



ANESTHETIC EFFICACY OF CONVENTIONAL SUPRAPERIOSTEAL INFILTRATION VERSUS PERIODONTAL LIGAMENT INJECTION IN DENTAL EXTRACTIONS OF PREMOLAR TEETH: A PROSPECTIVE RANDOMIZED CLINICAL TRIAL

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Article History: Received: 07.06.2023 Revised: 21.07.2023 Accepted: 27.08.2023

Abstract

Introduction: Application of local anesthesia has been a stressful task, both for the clinician and patient due to the psychological and physiological effects of both the needle and solution used. The supraperiosteal local infiltration technique requires deposition of comparatively larger volumes of anesthetic agents for dental extraction, which leads to an increase in the risk of systemic and local complications. Hence there is need to assess alternative means to administer local anesthetic agents for dental extractions which are safer, convenient and effective.

Materials and Methods: A total of 50 participants requiring bilateral extraction of premolars were injected with lignocaine with adrenaline by supraperiosteal infiltration and periodontal ligament (PDL) injection on either side respectively. The onset, depth and duration of anesthesia, and alterations in the pulse rate and blood pressure were recorded at baseline and post injection. Also the pain during extraction was recorded using Visual Analog Scale and effectiveness of anesthesia with either techniques were compared.

Results: The change in pulse rate, systolic blood pressure (BP) and diastolic BP was more with supraperiosteal infiltration technique than PDL injection technique but the results were statistically insignificant. The onset, duration and effectiveness of anesthesia was comparatively more and statistically significant with supraperiosteal infiltration. The depth of anesthesia was more but statistically insignificant with the conventional infiltration technique as compared to the PDL technique.

Conclusion: The advantages of the PDL technique noted in the study are significantly lower volume of anesthetic agent required thereby reducing the chances of systemic toxicity, faster onset of anesthesia, minimal fluctuations in vital parameters viz. pulse rate and blood pressure and minimal collateral anesthesia to the adjacent soft tissues.

Key words: Dental extraction; anesthesia; supraperiosteal infiltration; oral surgery.

Introduction

Ever since the understanding of the dental diseases and the importance of their treatment, various anesthetic agents and techniques have been introduced by the researchers so as to achieve a comfortable and pain free environment for the patients who receive the dental procedure. Historically, the pain of dental ills has been a constant tormentor. The experience of pain during the dental procedure makes both patient and clinician uncomfortable and anxious [1]. Thus, while providing dental treatment, the dentist has to be skilful in carrying out the operative procedure as well as has to master the local anesthesia techniques.

Application of local anesthetic has been a stressful task, both for the clinician and patient due to the psychological and physiological effects of both the needle and solution used, necessitating search for alternative methods which are convenient and effective. This has stimulated the process for search of more atraumatic techniques for effective local anesthesia application [2]. Since the first use of cocaine as local anesthetic agents; the field of local anesthesia for dentistry has evolved to a great extent, from the changes of local anesthetic agents and their delivery system to the changes in technique of administering local anesthesia.

The most common techniques used for dental anesthesia are regional nerve blocks and local infiltration. Also there are other techniques like periodontal ligament injection, intraseptal and intraosseous techniques which can anesthetize isolated areas of the jaw with comparatively less volume of the solution [3]. The supraperiosteal local infiltration technique requires deposition of comparatively larger volumes of anesthetic agents to anesthetize the tooth for dental extraction, which leads to an increase in the risk of systemic and

local complications. Moreover there are patients in whom these techniques may be contraindicated like hemophiliac patients or others with bleeding disorders, in whom post injection bleeding may be dangerous and young children and mentally or physically handicapped persons in whom the risk of post injection soft tissue trauma due to the prolonged persistent anesthetic effect is increased [4,5].

In the PDL injection technique, the local anesthetic is deposited in the periodontal ligament at the depth of gingival sulcus. The mechanism whereby the local anesthetic solution reaches the periapical tissues and into the marrow spaces surrounding the teeth with the PDL injection is by apical diffusion [6]. It is administered in the vicinity of the tooth to be extracted so that the injury to the vital structures can be avoided [7]. Thus, the PDL technique is said to enable administration of precise and optimal amounts of local anesthetic solution thereby ensuring better anesthetic effect limited only to the operative site [8].

Not many studies have compared the PDL injection with the conventional infiltration technique for dental extractions. In this context the present study was aimed to compare the efficacy of PDL injection with the conventional supraperiosteal infiltration for the extraction of the premolar teeth and further verify which injection technique was less painful and more acceptable to the patients. The study had the objectives to analyze the various parameters associated with the PDL injection technique such as the time required for the onset, depth and duration of local anesthetic effect and its vasoconstriction capability and compare it those with the conventional local infiltration method.

Materials and Methods

The present prospective, randomized in vivo clinical trial was conducted from April 2014 to June 2015 after due approval from the institutional ethical committee. The study population comprised a total of 50 patients (26 females and 24 males) requiring bilateral nonsurgical extraction of erupted mandibular premolars in the same arch. Only healthy subjects (according to ASA –I classification) of ages ranging from 18 to 60 years were included. Patients with systemic or mental conditions and pregnant females were excluded from the study. Those having a history of recent acute infection, radiotherapy to the jaws or hypersensitivity reaction were also excluded.

Patients requiring extraction of minimum two teeth in the same arch but different quadrants were selected after obtaining informed consent. One quadrant was used as the control side where dental extraction was carried out with supraperiosteal infiltration technique using conventional syringe while the other was used as the test side where extraction was carried out with PDL injection technique using the intraligamental syringe. In both sides, the local anesthetic cartridge of 2% lignocaine hydrochloride with 1:80,000 adrenaline was used to obtain local anesthesia.

A detailed case history was noted from the patients following which their baseline systolic and diastolic blood pressures and heart rates were recorded. During first sitting, 2% lignocaine HCl with 1:80,000 adrenaline was used for supraperiosteal infiltration on the buccal as well as lingual aspect of the tooth using conventional syringe. The objective confirmation of anesthetic effect was confirmed by a pin-prick test using a 20-gauge sterile needle which was applied over the attached gingiva of the tooth to be extracted and probing buccal and lingual gingival region. The time of onset of anesthesia was subsequently noted. The depth of

anesthesia was recorded using a visual analog scale. Minimal mucoperiosteum reflection was done and the extraction was carried out using appropriate dental extraction forceps under standard aseptic precautions. Discomfort (if any) during the procedure was noted. An appropriately sized cotton to serve as a pressure pack was placed over the socket for 45 minutes. The blood pressure and heart rate were recorded again at this point of time.

In the second sitting, the dental extraction was performed with the same protocol and local anesthetic agent but PDL injection was given to obtain anesthesia using intraligamental syringe. This syringe is a pistol type syringe with a 30-gauge disposable needle, placed in the gingival sulcus buccally and lingually at an approximately 30 degree angle to the long axis of tooth, with the bevel facing away from the tooth. Apical pressure was applied at the sulcus until the needle was wedged into the periodontal ligament between the tooth and the alveolar crest of the bone and 0.2ml of solution was injected each buccally and lingually. In case of patient experiencing pain during extraction, the tooth was extracted by administering anesthesia with conventional syringe and infiltration and the same was noted in patient's record.

In both groups, the duration of the anesthetic effect was marked by the return of pain sensation since the time of onset of anesthetic effect was noted. Discomfort, adverse effects and any signs of an allergic reaction including itching, redness, and localized odema during the procedure were recorded. Additional doses of anesthesia, if required, were also noted.

All patients were discharged after ascertaining hemostasis 45 minutes post-extraction. They were instructed to avoid rinsing for next 24 hours, maintain good oral hygiene and take adequate rest. Mild analgesics and antibiotics were prescribed

over a 3 day course and the patients were asked to report back in case of bleeding,pain or discomfort. A review was performed during the follow-up visit on third day post-surgery to check for the healing of socket.

Results

The age of the participants in the present study ranged from 18 to 60 years with a mean age of 46.02 years. Due to the wide age range, the effectiveness of PDL injection can be evaluated on young as well as geriatric patients. While for the PDL injection, the mean pulse rate was 77.30 and after extraction of teeth, the mean pulse rate was 80.06. This change in pulse rate is slightly on lower side as compared to that of conventional technique but to statistically insignificant

level. When using the conventional injection, the mean systolic and diastolic blood pressure was 121.60 and 71.08 respectively before injection and after extraction was 124.80 and 72.56 respectively. While for the intraligamental syringe, the mean systolic and diastolic blood pressure was 121.44 and 71.44 respectively before injection and after extraction was 123.72 and 72.08 respectively. It has been observed from the study (Table 1,2,3) that there is rise in pulse rate, systolic and diastolic blood pressure after the extraction in the both techniques. However, the rise in pulse rate and blood pressure after extraction, using the PDL injection was less than that caused by conventional technique. This difference is statistically insignificant.

Table 1: Comparison of Mean (SD) values of pulse rate (before injection) and (after extraction) among both the groups

Group	No of participants	Mean (SD) (before injection)	Mean (SD) (after extraction)
Supraperiosteal infiltration	50	77.22 (5.6)	81.56 (5.7)
PDL injection	50	77.30 (5.9)	80.06 (5.6)
p value	-	0.9	0.1

Table 2: Comparison of Mean (SD) values of Blood pressure (systolic and diastolic) (before injection) among both the groups

Group	No of participants	Systolic Mean (SD)	Diastolic Mean (SD)
Supraperiosteal infiltration	50	121.60 (6.2)	71.08 (3.5)
PDL injection	50	121.44 (6.1)	71.44 (3.7)
p value	-	0.8	0.6

Table 3: Comparison of Mean (SD) values of Blood pressure (systolic and diastolic) (after extraction) among both the groups

Group	No of participants	Systolic Mean (SD)	Diastolic Mean (SD)
Supraperiosteal infiltration	50	124.80 (6.4)	72.56 (3.7)
PDL injection	50	123.72 (5.9)	72.08 (3.4)
p value	-	0.3	0.5

The onset of anesthesia with the PDL injection was within 20 seconds in all the patients. While the same for the conventional injection was ranging from 1 minute 30 seconds to 3 minutes, depending upon the site of anesthesia. The duration of anesthesia was adequate enough to carry out the dental extraction without causing discomfort to the patient. No patient reported post extraction pain after one hour of the procedure.

Table 4: Comparison of Mean (SD) values of VAS scores among both the groups using unpaired t test

Group	No of participants	Mean (SD)
Supraperiosteal infiltration	50	0.98 (0.6)
PDL injection	50	0.78 (0.6)
p value	-	0.119

Out of 50 patients, nine patients had VAS score of infiltration technique one unit higher than that of PDL injection. (Table 4) Mean (SD) for conventional technique was 0.98 (0.6) and the same for PDL injection was 0.78 (0.6). The p value was 0.119

which is statistically insignificant. Thus, it can be concluded that statistically, there was no significant difference in pain and discomfort upon injection in both the groups.

Table 5: Cross tabulation of effectiveness of anesthesia among both the groups

Group	Effectiveness of anesthesia		Total N %
	Yes n%	No n%	
Conventional	50 (100)	0 (0)	50 (100)
Intraligamental	44 (88)	6 (12)	50 (100)
Total	94 (94)	6 (6)	100 (100)
Chi square value: 6.383 p value: 0.012*			

*indicates statistically significant difference

Out of 50 cases of intraligamental injection, 6 patients didn't have the objective symptoms of anesthesia. (Table 5) These teeth were then extracted using conventional infiltration injection. The success rate for extraction in PDL injection group is 88 % as compared to 100% efficacy of supraperiosteal infiltration. The p value of .012 shows statistical significance. All the 88% of teeth in which the PDL anesthesia was used, were extracted successfully without any pain or discomfort.

Discussion

Local anesthesia is an exceptionally important therapeutic tool. Its preeminence in pain control for restorative and surgical

procedures in the mouth is underscored by its widespread use by dentists. Without the availability of regional anesthesia, much of dental therapy considered routine today would be difficult or impossible to perform. Regional block anesthesia and infiltration techniques are most routinely used techniques of anesthesia for dental extractions^[9]. Other techniques of dental anesthesia like intraligamentary, intraosseous and intrapulpal anesthesia are not much studied for dental extractions. As compared to the conventional supraperiosteal infiltration, the intraligamentary technique is said to enable the direct administration of precise and optimal amounts of local anesthetic solution into periodontium thereby

ensuring better anesthetic effect with lesser amounts of the local anesthetic agent. The effect of local anesthesia is limited only to the operative site thus avoiding the extraneous numbness.

The PDL injection can be administered using conventional syringes and the special PDL syringes^[10]. The intraligamental syringe is a pistol-type syringe and has a trigger for the injection of the anesthetic solution. Every shot of the trigger forces the anesthetic solution from the cartridge into the periodontal ligament area with pressure (0.2cc per shot). The intraligamental syringe offers advantages over conventional syringe when used for the PDL injection because the trigger permits measured dose administration and enables the relatively weak administrator to overcome the significant tissue resistance which is encountered while performing intraligamental anesthesia. In our study, we had used intraligamental syringe for PDL injection and conventional syringe for infiltration technique.

All the patients who were enrolled in the study were normotensive and without any relevant medical history. It was observed that there was increase in heart rate and blood pressure post extraction in both groups. This elevation in pulse rate and blood pressure may be caused by the fear of the needle, anxiety of the procedure and also due to the vasoconstrictor used in the local anesthetic solution (1:80,000 adrenaline). Meiller et al. in a study on normotensive and hypertensive patients, determined that during local anesthesia and tooth extraction BP increased continually, though without statistical significance. They concluded that this may be due to the agents themselves or to the dental anxiety felt by the patients^[11]. Smith and Pashley found intraligamentary injections of epinephrine-containing solutions, using a high-pressure syringe in dogs, caused cardiovascular responses

similar to an intravenous injection^[12]. Cannell et al, using a high-pressure syringe in human volunteers, found that the intraligamentary injections of epinephrine-containing anesthetic solutions did not significantly change heart rate, rhythm, amplitude, or blood pressure^[13].

In present study, using the conventional infiltration technique, the mean pulse rate before injection was 77.22 and after the dental extraction, the same was 81.56. While for the intraligamental injection, the mean pulse rate was 77.30 and after extraction of teeth, the same was 80.06. This is slightly on lower side as compared to that of conventional technique but to statistically insignificant level. When using the conventional injection, the mean systolic and diastolic blood pressure was 121.60 and 71.08 respectively before injection while the mean systolic and diastolic blood pressure after extraction was 124.80 and 72.56 respectively. For the intraligamental syringe, the mean systolic and diastolic blood pressure was 121.44 and 71.44 respectively before injection while the mean of systolic and diastolic blood pressure after extraction was 123.72 and 72.08 respectively. In the present study it has been observed from the study that there is rise in pulse rate, systolic and diastolic blood pressure after the extraction in the both techniques. However, the rise in pulse rate and blood pressure after extraction, using the intraligamental syringe was less than that caused by conventional technique. This difference is statistically insignificant.

Earlier studies have reported the onset of anesthesia with lignocaine with adrenaline (1:80000) to be 3 to 5 minutes by conventional method^[14]. In our study, the onset of anesthesia with the PDL injection was rapid, usually within 20 seconds in all the patients. While the same for the conventional injection was ranging from 1 minute 30 seconds to 3 minutes, depending

upon the site of anesthesia. Malamed SF in 1980, in his study stated that the duration of onset of anesthesia with PDL technique was less than 30 seconds ^[3]. This may be attributed to the pressure created using the intraligamental syringe, which causes rapid diffusion of the solution in the PDL tissues. While the conventional technique doesn't utilize this amount of pressure, the diffusion of solution is slow leading to slower onset of anesthesia.

Another important advantage of the PDL injection is the volume of anesthetic solution used to anesthetize the tooth is lesser. Small amount of solution was used under pressure to bring about the anesthesia of the PDL and pulp ^[15]. The optimal amount of anesthetic solution required while using the PDL injection was 0.4 ml per tooth in this study. While the volume of anesthetic solution for the infiltration technique being 1.8 ml per tooth which is significantly larger than that of PDL injection. Moreover, with the decrease in the quantity of anesthetic solution, the duration of anesthesia was not affected and was adequate enough to carry out the dental extraction without causing discomfort to the patient. The average duration of anesthesia in our study was 22.02 minutes with a standard deviation of four minutes. No patient reported post extraction pain after one hour of the procedure. Hemad SA in 2006 conducted a study, in which he evaluated the duration of pulpal anesthesia which was 18.34 minutes, the extent of soft tissue anesthesia was 14.77 mm on the labial aspect and 11.18 mm on the lingual aspect ^[16].

The intraligamental syringe forces the solution into the PDL space with a higher pressure of 17,630 mmHg (approximately 330 psi) than that injected by conventional infiltration technique ^[17]. This causes more tissue distention and is thought to cause more pain and discomfort. The same doesn't hold true in this study. The Visual Analogue Scale score remained similar for both the techniques. Out of 50 patients,

nine patients had VAS score of infiltration technique one unit higher than that of intraligamental injection. Comparison of mean values (with SD) of VAS of conventional infiltration technique and intraligamental injection was done. Mean (SD) for conventional technique was 0.98 (0.6) and the same for intraligamental injection was 0.78 (0.6). The p value was 0.119 which is statistically insignificant. Thus, it can be concluded that statistically, there was no difference in pain and discomfort upon injection in both the groups. Some studies have even reported less discomfort during PDL technique ^[18,19].

Kaufmann et al ^[20] noted that they had a success rate of only 46% when trying to attain anesthesia of premolars with periodontal ligament injections. The reason for anesthesia failure in maxillary teeth may be varying root pattern. In present study amongst the 50 patients, six patients were not having objective signs of local anesthesia after giving PDL anesthesia. However, rest of the patients i.e. 44 were not having pain on gingival probing. The effectiveness of anesthesia was the same as compared to the local infiltration technique in these patients. Extractions were carried out successfully in all patients after injection of PDL anesthesia, except for the six patients, in whom the infiltration of local anesthesia was given later. 88% success rate for extraction in PDL injection group compares favorably with the overall success rates obtained in the previous studies where the intraligamental syringe was used to administer PDL injection for a variety of dental procedures ^[21,22,23]. In this study, amongst the 6 cases in which anesthesia was not achieved using intraligamental syringe, 2 maxillary teeth had 2 dilacerated roots. In the mandible, the fact that the bone density is more distal to canine, premolars are difficult to anesthetize ^[24]. Failure rate may not be as significant when the above factors are

taken into consideration. Secondly, all the patients had given conventional infiltration first and thereby a feeling of numbness surrounding the soft tissues of the tooth. So, the patients felt psychologically relaxed as they knew that the area is now numb and extraction will not be painful. While for the PDL injection, this was not the case. Patients do not feel the extraneous numbness while using the PDL injection. So, it is less convincing for the patient to accept that the procedure will be painless. With increased use in routine practice, it will be possible to reduce the failure rates due to the improvement in motor skills and technique of the operator in using the PDL injection. Also it is noteworthy that there was no difference in the quality of anesthesia across all age groups of patients included in the study. There was no tissue change noted following extraction with the PDL injection. The extraction socket healed well without any sign of delayed healing. Nelson ^[25] reported avulsion of a lower premolar following PDL injection. No such incidence was reported in this study.

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Several studies were done to review the effects of the PDL injection on the periodontium and pulp ^[26,27]. All concluded that the PDL injection does not have any short term or long term deleterious effect on the periodontium.

Conclusion

The 88% success rate in our study is adequate to establish the PDL technique as a useful injection technique for securing anesthesia for the dental extractions. The advantages of the PDL technique noted in the study are significantly lower volume of anesthetic agent required thereby reducing the chances of systemic toxicity, faster onset of anesthesia, minimal fluctuations in vital parameters viz. pulse rate and blood pressure and minimal collateral anesthesia to the adjacent soft tissues. It is recommended that the use of the intraligamental syringe to be included in the curriculum for the improved skillfulness of the dental graduates in this technique.

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