported that administration of Articaine to gingiva infiltrates rapidly and blocks the peripheral nerve in dentistry.

The use of Articaine achieves successful pain control in low doses and it is safe and effective than lidocaine (Malamed, 1997)

Articaine contains a thiophene ring which makes it more potent and More lipid soluble; thereby enabling it diffuse more readily through both hard and soft tissue.

Articaine is more potent and more lipid soluble because it contains a thiophene ring, which results in its ready diffusion through hard and soft tissues.[41]

Onset and Duration of anaesthesia:
Average onset of anaesthesia is less than one minute.

Total duration of pulpal anaesthesia is 90 to 150 minutes.[43]

Bupivacaine:
Bupivacaine is a long acting local anaesthetic in which addition of epinephrine is rarely required. It blocks initiation and transmission of nerve impulses at the site of application by stabilizing the neuronal membrane.

A study by Laskin et al (1977) reported several advantages of Bupivacaine over Lignocaine. They showed that bupivacaine has a much greater potency; therefore, a smaller concentration could be used with the same results.

It has a lower toxicity at equally effective concentrations; therefore, a larger dose can be used safely.

For infiltration anaesthesia where the nerve sheaths are not thick, the rates of onset of either Lignocaine or bupivacaine do not appear significantly different but studies have reported a longer time of onset of anaesthesia for bupivacaine.[44]

Onset and Duration of anaesthesia:
Bupivacaine acts within 2 to 10 mins and lasts for 2.5 to 3 hours for pulpal anaesthesia.

The numbness of the lips and the peri-oral tissue anaesthesia stays for more than 4 to 6 hours.[45]

Electric pulp testing:
In the present study to evaluate onset and duration of pulpal anaesthesia and to evaluate the potency of anaesthetic solution electric pulp testing was done.

Electric pulp testing is a standardized method used to evaluate of way onset and duration of pulpal anaesthesia.

However, according to Colley et al [46] there are some limitations: which may be the false-positive responses, which can also be involved with the complex mechanism of neuroinflammatory and neuro-pulpal interactions (nerve-odontoblast interactions), which still need to be clarified.[46]

ONSET:
In this study the early onset was calculated by post-dosing electronic pulp test readings, the mean scores were 26 (lidocaine), 37 (Articaine), 18 (Bupivacaine) according to (table no 1).

As per the results obtained from the present study, the post-dosing results with electronic pulp tester was highest with Articaine followed by lignocaine and was least with bupivacaine.

This showed that the Articaine had early onset amongst all three and bupivacaine showed late onset.

The onset of action of an anaesthetic agent depends on several factors, such as the particular anaesthetic technique employed and the intrinsic factor of the drug substance used.

The pKa value directly influences the latency period, shorter latency period is due to smaller pKa value.

The pKa value for 4% Articaine is 7.8 which would present with a shorter latency period as compared to lidocaine which has pKa value of 7.9.[35]

Al-Shayyab et al found that many factors could affect the onset time and duration of action of local anaesthesia, such as age, gender, and smoking status.[47]

Gregorio et al. stated that the onset of action of Articaine was 1.66 ± 0.13 min. The onset was faster with Articaine compared to bupivacaine because of the better diffusion of the anaesthetic agent.[48]

Total duration:
The mean score for all the anaesthetic agents were almost equal at the time interval of one hour.

The signs and symptoms of the lidocaine anaesthesia were diminished post to two hours of its administration. At same time interval, mean EPT scores for Articaine and bupivacaine were 23 and 49 respectively. (Table no 1)

This showed that Articaine had intermediate duration and Bupivacaine showed longest of all.

The results of the studies of Oliveira et al and Costa et al suggested that the duration of pulpal anaesthesia also lasts longer with Articaine than with lidocaine.[42]

Articaine occurs both in plasma and liver through which it hydrolyses rapidly. Its elimination from the body is rapidly, but bupivacaine takes longer time for elimination. [25]

Hence, the duration of analgesia and postoperative analgesia offered was significantly longer with bupivacaine than Articaine.[32] This finding was in accordance with previous studies. [22, 48, 49, 50, 51] Because of the longer duration of postoperative analgesia offered by bupivacaine, the time to rescue analgesic medication was also longer. [32]

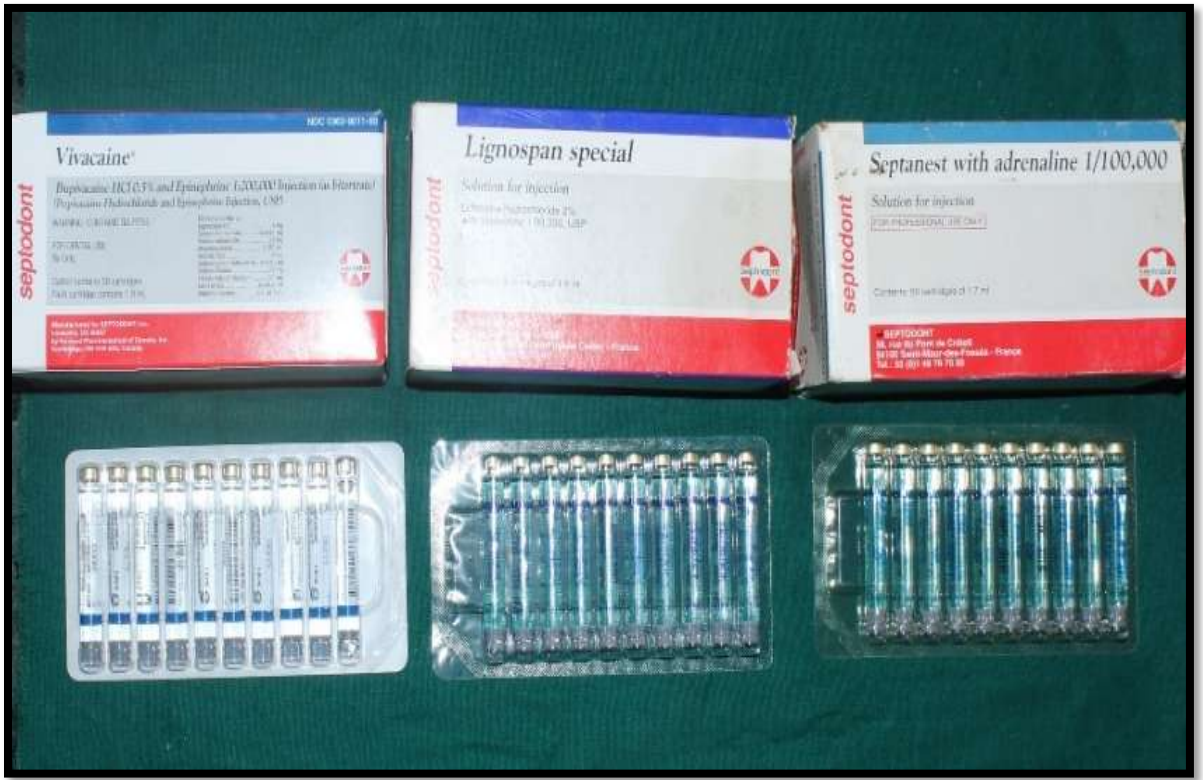
So, results obtained from present study showed that the duration of anaesthesia was longest with respect to bupivacaine.

In a study done by Gregorio et al, additional anaesthesia, which the author called reinforcement anaesthesia, was necessary in 14% of surgeries performed with bupivacaine and 2% of those performed with Articaine.[48]

According to D. Robertson et al, found that the anaesthetic efficacy of Articaine was significantly better than that of bupivacaine. This is possibly because of the better diffusion of Articaine in the tissues rendering more profound anaesthesia.[52]

So, from the results obtained from present study, onset of local anaesthesia was earliest with Articaine followed by lignocaine and bupivacaine and duration of anaesthesia was longest with bupivacaine followed by Articaine and lignocaine.

Fig No 1:-



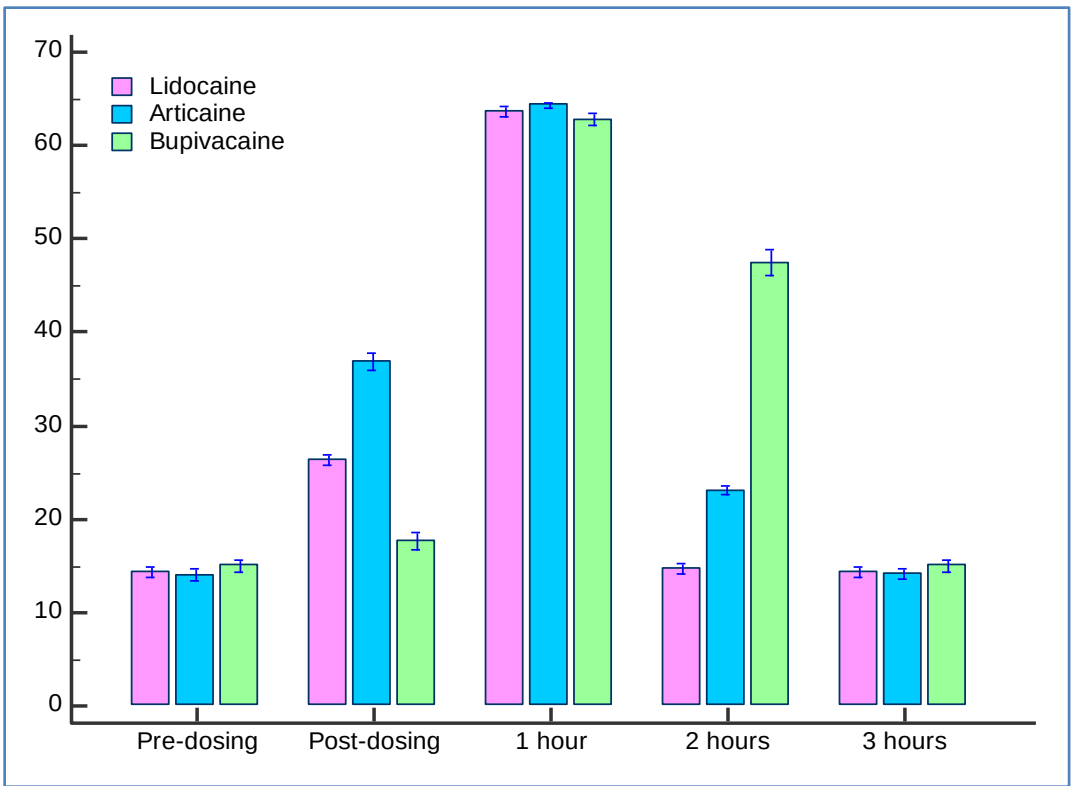
EPT score

	Lidoocaine (n=25)			Articaine (n=25)			Bupivacaine (n=25)			Kruskal-Wallis test	
	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD	χ^2	p
Pre-dosing	14.36	14	1.25	14.12	14	1.39	15.08	15	1.71	4.068	0.131
Post-dosing	26.36	26	1.29	36.92	37	2.27	17.72	18	2.32	65.648	<0.0001
1 hour	63.72	64	1.24	64.40	65	0.71	62.84	63	1.62	14.445	0.001
2 hours	14.72	14	1.31	23.16	23	1.11	47.52	49	3.48	66.166	<0.0001
3 hours	14.36	14	1.25	14.16	14	1.34	15.08	15	1.71	3.906	0.142
Friedman test • F • P	(Within group) 153.06 <0.00001			2298.58 <0.000001			100.00 <0.0001				

TABLE -1EPT scores of 3 local anaesthetics (lidocaine, articaine and bupivacaine) at different time interval (i.e. pre-dosing, post-dosing, after 1 hr, 2hr and 3hr) calculating mean, median and standard deviation of each.

Table 2:- Post-hoc test for EPT (pairwise comparisons).

			Mean Difference	SEM	p	95% C.I. for diff.	
						Lower	Upper
Post-dosing	Lignocaine	Articaine	-10.56	0.57	<0.0001	-11.96	-9.16
		Bupivacaine	8.64	0.57	<0.0001	7.24	10.04
	Articaine	Lignocaine	10.56	0.57	<0.0001	9.16	11.96
		Bupivacaine	19.20	0.57	<0.0001	17.80	20.60
	Bupivacaine	Lignocaine	-8.64	0.57	<0.0001	-10.04	-7.24
		Articaine	-19.20	0.57	<0.0001	-20.60	-17.80
1 hour	Lignocaine	Articaine	-0.68	0.35	0.175	-1.55	0.19
		Bupivacaine	0.88	0.35	0.045	0.01	1.75
	Articaine	Lignocaine	0.68	0.35	0.175	-0.19	1.55
		Bupivacaine	1.56	0.35	<0.0001	0.69	2.43
	Bupivacaine	Lignocaine	-0.88	0.35	0.045	-1.75	-0.01
		Articaine	-1.56	0.35	<0.0001	-2.43	-0.69
2 hours	Lignocaine	Articaine	-8.44	0.63	<0.0001	-9.99	-6.89
		Bupivacaine	-32.80	0.63	<0.0001	-34.35	-31.25
	Articaine	Lignocaine	8.44	0.63	<0.0001	6.89	9.99
		Bupivacaine	-24.36	0.63	<0.0001	-25.91	-22.81
	Bupivacaine	Lignocaine	32.80	0.63	<0.0001	31.25	34.35
		Articaine	24.36	0.63	<0.0001	22.81	25.91
3 hours	Lignocaine	Articaine	0.20	0.41	1.000	-0.80	1.20
		Bupivacaine	-0.72	0.41	0.249	-1.72	0.28
	Articaine	Lignocaine	-0.20	0.41	1.000	-1.20	0.80
		Bupivacaine	-0.92	0.41	0.083	-1.92	0.08
	Bupivacaine	Lignocaine	0.72	0.41	0.249	-0.28	1.72
		Articaine	0.92	0.41	0.083	-0.08	1.92



Graph 1:- (Electronic Pulp Tester Scores: - Pre-Dosing, Post-Dosing, 1hour, 2 Hours And 3 Hours). Pre-dosing values were almost same for all three anaesthetics. After post-dosing the Articaine group showed highest among three and bupivacaine showed lowest. After 1 hour – Scores were significantly same for all three anaesthetics. After 2 hours – score for bupivacaine was highest, followed by articaine and lignocaine score was at the level it was before pre-dosing. At three hours scores were at the level it was at the pre-dosing.

Conclusion:-

This study shows that statistically significant difference was observed between lidocaine, Articaine and bupivacaine.Articaine has a faster onset and provides clinically effective anaesthesia in root canal treatment and other restorative procedures.

1. Within the limitations of this study, Articaine 4% with infra-orbital nerve block can be effectively used for anaesthesia of maxillary anterior and first premolar.
2. In terms of duration of anaesthesia, bupivacaine showed longest duration of anaesthesia and post-analgesia period.

This property of bupivacaine can be useful for patients undergoing surgical procedures such as apicoectomy and also avoids the patients from its requirement for post-operative analgesia.

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