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Evaluation of the Efficacy of Different Topical Anesthetic Agents in Reducing Pain during Administration of Local Anesthesia in Children

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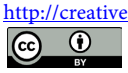

Abstract

Objective: to discuss the effectiveness of some products (Lidocaine gel 9.6%, Lidocaine spray 8% and Benzocaine 20%) in pain relief during local anesthesia before procedures in children. **Patients and Methods**: this study concluded 90 children between 5 - 12 years who were admitted to pediatric dentistry clinic at Tishreen University Hospital (TUH) during the period of 2021-2024. The study sample was divided into equally separated groups. Group I: Children received Lidocaine gel 9.6%; Group II: Children received 2% Lidocaine spray 8%; Group III: Children received Benzocaine gel 20% before infiltration anesthesia. **Results**: the study sample included 90 children between 5 - 12 years old with an average age of (8.23 ± 2.24). All subgroups had similar average of ages with no important differences ($p > 0.05$). There were significance differences among the studied groups according to the average values of SEM scale and faces pain rating scale during local anesthesia, the best values were in the Lidocaine gel group with 1.23 ± 0.4 and 4.76 ± 0.4 in order. We noticed no significant differences between Benzocaine and Lidocaine spray. **Conclusion**: the application of Lidocaine gel 9.6% for 1 min before infiltration anesthesia can safely and significantly decrease pain during mucosal puncture and anesthetic injection. Whereas lidocaine spray and benzocaine gel are equally effective in controlling pain during the administration of local anesthesia. The findings in this study can significantly aid in the development of painless dental treatments with minimal stress for young children.

Subject Areas

Anaesthesiology & Pain Management, Dentistry

Keywords

Local Anesthesia, Lidocaine Gel, Lidocaine Spray, Benzocaine, Pediatric

1. Introduction

Fear and anxiety are the most prevalent problems in pediatric dentistry [1]. For these reasons behavior management and pain control is an important part the management of children at the dental chair, therefore, reducing the pain during the dental appointment should reduce fear and anxiety, and promote a positive dental attitude [2]. Despite the continuous development of new dental injection techniques, the injection of local anesthesia still causes discomfort and pain for many patients and has been described as a major reason for dental anxiety [3]. To reduce the inconvenience of injection fear, especially in pediatric populations, the local anesthesia technique can be combined with topical anesthesia [4]. There are ongoing efforts to develop various forms of topical anesthetics with more potent effects in order to facilitate the provision of quality care by dentists, upon a thorough understanding of the products [5]. The anesthetics used for the topical technique have clear differences from those used for infiltration anesthesia: the molecules used for topical anesthesia must have a high permeability of the mucosa to increase the anesthetic effect, in order to block the more superficial free nerve terminals. For this same reason, vasoconstrictors are not added to topical anesthetic mixtures because they undermine this mucosal permeability. Additionally, topical anesthetic formulations typically have higher concentrations than injectable to promote diffusion after passing through the mucosa [4].

Topical anesthetic agents have proven to be a boon in their attempts to painless dentistry. The ability of various topical anesthetics to penetrate the oral mucosa and produce anesthesia has been well-documented. They act by inhibiting the rapid ionic influx of sodium necessary for neuron impulse generation [6] and blocking the transmission of signals from the termina fibers of the sensory nerves and provide effective surface anesthesia for a depth of 2 to 3 mm. This property of surface anesthesia effectively reduces the pain associated with needle penetration of the mucous membrane [7]. Topical anesthesia is a reversible abolition of sensitivity in a small part of the body by external and localized administration of anesthetics in the form of creams, ointments, gels or sprays, usually on an area of skin or mucosa. The intensity of anesthesia is weak, but it is easy to administer and can reduce the pain caused by needle injections, having minimal side effects, and can therefore lead to improved behavior toward dental treatment. The effect of topical anesthetics is increased when the mucosa is dry, therefore, before the application, surfaces should be adequately dried [4].

Topical anesthetics are commercially available as aerosols, ointments, gels, lozenges, tablets, pastes, powders, solutions and impregnated patches. The concentration of the agent varies depending on the formulation. Lidocaine spray and gel are two commonly used forms of topical anesthetic agent [5].

Lidocaine is the most common and used topical anesthetic and has prompt and fast action. Benzocaine is characterized by slow absorption and, to have a sufficient anesthetic effect, it is used in higher concentrations, ranging from 10% to 20% [4].

2. Materials and Methods

The study group consisted of 90 children between 5 - 12 years old of both genders who were treated between 2021-2024. Informed consent was obtained from the parents of all the study participants.

Children who were classified as "positive" and "definitely positive" according to Frankl's behavioral rating scale were included in the study to avoid any bias in the response rate. Positive includes those patients that accept treatment at times cautiously and those who are willing to comply but at times with reservations. Definitely positive includes those patients who develop a good rapport with the dentist, takes an interest, laughs, and enjoys the treatment. Children with any allergic history to any local anesthetic agents were excluded from the study.

A total of 90 children who required administration of local anesthesia for their dental treatment were randomly selected. They were divided equally into three subgroups (Figure 1) depending on the type of topical anesthetic application. No control group was present in the study.

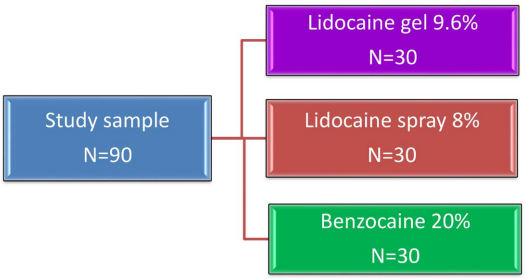

Figure 1. Distribution according to the method of treatment.

- Group I: Children received Lidocaine gel 9.6%.
- Group II: Children received 2% Lidocaine spray 8%.
- Group III: Children received Benzocaine gel 20%.

The same dentist performed all examinations and treatments. Children were seated on a dental chair that was positioned to adequate light to facilitate application of the topical anesthetic agent at the desired site. Following isolation, the testing area was dried using a sterile gauze and, in each group, a topical anesthetic agent was applied prior to local anesthetic infiltration.

For the application of gel, the injection site has dried out, and experimental topical anesthetic gel was applied with a cotton pellet, using moderate pressure with rubbing circular motion for 30 - 45 s to a confined site and left for about 1 min, before local injection.

For application of spray form, one puff of spray was used for each subject for the purpose of standardization. The volume of Lidocaine delivered in one spray was 10 mg. After 1 min wait, local infiltration anesthetic administration was carried out. Pain responses were compared based on the subject self-report using face scale (Figure 2) to record subjective symptoms and sound eye motor (SEM) scale with its 4 degrees [8] (Table 1) was used to record objective symptoms.

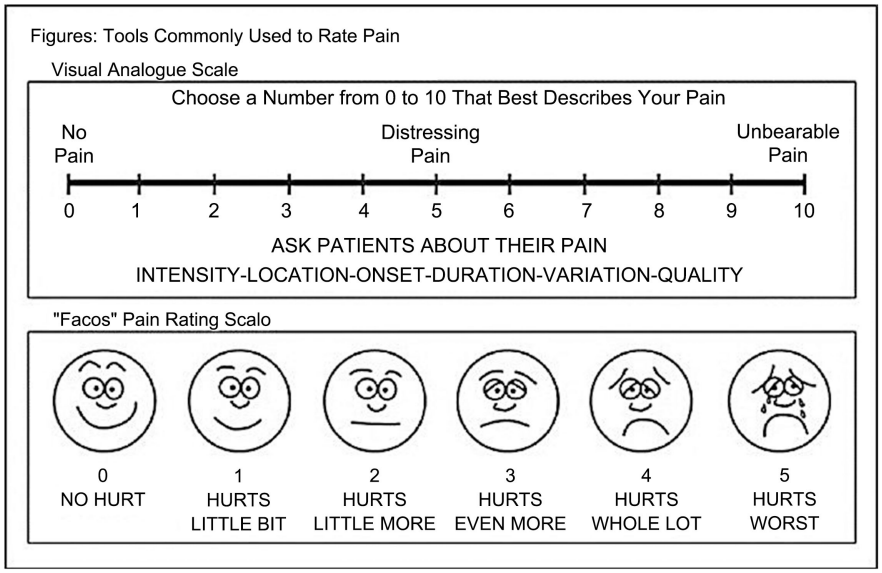

Figure 2. Faces pain rating scale.

Table 1. SEMS tool scale.

Observation	1-comfort	2-enough uncomfortable	3-enough painful	4-painful
Sound	No sound, of pain	No specific sound of pain	Complaint verbally by raising voice	Complaint verbally painful
Eyes	No pain	Eyes open, look concentrate	Blink some times Drop tears	Cry tears drop to face
Motoric	calm	Hand holds chairs, show anxiety	Contact physically, hand and body movement	Aggressive movement to avoid treatment

2.1. Exclusion Criteria

- Children with a history of hypersensitivity reactions to anesthetic agents;
- Recent trauma to oral tissues;
- Children taking medications which suppress the CNS such as diazepam, chlordiazepoxide HCl, alprazolam, etc.

2.2. Statistical Analysis

- Statistical analysis was performed using IBM SPSS program (version 25).
- Descriptive statistics:
  - For quantitative variables: measures of central tendency were used.
  - For qualitative variables: frequencies and percentages were used.
- Chi-Square tests were used to assess the differences in the distribution of categorical variables of the study group.
- One-way ANOVA test was used to study differences of averages among several independent groups, in case of statistical significance, the least significant difference (LSD) test was performed for dimensional comparisons.
- Differences at the p-value threshold less than or equal to 0.05 were considered

statistically significant.

3. Results

The study sample included 90 children between 5 - 12 years old with an average age of (8.23 ± 2.24). They were divided equally into three subgroups (30 children in each group) depending on the type of topical anesthetic application as shown in (Table 2). The average age of each group was similar with no important statistical differences (p value > 0.05).

Table 2. Distribution of study sample according to age.

Age	Group I (Lidocaine Gel 9.6%)	Group II (Lidocaine spray 8%)	Group III (Benzocaine 20%)	p-value
Mean ± sd	8.38 ± 2.2	8.15 ± 2.25	8.16 ± 2.28	0.604

There were significance differences among the studied groups according to the average values of SEM scale during local anesthesia, the best values were in the Lidocaine gel group with 1.23 ± 0.4 and the highest were in Benzocaine group with 2.53 ± 1.008. After studying the statistical differences in sub groups, we noticed no significant differences between Benzocaine and Lidocaine spray (Table 3) (Figure 3).

Table 3. Average values of SEM scale during local anesthesia among the studied groups.

SEM degree	Lidocaine Gel 9.6%	Lidocaine spray 8%	Benzocaine 20%	p-value
Mean ± SD	1.23 ± 0.4	2.30 ± 0.7	2.53 ± 1.008	0.0001
Min – Max	2 - 1	2 - 1	1 - 4	
Multiple Comparisons	Re	0.0001	0.0001	
Pot HOG Test (LSD)	0.0001	Re	0.2	
	0.0001	0.2	Re	

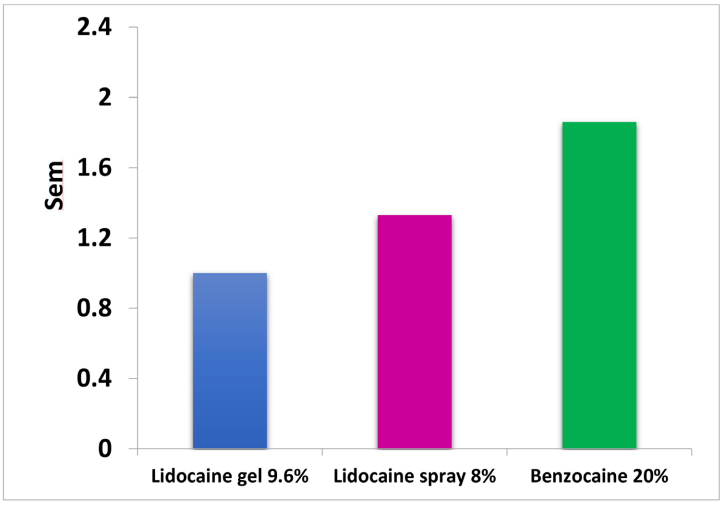

Figure 3. Average values of SEM scale during local anesthesia among the studied groups.

There were significance differences among the studied groups according to the average values of faces pain rating scale during local anesthesia, the best values were in the Lidocaine gel group with 4.76 ± 0.4 and the lowest were in Benzocaine group with 2.90 ± 1.3. After studying the statistical differences in sub groups, we noticed no significant differences between Benzocaine and Lidocaine spray (Table 4) (Figure 4). In our study, the results above may be explained as topical gel (Lidocaine gel 9.6%) had better localization and absorption in comparison with lidocaine spray.

Table 4. Average values of faces pain rating scale during local anesthesia among studied groups.

Faces pain rating scale degree	Lidocaine gel 9.6%	Lidocaine spray 2%	Benzocaine 20%	p-value
Mean ± SD	4.76 ± 0.4	3.43 ± 1.1	2.90 ± 1.3	0.0001
Min - Max	5 - 4	5 - 2	1 - 5	
Multiple Comparisons	Re	0.0001	0.0001	
Pot HOG Test (LSD)	0.0001	Re	0.05	
	0.0001	0.05	Re	

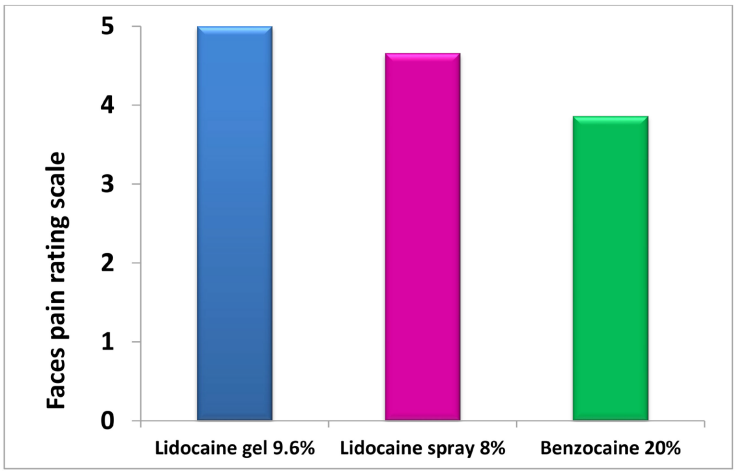

Figure 4. Average values of faces pain rating scale during local anesthesia among the studied groups.

4. Discussion

Pain control is considered one of the most challenging aspects during dental procedures. There has been much advancement in anesthetic agents and techniques to achieve pain-free local anesthesia.

Injections are the biggest cause of anxiety during a dental appointment. Anxiety is a significant factor resulting into avoidance of dental care by some patients, especially children. Circumventing this fear makes the experience much more comfortable for the patient and allows the pediatric dentist to provide the best standard of the care for the child. There is a considerable amount of information available concerning the efficacy and duration of local anesthetics following intraoral

injection. The efficacy and duration of intraoral anesthesia varies between different local anesthetic solutions and techniques as well as the site of administration for example palatal region is one of the most painful areas [9]. The duration of soft tissue anesthesia varies between regional block and infiltration techniques. Topical anesthetic spray and gel have both advantages and disadvantages. The advantages of topical gels include better localization of drug in comparison with ointments and solutions, better control over systemic drug absorption, greater bioavailability and reduction in dosage.

However, gels get diluted in the mouth with time, resulting in is difficulty in maintaining prolonged mucosal contact resulting in inadequate anesthesia. Topical anesthetic sprays have greater concentration of local anesthetic and are absorbed rapidly across the mucous membrane, thus providing effective anesthesia [10]. Unmetered sprays have potential for systemic toxicity and hence it is recommended that metered spray with disposable nozzles be used [5].

The results of our study differ from (Tejashri Gupte *et al.*) study [11]. They found that Lidocaine spray was more effective than Lidocaine gel after waiting for one minute. This difference may happen due to the concentration of the substance cause we used Lidocaine gel as 9.6% in our study, meanwhile Lidocaine gel was used as 2% in their study.

However, no statistically significant differences were found in (Anshul Sharma *et al.*) study [12] between Lidocaine gel 8% and Lidocaine spray 15% in reducing pain of local anesthesia after waiting for 3 minutes. In contrast, our results showed that Lidocaine gel 9.6% was more effective than Lidocaine spray after waiting for one minute, due to differences in concentrations.

The results of our study differ from (Manisha Nair *et al.*) [13], where Benzocaine gel was more effective than Lidocaine gel in reducing pain of local anesthetic injection. They used Lidocaine gel 2% in contrast of our study (9.5%).

Also, the results differ with (Niharika kotian *et al.*) [14] who did not find any statistical significant differences between Lidocaine 5% and Benzocaine gel 20% after 30-second wait in controlling pain when administering a local anesthetic injection. This may be explained by the difference in waiting time between the studies (30 seconds versus one minute). Sudha *et al.* found that lignocaine 2% has a limited capacity of penetrating deep into the tissue and was ineffective at greater depth of penetration [15].

5. Conclusions

Our findings suggest that applying lidocaine gel 9.6% for 1 min before infiltration anesthesia can safely and significantly decrease pain during mucosal puncture and anesthetic injection. Whereas lidocaine spray and benzocaine gel are equally effective in controlling pain during the administration of local anesthesia. The findings in this study can significantly aid in the development of painless dental treatments with minimal stress for young children.

Therefore, the use of a topical anesthesia should always be recommended before

performing local anesthetic injection in pediatric population, to decrease discomfort and for optimal behavioral outcomes.

6. Study Limitations

The exceptional circumstances that the country is going through, which negatively affected the access to a larger sample size that supports the results of this research.

The privacy of patients and difficulties in pediatric dentistry, as well as the challenges in providing medicines in our country.

Declarations

Ethical Approval

This research received approval from the Scientific Research Committee at Tishreen University and Tishreen University Hospital.

Acknowledgments

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Conflicts of Interest

The author declares no conflicts of interest.

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