ORIGINAL RESEARCH PAPER
Volume-8 | Issue-10 | October - 2019 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

NEEDLE-LESS INJECTORS : CLINICAL EVALUATION OF EFFECTIVENESS OF JET INJECTOR AS LOCAL INFILTRATION ANESTHESIA FOR DENTAL EXTRACTIONS

Dental Science

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ABSTRACT

Pain is one of the main reasons that bring patients to the dental office, but at the same time fear of the pain is the chief reason that keeps them away. Needle-less jet injection device has been proposed by which a high-velocity spray of anesthetic solution is forced under high pressure into the oral mucosa, leading to mechanical infiltration of the compound

Aim and objectives: To clinically evaluate the efficacy of needle-less jet injector using 2% Lidocaine with 1:80,000 epinephrine as anesthetic solution and to compare the jet injection with the standard conventional needle injection technique.

Materials and Methods: 27 patients including 108 dental extractions were anaesthetized by needle-less jet injector and conventional needle infiltration technique. Pain during administration of anesthetic solution and during dental extraction was evaluated using Wong Baker Faces Pain Rating scale, VAS scale line and VAS numeric pain rating scale. The time of onset of soft tissue anesthesia and depth of infiltration anesthesia were evaluated and patient acceptance was evaluated.

Results: Pain during administration of anaesthesia was significantly less using needle-less jet injector than conventional infiltration (p=0.0001) and there was no significant difference in pain during dental extraction. The success rate of needleless injectors was 92.59% in maxilla and 85.18% in mandible. Overall 77.78% of patients preferred jet injectors over conventional infiltration technique.

Conclusion: Needle-less jet injector was proved to be less painful during administration of anaesthetic solution, similarly efficacious and more preferred as compared to conventional needle infiltration.

KEYWORDS

Needleless Injectors, Conventional Needle syringes, Jet injectors.

INTRODUCTION

Pain is one of the main reasons that bring patients to the dental office, but at the same time fear of the pain is the chief reason that keeps them away too[1]. One of the major apprehensions of patients in dental practice is the fear of the dental injection, which most of the patient exhibit during treatment[1]. Patients are often more distressed by the sight of a needle during administration of local anesthetic than by the ensuing treatment.

Despite improvements in both the effectiveness of anesthetic solutions and the quality of dental needles, the method of administration has largely remained unchanged. A needle connected to a syringe remains a necessity, and the realization that it will penetrate the oral mucosa is frightful for most patients. Therefore, the challenge is to device a less invasive method of administration rather than to discontinue the use of local anesthesia. A step in that direction is the application of techniques whereby the anesthetic solution is introduced into the tissue without the use of a needle.

Needle-less jet injection device has been proposed by which a high-velocity spray of anesthetic solution is forced under high pressure into the oral mucosa, leading to mechanical infiltration of the compound. The current opinion is that this technique can be used only for surface anesthesia and thus is supplementary to the standard infiltration technique intended to reduce the discomfort of the ensuing syringe injection.

Hence a randomized controlled split mouth study was formulated to clinically evaluate the outcome of the jet injection system in delivering Local infiltration anesthesia using 2% Lidocaine with 1:80,000 epinephrine solution over standard technique.

MATERIALS AND METHODS

A Prospective, randomized, self-controlled, split mouth design study was performed amongst 27 patients requiring 108 dental extractions reporting to the Department of Oral and Maxillofacial Surgery, Babu Banarasi Das College of Dental Sciences, Lucknow, for extraction of teeth after approval from the Institutional Ethical Committee.

Patients older than 14 years of age and requiring intra-alveolar extraction of two or more teeth were included in study irrespective of sex/caste/creed. Patients allergic to local anesthesia or with debilitating disease and peri-apical pathology were excluded.

Patients were randomly divided into two groups. In Group I patients, extraction was attempted after Infiltrations Using Needle-Less jet Injection System with Lignocaine hydrochloride 2% (20mg/mL) with epinephrine 1:80,000 injection. Patients in Group II underwent extraction procedure after Infiltrations Using Conventional Syringes with same anesthetic solution. Each group was further subdivided on basis of maxillary and mandibular tooth extraction.

Buccal and palatal/lingual infiltrations were done with 0.6 ml of anesthetic solution. Group I patients were anaesthetized by two simultaneous shots of 0.3 ml solution each using needle-less injector INJEX, both buccal and palatal/lingual.

To alleviate anxiety due to the clatter with needle-less injector, a demonstration of the procedure was given, by firing a shot in air. Pain perceived by the patient during the anesthetic infiltration was recorded, using WONG-BAKER FACES PAIN RATING SCALE, immediately after injecting the solution.

Time of onset of anesthetic effect was recorded from the point of time immediately after complete deposition of anesthetic solution. To compare the anesthetic efficacy of the infiltrations given by needle-less injector system and conventional injection, soft tissue anesthesia was judged objectively by an examiner blinded about the procedure. This was done by applying pressure over the site of injection, using periosteal elevator after more than 2 minutes. Depth of anesthesia was determined by pulpal Anesthesia which was assessed using an Electric Pulp Tester pre-anesthesia and 2 min Post-anesthesia.

After the completion of the anesthetic procedure, patient was asked to

mark a point on the VAS SCALE LINE representing the pain perception of his/her current state and also rate the severity of pain experienced on VAS NUMERIC PAIN SCALE during administration of drug.

In cases where objective confirmation of anesthesia wasn't achieved within 5 min the infiltration was declared unsuccessful and supplementary nerve block was given. Patients in whom anesthesia wasn't secured by local infiltration on both the surfaces (buccal or palatal/lingual) were also considered as unsuccessful. Tooth was extracted with the help of extraction forceps.

Pain perceived by the patient during extraction was recorded, using WONG-BAKER FACES PAIN RATING SCALE, immediately after extraction of the tooth. After the completion of the extraction procedure, patient was again asked to mark a point on the VAS SCALE LINE representing the pain perception and rate the severity of pain experienced on VAS NUMERIC PAIN SCALE.

The study parameters were compared by using student't' test and Chi Square test. The p-value <0.05 was considered significant. All the analysis was carried out by using SPSS 16.0 versions (Chicago, inc., USA).

RESULTS

A total of 27 patients requiring 108 dental extractions satisfying the inclusion and exclusion criteria were included in this study with 54 in each group. None of the patients showed sensitivity to LA solution or were excluded from the study. Thus there was no attrition rate in our study. None of our patient reported back with any type of complication. The same amount (0.60 ml) of solution was used in both the groups.

There was no (p>0.05) significant difference in the time of onset for soft tissue anesthesia between Group I (30.00±9.80) and Group II (34.25±13.49) (in seconds) in maxilla whereas a significant (p=0.04) difference was observed in Group I (32.03±11.37) and Group II (40.37±17.75) (in seconds) in mandible (Table 1).

Table-1: Comparison of the time of onset of soft tissue anesthesia (in seconds) between the groups

Groups	Time of Onset (in seconds) (Mean ± SD)	
	Maxilla	Mandible
Group I	30.00±9.80	32.03±11.37
Group II	34.25±13.49	40.37±17.75
p-value	0.19	0.04*

The reaction of pulp was significantly decreased from pre (4.15±0.90) to post (0.59±2.13) anesthesia in Group I and became nil in Group II from pre (4.59±0.93) to post (0.00±0.00) anesthesia in maxilla. Similarly the reaction of pulp tissue in mandibular teeth was significantly decreased from pre (4.37±0.88) to post (1.11±2.72) anesthesia in Group I and became nil in Group II from pre (4.19±1.00) to post (0.00±0.00) anesthesia (Table 2)

Table – 2: Comparison of pre and post anesthesia sensitivity of pulpal tissue to Electric Pulp testing output between the groups (Mean ± SD)

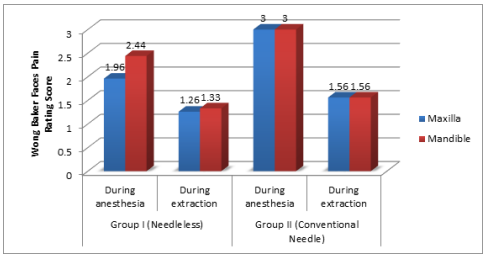
Groups	Sensitivity Of Pulpal Tissue to Electric Pulp Testing output (Mean ± SD)				p-value
	Maxilla		Mandible		
	Pre-Anesthesia	Post-Anesthesia	Pre-Anesthesia	Post-Anesthesia	
Group I	4.15±0.90	0.59±2.13	4.37±0.88	1.11±2.72	0.0001*
Group II	4.59±0.93	0.00±0.00	4.19±1.00	0.00±0.00	NA
p-value	0.08	NA	0.47	NA	

There was significant (p=0.0001) difference in Wong baker pain score during the anesthesia between the Group I (1.96±0.70) and Group II (3.00±0.87) and almost similar (p>0.05) during extraction in both the groups for maxilla. There was significant (p=0.006) difference in Wong baker pain score during the anesthesia between the Group 1 (2.44±0.64) and Group 2 (3.00±0.78) and almost similar (p>0.05) during extraction in both the groups in mandible as well (Table 3 and Graph 1)

Table - 3: Comparison of Wong Baker Faces pain rating score between the groups

Groups	Wong Baker Faces Pain Rating Score (Mean ± SD)			
	Maxilla		Mandible	
	During anesthesia	During extraction	During anesthesia	During extraction
Group I	1.96±0.70	1.26±0.59	2.44±0.64	1.33±0.62
Group II	3.00±0.87	1.56±0.57	3.00±0.78	1.56±0.57
p-value	0.0001*	0.06	0.006*	0.17

Graph - 1: Comparison of Wong Baker Faces pain rating score between the groups



Similarly there was significant (p=0.0001) difference in VAS numeric pain score during the anesthesia between the Group I (2.63±1.18) and Group II (4.59±1.86) and which almost similar (p>0.05) during extraction in both the groups in maxilla. The score in mandible was significantly different in Group I (3.11±1.05) and Group II (4.81±1.88) during anesthesia administration and almost similar (p>0.05) during extraction.

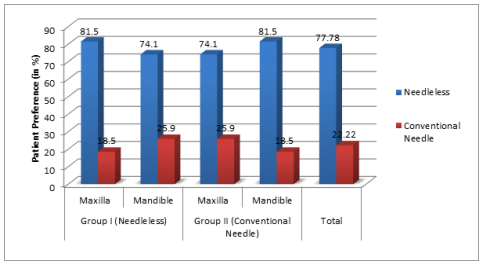
Also there was significant (p=0.0001) difference in visual analog pain score during the anesthesia between the Group I (2.26±0.98) and Group II (4.37±2.09) in maxilla and Group I (2.78±0.89) and Group II (4.63±1.98) in mandible. Similar score was observed (p>0.05) during extraction in both the groups in maxilla and mandible.

Less number of patient who underwent extraction of maxillary teeth preferred conventional needle method than needless in both Group I (18.5%) and Group II (25.9%); however, the difference was statistically not significant. Also in mandible the patient's preference was higher for needless in Group I (74.1%) and Group II (81.5%); the difference being statistically not significant (Table 4 and Graph 2)

Table-4: Comparison of patient's preference for Future Dental treatment

Group	Needleless				Conventional Needle			
	Maxilla		Mandible		Maxilla		Mandible	
	No.	%	No.	%	No.	%	No.	%
Group I	22	81.5	20	74.1	5	18.5	7	25.9
Group II	20	74.1	22	81.5	7	25.9	5	18.5
Total	42	77.78	42	77.78	12	22.22	12	22.22
p-value	0.51				0.51			

Graph-2: Comparison of patient's preference for Future Dental treatment



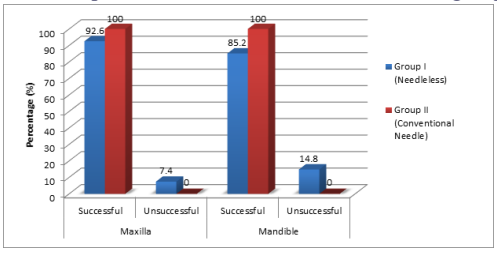
The rate of success of block was in 92.6% in Group I and in all the patients of Group II (100%) in maxilla. Whereas it was 85.2% in Group I and in all the patients of Group II in mandible (Table 5 and Graph 3). The result was statistically significant in mandible.

Table-5: Comparison success of block between the two groups

	Maxilla				Mandible			
	Successful		Unsuccessful		Successful		Unsuccessful	
	No.	%	No.	%	No.	%	No.	%

Group I	25	92.6	2	7.4	23	85.2	4	14.8
Group II	27	100.0	0	0.0	27	100.0	0	0.0
p-value	0.15				0.03*			

Graph-3: Comparison success of block between the two groups



DISCUSSION

How ironical is it to subject a patient to painful stimulus aiming to relieve him from his pain? In a survey by *Milgrom P. et al*[2] in 1997 found that fear of dental injections is associated with avoidance of dental care in almost 1 in 20 people.

Thus, a necessity to eliminate this pain was deeply felt *(Kaufman E. et al 2005)*[3], and research aiming towards this goal commenced, which rested in 1947, when *Hingson R. A. et al*[4] used needle-less delivery system (based on the principle of pressure dynamics) in medical field. Since then modifications in basic design are being proposed.

The experience with needle-less injector by various controlled and uncontrolled studies, *Hingson R. A. et al (1947)*[4], *Bennett C. R. et al (1971)*[5], *Lambrianidis T. et al (1979)*[6], Saravia M. E. *et al (1991)*[7], Munshi A. K. *et al (2001)*[8] and *Geenen L. et al (2004)*[9] are quite promising and calls for widespread use of the device in dentistry, but it has not been the case.

The study was aimed to evaluate effectiveness and to compare pain perception during administration of anaesthetic solution using needle–less jet injector and conventional technique for routine dental extractions.

Hochman M. et al[1] in 1997 showed that upon activation, a high pressure jet of anesthetic solution is released from the needle-less injector. This jet of anesthetic solution painlessly or by causing only slight pain can penetrate the mucosal tissue *(Hingson R. A. et al 1947)*[4]; also it is seen to have a lateral spread in the tissue *(Whitehead F.I.H. et al 1968)*[10]. The degree of penetration in the tissue is a function of volume of anesthetic being used and the nozzle pressure (*Bennett C. R. et al 1971)*[11]. Researchers *Margetis P. et al (1958)*[12] and *Bennett C. R. et al (1971)*[11] also suggested that a layered deposition of anesthetic solution was seen with needle-less injector. The depth of penetration for the volume (0.3 mL) used in this study is 1 cm as observed by *Bennett C. R. et al (1971)*[11], which would be sufficient enough for giving infiltrations. Directing the jet within the tissues, so that it reaches the foramen is not feasible, thus ruling out the possibility of its use in giving blocks *(Bennett C. R. et al 1971)*[11].

Difficulty in positioning the device *(Lambrianidis T. et al 1979)*[6] and the need for close tissue contact during deposition of solution using needle-less injector precludes its use in the posterior region on buccal aspect and in anterior region on palatal/lingual aspect. Thus, we confined the study to maxillary and mandibular bicuspid region which is in accordance with the studies of *(Lambrianidis T. et al 1979)*[6] and *(Saleh G. et al 2002)*[13] respectively.

Upon activation a sudden hissing sound is produced from the needle-less injector device. To alleviate anxiety due to sudden noise and a sense of pressure due to jet stream produced on firing the needle-less injector, a demonstration of the process was given to every patient prior to subjecting him to the device as suggested by *ElGeneidy A. K. et al (1974)*[14].

Determining if a patient is allergic to a local anaesthetic is essential in the selection of appropriate pain control techniques. Local anaesthetic allergy testing was performed safely and with reasonable accuracy by injecting 0.1 mL of the agent intra-dermally just underneath the surface of the skin of forearm *(Canfield D. W. et al 1987)*[15]. None of the patients showed sensitivity to LA solution. Thus there was no attrition rate in our study.

In this study, we used 0.6 mL of anesthetic solution (2% Lignocaine HCl with 1:80,000 Epinephrine) for infiltrations. This is in accordance with the conclusions of studies by *Rozanski R. J. et al (1988)*[16] who suggested 2% lidocaine and *Malamed S. F. (2013)*[17,18] suggested 0.6 mL for giving all infiltrations. Since 0.3 mL is the maximum volume that can be delivered with a single shot of needle-less injector two simultaneous infiltrations were given on each surface. Also this anesthetic solution is superior to other as it possesses a significantly more rapid onset of action (3 to 5 minutes), produces more profound anesthesia, has a longer duration of action, and has a greater potency. Allergy is virtually non-existent; true, documented and extremely rare, although possible *Malamed S. F. (2013)*[19].

No significant difference was seen in the Mean ± S.D. time of onset of soft tissue anesthesia in two groups in maxilla but was significant less in cases with needleless injectors in mandible. This can be explained on the basis of pressure dynamics. This is in disagreement with the prevalent belief of *Wong J. K. (2001)*[20] and *Dabarakis N. N. et al (2007)*[21] that needle-less injection can produce rapid onset of anaesthesia but is in accordance in mandible. *Dabarakis N. N. et al (2007)*[21] reported a rapid onset of soft tissue anesthesia (<1 min) when needle-less injector was used, but the onset of pulpal anesthesia was similar in both the needle-less and conventional needle group, but no reason was given by both of the researchers. Testing interval of 1 min, allows wide grouping and two onset times differing by as much as 55 sec could convincingly be classified with the same latency index. To have more accurate time of onset, we used a time interval of 5 seconds. Depth of anaesthesia was recorded by means of pulpal anaesthesia. It was assessed using an Electric Pulp Tester pre-anaesthesia and 2 min Post-anaesthesia. The sensitivity of pulp to EPT was significantly decreased pre (4.15±0.90) to post (0.59±2.13) anesthesia values in Group I and became nil in Group II from pre (4.59±0.93) to post (0.00±0.00) anesthesia in maxilla. Similarly, results were significantly decreased from pre (4.37±0.88) to post (1.11±2.72) anesthesia in Group I and became nil in Group II from pre (4.19±1.00) to post (0.00±0.00) anesthesia in mandible. This possibly explains that the solution diffuses through the cortical plate in both jaw bones and anesthetizes the pulpal nerves thereby self-explanatory of success of infiltration block. This contradicts *Oulis C. J. et al (1996)*[22] and *Yonchak T. et al (2001)*[23] who had questioned the success of mandibular infiltrations, *Meechan J. G. et al (2011)*[24] though has a contrary view and reported successful mandibular anesthesia after a comparative study on a small sample, but he credits this success to 4% Articaine solution used by him.

Pain perceived by the patient was recorded, using Wong-Baker Faces Pain Rating Scale, immediately after injecting the solution and asked to mark a point on the VAS Scale Line representing the pain perception of his/her current state and also rate the severity of pain experienced on VAS Numeric Pain Scale. *Tomlinson et al (2010)*[25] reported Wong Baker Faces pain rating scale was preferred choice among children and had a high degree of validity and reliability. *Harland et al (2014)*[26] reported good validity of Scale and recommended it because of its greater utility.

We used Wong Baker face pain rating scale because it was seen to have high degree of acceptance among illiterate, cognitively impaired and geriatric members of the population. This showed that needle-less injection can provide painless anesthesia when compared to conventional syringes. Our observation is analogous to the findings of many studies *(Hingson R. A. et al 1947*[4], *Margetis P. M. et al 1958*[12], *Bennett C. R. et al 1971*[5], *Epstein S. 1965*[27], Saravia M. E. *et al 1991*[7], Munshi A. K. *et al 2001*[8] and *Geenen L. et al 2004*[9]*).*

Quaba O. et al (2005)[28] suggested following guidelines to reduce pain associated with infiltration anaesthesia. Firstly, the finer a needle is, the lesser the pain is, on injection, due to expansion of subcutaneous tissues during the infiltration of LA and thus injecting slowly therefore has an important role in minimizing the pain. Secondly infiltration at a deeper sub-dermal level was less painful than a superficial intradermal injection, although slower to work. Possibly, this could be attributed to anatomic location of free nerve endings and area of tissue stimulation. Needle-less device fulfill these criteria's as it makes use of small diameter hole (0.17 mm), present on the surface of the ampoule to produce a jet of solution i.e., half the diameter of the orifice of hypodermic insulin syringe *(*Baxter J. R. *et al 2006)*[29] and uses small volume of anesthetic solution (0.3 mL) thereby producing less tissue expansion, gradual reduction in pressure causes deposition of the

solution in layers, initial deposition occurs in deeper layer less painful followed by superficial layer *(Margetis P. M. et al 1958*[12] and *Bennett C. R. et al 1971*[11]*)*.

Kaufman E. et al (2005)[3] objects the role of needle size in reducing pain and were in support of the view that degree of pain was not related to needle gauge size instead promoted the hypothesis that the sharpness of the bevel, not the gauge, is important in pain avoidance. *Dabarakis N. N. et al (2007)*[21] reported that 17.6% of patients experienced pain during the injection of the anesthetic solution and 32.3% reported feeling of dread or fear from the explosion of the injector as it released the anesthetic solution. On the contrary, we in our study found that, of all our successful cases, minimal pain during infiltration was experienced by 77.78% of patients.

Success of mandibular infiltrations is widely questioned *(Oulis C. J. et al 1996*[22] and *Yonchak T. et al 2001*[23]*)*, *Meechan J. G. (2011)*[24] though has a contrary view and reported successful mandibular anesthesia after a comparative study on a small sample, but he credits this success to 4% Articaine solution used by him. We obtained successful local infiltrations in 85.2% of the patients in Group I (needle-less) and in all the patients of Group II (100%). A reason that infiltration techniques may not be the first choice in the adult mandible is because practitioners tend to think that the thick cortical plate prevents diffusion of solution into the cancellous bone and, therefore, to the nerves supplying the pulps of the teeth. *Meechan J. G.*[24] in *2011* explained this controversial statement by saying that there are holes in the body of the mandible, which could permit diffusion of solution into the cancellous space. Such holes include the mental foramen and multiple minor perforations, especially in the lingual aspect of the anterior mandible and the retromolar ridge. The mental foramen played an important role in achieving pulpal anesthesia in our study. In present study we obtained the infiltration success rate with needle-less infiltration (85.2 % in mandible and 92.6% in maxilla). Previous observations reported by the researchers *Saravia M. E. et al (1991)*[7] with these techniques, fall in conjugation with our findings. This finding was in contrast to the findings of *Lehtinen R. et al (1979)*[30] and *Arapostathis K. N. et al (2010)*[31] who reported only 13% success rate, and observed, additional anesthesia (delivered via traditional local infiltration) was required in 70 of 87 cases. *Malamed S. F. (2013)*[32] suggested regional nerve blocks or supra-periosteal injections are necessary for complete anesthesia. Our results showed a 85.2 % in mandible and 92.6% in maxilla success rate being achieved with needle-less injector alone, which is comparable to 50% to 100% success rate reported by various studies *Margetis P. M. et al (1958)*[12], *Bennett C. R. et al (1971)*[5], *Greenfield W. et al (1973)*[33], *Lambrianidis T. et al (1979)*[6], Saravia M. E. *et al (1991)*[7], Munshi A. K. *et al (2001)*[8] and *Dabarakis N. N. et al (2007)*[21]. This difference in observation could be because *Malamed S. F. (2013)*[17,18] and *Arapostathis K. N. et al (2010)*[31] reported the cases in which only 0.05 to 0.2 mL and 0.3 mL anesthetic solutions were used respectively, whereas we used 0.6 mL solution on both the surfaces. Also we restricted our study to bicuspid region in mandible where mental foramen might have played an important role in diffusion of anesthetic solution.

No case in our experience, which was initially labeled as successful required supplemental injection. Few failures seen in the present study can be explained on the basis of difficult to position the instrument correctly, thereby delivering inadequate anesthesia. *Lambrianidis T. et al (1979)*[6] also explained failure in their series. The success rate improved as the concentration was increased". This conclusion of *Lambrianidis T. et al (1979)*[6] provided a viable option to improve the success rate. *Aberg G. et al (1978)*[34] proposed that the depth and duration of local anesthesia depend on the potency and the penetration properties of the drug injected, since we are not changing the drug in both the groups this could also be used in support to explain the similar depth of anesthesia seen in both the groups.

No failure was observed in conventional infiltration group, whereas 6 (100.0%) out of 6 initial failures in needle-less group, turned effective after supplemental injection, again reinforcing the high success rate of conventional infiltrations in comparison to needle-less injection. Few authors like *Wong J. K. (2001)*[20] reported loss of anesthetic solution due to backsplash phenomenon when needle-less injectors are used; he attributed the failure to this loss of solution, and also suggested that backsplash increases the risk of cross contamination. But *Cooke E. D. et al (1980)*[35] by radioactive analysis confirmed that no anesthetic solution is lost using needle-less injector, and use of autoclavable silicone tip (sili top) as proposed by Weintraub A. M. *et al (1998)*[36] reduces the cross infection potential of needle-less injector. During early period of our study we also found a little fraction of anesthetic solution loss due to same and may be attributed for our failures. But since we were in phase of learning, this problem was solved in later part of learning curve.

Ware L. J. et al (2006)[37] stated many patients dislike the feeling that accompanies use of the jet injector, as well as the possible post-injection soreness of the soft tissue that may develop even with proper use of device. In an another study by *Arapostathis K. N. et al (2010)*[31] found that in 50% of 87 children, subjected to needle-less infiltration, bleeding was encountered, out of them 25% reported it annoying and disliked the device because of the bleeding. Similarly, *Tabita P. V. (1979)*[38] reported 2 cases of small hematoma on using jet injector on giving 103 infiltrations. *Dabarakis N. N. et al (2007)*[21] reported that in 14.6% of the patients, there was limited bleeding at the injection site, 11.8% of patients experienced intense pain in the area of the injection after the anesthesia subsided. Our observation diverge these observations. Every infiltration using needle-less injector produced, blanching in the adjacent tissue and a bleeding knick in the mucosal tissue, and 24 out of 108 of our patients found it distressing and reported more anxiety due to sudden hissing sound during activation and introduction of a new injection technique. These were normal and routine finding, also reported previously by multiple researches *Margetis P. M. et al (1958)*[12], *Bennett C. R. et al (1971)*[5], *Arefian D. et al (1972)*[39] and *ElGeneidy A. K. et al (1974)*[14]. These findings were asymptomatic, reversible and none of these complications was of any real consequence *(Greenfield W. et al 1973)*[33]. No cases incorporated in the present study reported back with any form of complications (hematoma, local ulceration and/or sloughing).

Bleeding can be minimized by proper positioning of the instrument with respect to the surface of the tissue, and by allowing the lip to fall over the instrument at the time of injection *(Greenfield W. et al 1973)*[33]. This suggestion was taken into practice while we used the jet injector which possibly explains reduced complication in our study.

Needleless injectors may be contaminated during in-vitro use and/or direct contact with the contaminated surfaces and carry the contamination to subsequent sites of release. The replacement of the injector's rubber cap with a new one after initial discharge or the removal of an exposed rubber cap and immersion of the head of the injector in 2% gluteraldehyde followed by a rinse of the head in sterile water, as recommended by Weintraub A. M. *et al (1998)*[36] can minimize or eliminate the carryover. Needle-less injector used in the study (INJEX 30) was sterilized by immersion in chemical disinfectant using "Korsolex® Rapid" (2% gluteraldehyde solution and 75% alcohol), for 10-15 mins every time before use. Autoclaving or dry heat sterilization was not done because the device had a stainless steel spring which gets corroded on exposure to moisture, and loses its strength when exposed to high temperature. Also intensive sterilization was not required as the device remained extra-oral throughout the procedure and the parts in tissue contact like the cartridge or silicone tip were disposable and autoclavable respectively[40].

CONCLUSION

"It is sarcastic that local anaesthetic is both the salvation and the bane of modern surgery. It allows virtually pain-free treatment, yet is associated with many anxious thoughts and misconceptions. Dental practitioners can do much to alleviate these fears"- Milgrom P. et al (1997)[2].

Based on our study, we conclude that,

- There was significant reduction in the level of pain perceived during anaesthesia administration with needle-less injector.
- No statistically significant difference in the level of pain perceived during extraction procedure.
- Comparable degree of anaesthesia was seen in cases successful with the needleless injector. This conclusion reinforces the belief that needleless injection can be safely and effectively used to provide painless anaesthesia in maxillary and mandibular anterior region.
- Needle-less injectors can be used for performing painless single tooth extraction, as it produces analgesia comparable to that produced by conventional infiltration.
- No incidence of complication was reported, thus suggesting the

device to be safe for clinical usage

In our experience need for two successive infiltrations, slightly lower success rate, cost effectiveness, intrusive appearance of the device and 'jolting' produced by the device during use are insignificant challenges enigmas. Thus, we suggest a need of further modifications in the device and research to substantiate its advantages, so that frequent usage in routine practice can be advocated.

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