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Evaluation of influence of bone quality on onset of action and the volume of anesthetic solution required: An original research

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***Abstract*---**Aim: To evaluate the drug volume and onset of action of local anesthetic agent in different bone densities. Methodology: Present study was conducted on 40 subjects (20 male and 20 female) between 25 to 50 years attending to Sibar Institute of Dental Sciences, A 1.8ml 2% lignocaine with adrenalin was injected in the buccal mucosa(1ml) and palatal mucosa (0.8ml) in desired site of evaluation in maxilla. The duration of onset of action in minutes and drug volume used in milliliters was evaluated, where mainly comparison was done between two different densities of bone (D2,D3) according to

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Misch classification. Results: Areas of maxillary which had a denser cortical bone (D2) needed more volume (1.8-3.6 ml) of local anaesthetic solution (mean ± sd= 2.98 ± 1.02) for achieving its mode of action and subsequently lead to numbness when compared to D3 bone which was more of a porous variety which needed less volume of anaesthetic solution (mean ± sd= 1.63± 0.78) to achieve results. The comparative result was statistically significant (P=0.037). Conclusion: The denser the bone, more time it would take to achieve adequate level of anesthesia.

***Keywords*---**local anesthesia, cortical bone, infiltration anesthesia.

Introduction

Over the past century, there is perhaps no greater contribution to the practice of clinical dentistry than the development and application of local anaesthesia. What were once considered painful procedures have now been made routine by the deposition and action of local anaesthetics. The majority of commonly used dental local anaesthetics fall into the amide category (lidocaine, mepivacaine, bupivacaine, prilocaine), though there are some amide-type local anaesthetics that also contain an additional ester linkage (articaine). While both types of local anaesthetics have the same mechanism of action, they differ slightly in their metabolism. Intraosseous anaesthesia (IO) allows the anaesthetic solution to be injected directly into the cancellous bone. The anaesthetic solution immediately reaches the periapical region, and thus the axonal area of the nerve, where it can temporarily disable the sodium pump. The anaesthetic effect can be achieved with almost no time lag, and only a small amount of anaesthesia is needed. The transcortical injection technique avoids nerve injuries that are commonly related to the use of intraoral nerve z blocks in cases of symptomatic pulpitis. Accidental vessel injection or lingual nerve injuries can be prevented.[1] The duration of action of a local anaesthetic is contingent on two factors: the protein binding and redistribution of the local anaesthetic. Protein binding of the local anaesthetic is an inherent drug characteristic − the more protein-bound a drug is, the longer the duration of action. Duration of action on dental pulp and soft tissues is contingent almost completely on diffusion away from the site of action of the local anaesthetic. If an area is more vascular, the faster the drug will be absorbed into systemic circulation and away from the target tissue. [2] Use of local anaesthesia is necessary to achieve an uninterrupted field of operation and necessary for the comfort of the patient. The knowledge of pharmacology is a paramount for safe and optimum use of this group of drugs. There are many factors that influence the mechanism of action of local anaesthetic solution like the type of drug used, volume of solution, bone quality in the area of usage, local condition of tissues, technique of injection etc. Computed tomography (CT) scan has been commonly used for pre-operative quantitative and qualitative assessment of implant sites and is routinely used to determine the bone density (quality) of the bone. It allows precise 3D evaluation of anatomic structures and direct measurement of bone density, expressed in Hounsfield units (HUs).[3] HUs are standard numbers originating from CT imaging. HUs represent the relative density of body tissues according to a calibrated gray-level scale, based on values for air (−1000 HU),

water (0 HU), and bone density (+1000 HU).[4,5] Today, CBCT is increasingly substituting multislice CT in dentistry for evaluating mineralized tissues because it provides adequate image quality, associated with a lower exposure dose.[6-8] CBCT also offers advantages such as low cost, fast scanning time, and lower number of image artifacts.[9,10] Over CT, it provides shorter acquisition times, submillimeter resolution, and also delivers good spatial resolution, gay density range, and contrast, as well as a good pixel/noise ratio.[11,12] The current study focuses on the evaluation of influence of bone quality on onset of action and the volume of anaesthetic solution required.

Aim of the present study

To evaluate the drug volume and onset of action of local anesthetic agent in different bone densities. Correlation with onset of action and drug volume in different bone densities was evaluated.

Methodology

The present study was conducted on 40 subjects (20 male and 20 female) between 25 to 50 years attending to Sibar Institute of Dental Sciences, A 1.8ml 2% lignocaine with adrenalin was injected in the buccal mucosa(1ml) and palatal mucosa (0.8ml) in desired site of evaluation in maxilla. The duration of onset of action in minutes and drug volume used in milliliters was evaluated. Cone beam computed tomography (CBCT) was done to evaluate the quality of bone and the samples was categorized into different qualities. Clinicians were blinded and their opinion on the bone quality. Bone quality was determined according to Misch classification [13] (Table 1) Statistical analysis was conducted with the help of SPSS 25.0 from the data obtained from the CBCT values using Kruskal–Wallis test.

Results

It was observed that in maxilla, the areas which had a denser cortical bone (D2) needed more volume (1.8-3.6 ml) of local anaesthetic solution (mean ± sd= 2.98 ± 1.02) for achieving its mode of action and subsequently lead to numbness when compared to D3 bone which was more of a porous variety which needed less volume of anaesthetic solution (mean ± sd= 1.63± 0.78) to achieve results. The comparative result was statistically significant (P=0.037). However, when the time of the onset of anaesthesia was calculated, it was seen that bone which had D3 density achieved faster onset (average =2.8 minutes) as compared to D2 bone, due to more porous and vascular bone in the former which helps the anaesthetic solution to travel faster to the affected area. When the type of tooth which were anesthestized were compared, more volume of solution was needed to achieve the result in anterior teeth (mean ± sd= 2.157±1.813) as compared to posterior teeth. The result was not statistically significant (p=1.36). (Table 2)

Discussion

Pain control with irreversible pulpal pain or oral hard and soft tissue pathologies is one of the greatest challenges. Emphasis should be placed on the very precise anaesthetic effect into the jaw, and therefore, a small amount of anaesthetic

solution is needed. This is a benefit, especially for treating patients with risks. A j Certosimo et al., conducted a study on reliability of electric pulp tester on predicting the level of anaesthesia. The study was performed in vivo on patients requiring operative therapy. All teeth were pulp tested preoperatively for vitality using the electric pulp tester. After injection of local anaesthesia, traditional parameters of dental anaesthesia were verified (lip numbness, mucosal sticks). Teeth were then retested with the electric pulp tester and the results recorded and concluded that electric pulp tester is a valuable clinical aid for practicing dentists, which could enable them to objectively monitor the course of anaesthesia prior to the restorative procedure.[14] In a study stated that Hounsfielf units (HU) was derived from Grey Scale Values obtained from CBCT, using a mathematical formula(HU = −61.098 + 1.178 × GSV) derived by Razi et al. This can provide the exact bone quality in region required. The estimation of exact bone quality at surgical site can help clinicians, interpret, and plan before commencement of treatment. [15] Farhad et al. [16] included 60 patients and investigated the success rate, effect on blood pressure, and pain relief. After injecting 3% mepivacain, the success rate of pulpal anaesthesia was compared using pulp tests in both groups. The systolic and diastolic blood pressures of the patients were documented before and after injection. The severity of pain during injection was rated using the VAS. The success rate of pain relief of IO during treatment (56.7%) was significantly higher than that of Inferior alveolar nerve block (IANB) (23.3%) (P = 0.008). Both techniques showed no significant difference in pain during injection (P = 0.304), and systolic (P = 0.080) or diastolic (P = 0.28) blood pressure after injection. In a commentary of the study by Collier et al., he highlighted that the success rate of IANB as the primary technique for lower molars with irreversible pulpitis was assumed to be 18.9% only [17] and that this may be caused by methodological flaws. This further emphasizes the suitability of the IO as the primary technique for anaesthesia for these teeth. Martinez et al. tested IO in comparison with IANB for hot teeth in the posterior mandibular region.[18] In our study, it was evident that D2 bone which was more denser than the D3 bone, needed more of anaesthestic solution as well as there was increased duration related to onset of action of anesthesia.

Conclusion

The results of this study will help in assessing the influence of bone quality on onset of action and the volume of anesthetic solution required. The denser the bone, more time it would take to achieve adequate level of anesthesia.

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Tables

Table 1- Misch classification of assessing bone density.

Density	Hounsfield units	Description
D1	>1250 HU	Dense cortical bone
D2	850-1250HU	Thick dense to porous cortical bone on crest and coarse trabecular bone within
D3	350-850HU	Thin porous cortical bone on crest and fine trabecular bone within
D4	150-350HU	Fine trabecular bone
D5	<150HU	Immature, non-mineralized bone

Table 2- Efficacy of local anesthestic solution based on bone density

	Volume of Local anaesthetic solution (mean± SD)	Time of onset of anaesthesia (mean ±SD)	P value
Based on density of bone D2 D3	 2.98 ± 1.02 1.63± 0.78	 2.03±0.56 1.49±0.21	0.037
Based on which tooth affected Anterior teeth Posterior teeth	 2.157±1.813 1.889±1.002	 2.39± 2.01 1.97 ±1.16	1.36