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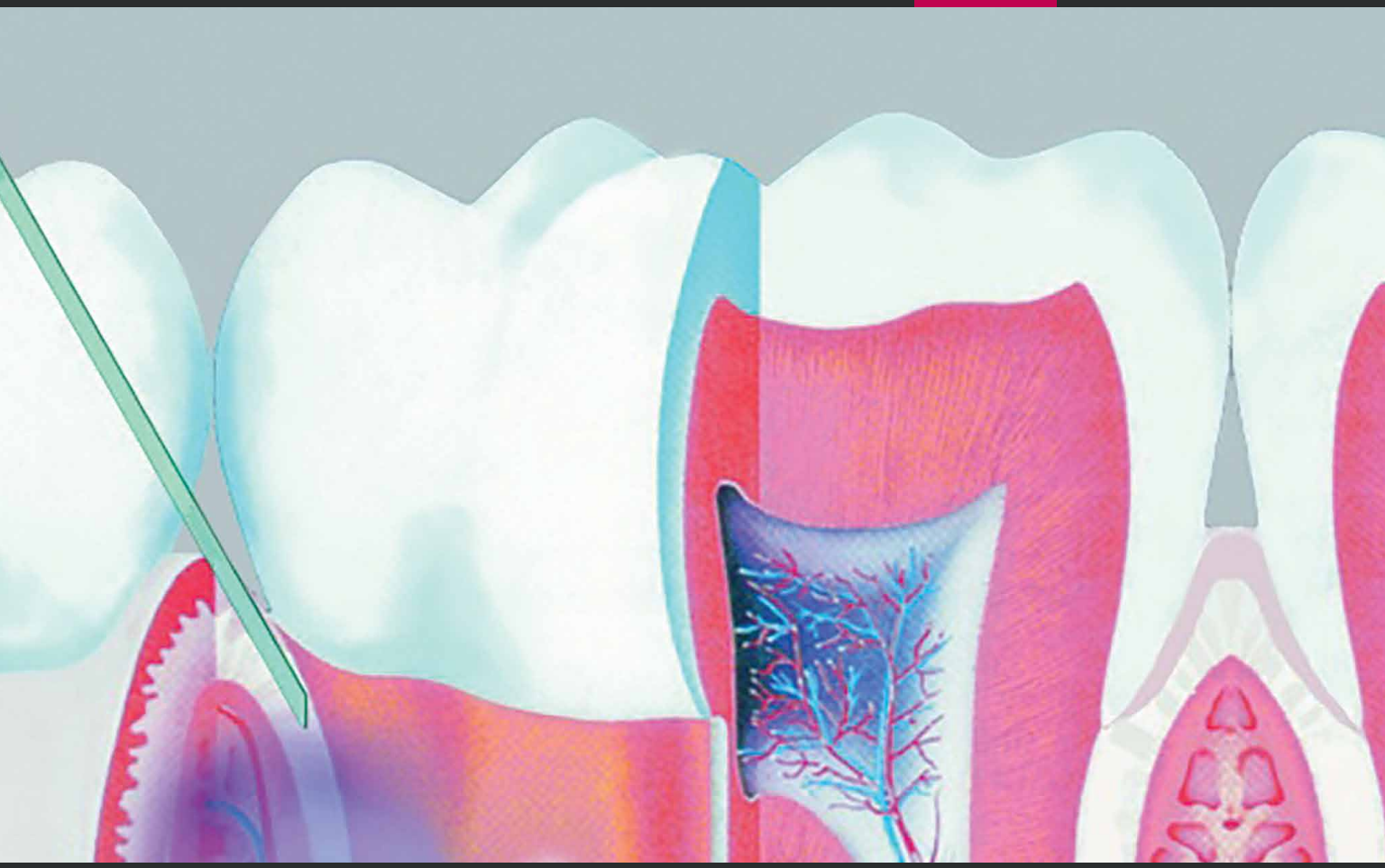

Intraligamentary Injections in Dentistry

A Peer-Reviewed Publication

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Intraligamentary Injections in Dentistry

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At the conclusion of this educational activity, participants will be able to:

1. Develop an understanding of the methodology employed during an Intraligamentary injection (ILI)
2. Discuss various armamentarium employed with an ILI
3. Discuss the risk and benefits associated with the administration of an ILI

ABSTRACT

Originally billed as peridental injections in the early 1900s, intraligamentary injections (ILIs), also referred to as periodontal ligament injections, were considered unconventional, and widespread utilization did not occur.[1] However, increased use of ILIs began in the late 1970s with the introduction of specialized syringes that allowed the operator to more easily administer anesthetic solution in a high pressure location.[2] A second resurgence occurred in the early 2000s with the introduction of computer-controlled local anesthetic delivery devices (C-CLAD) that provide a high-level of injection control. Today, ILIs are "perhaps the most universal of the supplemental injections," and commonly used when inferior alveolar nerve block techniques are unsuccessful or fail to achieve the desired level of anesthesia.[3] In addition, ILIs are indicated for single-tooth anesthesia; when low anesthetic dosage is required; widespread anesthesia is contraindicated; or certain systemic health issues are present.[3-4] Continued growth of ILI utilization is expected because patients want less soft tissue anesthesia following dental care and dental providers desire less use of the traditional inferior alveolar nerve block for routine restorative procedures. This article will explore and evaluate the current use of intraligamentary injections in dentistry and the technique's impact on the dental care experience.

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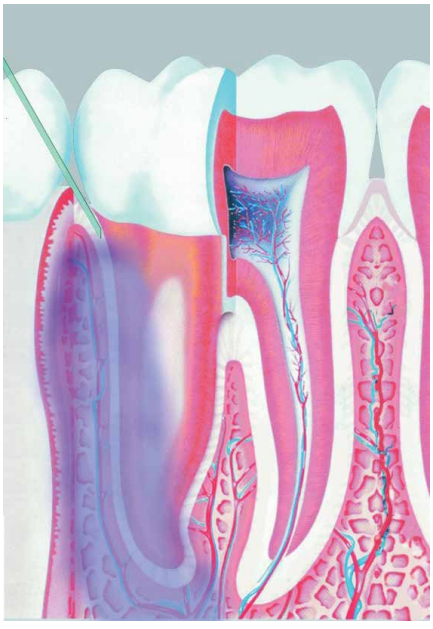
INJECTION METHODOLOGY

As described by Meechan, the term "intraligamentary injection" is a misnomer in that the ILI is considered a modification of the traditional interosseous injection technique.[5] As seen in **Figure 1**, the periodontal ligament space provides an accessible pathway to the cancellous alveolar bone, and the anesthetic reaches the pulpal nerve via natural perforations of intraoral bone tissue. While ILIs are becoming synonymous with the phrase "single tooth anesthesia," the spongy design of cancellous bone provides opportunity for diffusion of the anesthetic beyond the immediate area of deposition. ILIs often result in anesthesia of adjacent teeth and lip numbness has been reported (especially if the mental nerve area is involved).[5-7] However, the spread of soft tissue anesthesia is usually limited, and patients are not likely to experience the areas of anesthesia (lip, cheek, and tongue) following inferior alveolar nerve block injections (IANB).

Figure 1: Anesthetic spread during an intraligamentary injection



An ILI is commonly administered as a supplemental injection of the mandible; however, the near instantaneous anesthetic result, as well as a limited area of numbness, often influences providers to employ ILIs as an alternative injection to an IANB.[3,8] IANBs have traditionally been the anesthetic technique of choice for the majority of mandibular operative procedures. They can be associated with high failure rates and a comparatively higher level of intrinsic risks such as neuropathy, hematoma, trismus/jaw sprain, and self-inflicted soft tissue injury.[1,3,8-11] This results in demand for comparative methods and techniques that improve the patient experience. While there exists a wide range of anecdotal and scientific analyses on effective use of ILIs as primary injections, the determination of "superiority" or "inferiority" of the ILIs to IANBs has not currently been achieved.[10,12] Given the variation in training, technique, patient populations, and procedures administered, professional consensus on the best overall mandibular technique has been difficult to establish. It should also be noted that while ILIs can be administered with maxillary teeth, the supraperiosteal-infiltration injection is a more commonly employed method given its high success and low complication rates. When maxillary teeth are anesthetized with an ILI, it usually involves the anterior teeth where supraperiosteal injections have been associated with a higher level of discomfort.

The advantages and disadvantages should be considered prior to any injection administration to mitigate negative outcomes and evaluate the ideal anesthetic process for the patient visit (**Table 1**).[1-7,10,13-18] The success of an ILI to overcome unsuccessful or inadequate anesthesia is considered a primary advantage to its utilization. Success rates of 90% and higher have been reported following a secondary or supplemental ILI in which conventional injections did not produce adequate anesthesia.[13-14] The onset of anesthesia occurs more rapidly with the ILI; the amount of anesthetic required is a smaller quantity (0.2-1.0 mL); and the area of anesthesia is reduced, compared to other injections employed in the mandible. Another advantage relates to patients with bleeding diathesis (disorders that result in hypocoagulation or impairment of blood coagulation, such as hemophilia), who may present at an increased risk of bleeding in the retromolar or pterygomandibular space that can result in airway compromise following an IANB injection.[19-20] Previous analyses found that no complications related to hematoma formation in hemophiliac patients occurred following ILIs.[21-23] While concern has been expressed with use for patients with cardiovascular disease and the proposed rapid entry of anesthetic and vasoconstrictor into circulation with the ILI technique, a meta-analysis of literature from 1979 to 2012 found that cardiovascular disturbances occurred more often after IANB injection compared to ILIs.[10,24]

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TABLE 1: THE ADVANTAGES AND DISADVANTAGES OF INTRALIGAMENTARY INJECTIONS

Advantages:	Description:
• Small quantity of anesthetic required	• For a conventional ILI, the total recommended dosage is from 0.2 to 1.0 mL of a standard anesthetic cartridge.
• A limited area of anesthesia	• Anesthetic effect usually only affects one to three teeth and their associated periodontium.
• Quick anesthesia onset	• Anesthesia occurs immediately (within 30 seconds).
• Effective supplemental injection following inadequate or incomplete anesthesia	• Success rates above 90% have been reported for ILIs when used following standard technique failures in the mandible.
• Effective procedure for patients with hemophilia	• Safety with ILI injections has been reviewed with no complications related to hemorrhagic issues found with restorative care and without Factor VIII administration.
Disadvantages:	**Description:**
• Possibility of tissue damage	• Histological studies have found damage to tissues following ILI and postoperative discomfort can occur (both frequently temporary). Use in patients with periodontal inflammation and/or disease at the proposed injection site and/or 5 mm of periodontal attachment loss or more is not recommended.
• Possibility of bacteremia	• Some analyses have found that bacteremia can occur following ILIs and may result in endocarditis for at-risk populations.
• High pressure is required for anesthetic success	• Proper needle placement becomes paramount to achieve the appropriate pressure for injection where insufficient pressure is associated with anesthetic failure and excessive force can produce tissue damage or result in device or cartridge breakage. The potential for tooth extrusion or avulsion also exists, although extremely rare.
• May damage unerupted teeth	• It has been implied (not completely substantiated or refuted) that enamel hypoplasia and defects may occur when ILIs are administered in a primary tooth with a permanent tooth bud present in the area. These defects have not been reported from active practice in humans.

One disadvantage of the ILI technique is the possibility of periodontal tissue damage. While it is feasible for tooth atrusion and avulsion (extremely rare) to occur, tissue injury is frequently minor, localized, and reversible, with most insults completely resolving within eight days.[1,5,25-26] It has been postulated from animal studies that enamel defects and/or hypoplasia may occur when ILIs are administered in a primary tooth with a permanent tooth bud present in the area.[16] However, these adverse events have not been reported in humans.[5] It is not recommended to administer ILIs to patients with periodontal attachment loss and/or active periodontal inflammation. Lack of adequate pressure is associated with anesthetic failure and higher pressures can result in adverse events; therefore, techniques require the most appropriate force with the least variability in pressure during anesthetic deposition. This may require dental providers to utilize alternative syringes or technology assisted devices. Bacteremia occurring with ILI administration has been reported and could cause endocarditis in at-risk populations.[15] The shorter duration (usually 30 minutes or less) of pulpal anesthesia limits the use of ILIs for several restorative procedures.[3,5,10] The administration of a larger quantity of anesthetic may correlate to increased duration of anesthesia effect, although a high level of deposition control is necessary and further research is needed to determine the optimum volume of anesthetic.[3,5,27] Other disadvantages of ILIs include postoperative discomfort and operator sensitivity with technique administration.

TECHNIQUES

As with most dental anesthetic injection techniques, ILIs have multiple forms and variations in administration. Clinical decisions for ILI use are based on patient populations, provider training, operative procedure, and armamentarium. **Table 2** provides an abbreviated review of variation characteristics with ILI techniques. Like most injection techniques, the standard ILI involves a series of steps that leads to successful anesthesia. Many ILI technique descriptions begin with a recommendation that all plaque and/or calculus has been removed (ideally before the operative visit to facilitate good gingival tissue healing) and that prior to injection, the gingival sulcus be swabbed/cleaned with 0.2% chlorhexidine solution.[5,28] ILIs are not recommended for patients with active periodontal inflammation and should not be administered at tooth sites with 5 mm or more of periodontal attach-

ment loss. The use of topical anesthetics during ILI primary injection processes has not been well documented or compared. The limited analyses available suggest that topical anesthetics may decrease pain response, and combination topical anesthetics such as EMLA (a eutectic mixture of 2.5% lidocaine and 2.5% prilocaine) may be more effective.[29-30] However, the lack of available research limits consensus on a standard topical anesthetic process for ILIs, and further research is needed to evaluate effectiveness. It should be noted that most technique explanations recommend obtaining soft tissue anesthesia prior to ILI administration to increase patient comfort.[3] While the type of anesthetic does not directly affect anesthesia success, the absence of a vasoconstrictor significantly decreases efficacy.[31-32]

The choice of syringe usually relates to provider preference and is often determined by which device provides the easiest and least painful deposition of anesthetic solution under pressure. A 27-gauge short or 30-gauge ultra-short needle are most commonly utilized, although success is not dependent on needle gauge size.[13,33] The needle is inserted along the long axis (at a 30° angle) of the mesial or distal root for single rooted teeth and on the mesial and distal roots of multirooted teeth (**Figure 2**).[1] The bevel orientation (toward or away from the root) does not impact success and some technique explanations provide that bevel orientation toward the root may provide easier advancement of the needle apically.[1,34] Once the needle is placed between the root and crestal bone, significant resistance is experienced. Anesthetic deposition is recommended at 0.2 mL of the anesthetic cartridge, per root or site, injected for at least a 20 second period. Necessary for success, the anesthetic is deposited under pressure and the solution should not flow out of the sulcus into the mouth. It is important to wait to withdraw the needle at least 10-15 seconds to allow for complete deposition of solution, which can be slower than other injections due to the pressure that occurs during the anesthetic administration. Blanching, or whitening, of the tissue is usually noted and may be more pronounced when vasoconstrictors are utilized.[1,34] Blanching occurs due to a temporary obstruction of the tissue's blood flow. The duration of pulpal anesthesia following ILIs is commonly reported as ≤ 30 minutes with a range of 10 to

Figures 2a and 2b: Needle insertion during intraligamentary injections

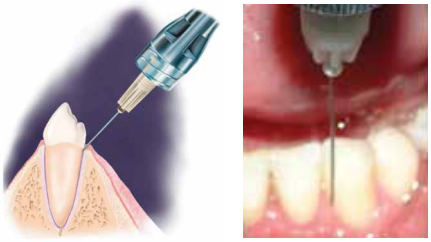

TABLE 2: AN ABBREVIATED REVIEW OF ILI TECHNIQUE VARIATIONS

Variation Characteristic:	Findings:
Anesthetic selection	• While anesthetic type does not influence effectiveness, the presence of a vasoconstrictor increases efficacy.
Bevel orientation	• While anesthesia success is not connected to bevel orientation, provider preference and ideology play a significant role in the alignment of the needle during an ILI. Recommendations and reasoning are provided below: • Bevel oriented toward alveolar bone to reduce chances of tissue related blockage of solution flow. • Bevel oriented toward the root for improved advancement and placement. • Bevel is twisted into place from root faced insertion to alveolar bone orientation for solution deposition. [Tissue damage occurrence from this technique has not been comprehensively explored.]
Needle selection	• Anesthesia success is not connected to needle gauge or type with anesthetic success observed for all available needle types. Provider preference most often dictates the type of needle used. • 27 gauge short and 30 gauge ultra-short more commonly utilized. • Use of 30 gauge needles may result in higher pressure at injection and have been reported to bend or flex during injection.
Site administration	• Multiple sites are often recommended to achieve anesthesia success with up to two sites of injection for single rooted teeth and up to four sites for multirooted teeth. The mesial and distal aspects are most commonly utilized due to accessibility.
Solution deposition	• 0.2 mL solution of a standard anesthetic cartridge is recommended per root, although ideal volume has not been comprehensively explored. • When computer controlled devices are utilized and/or variability in injection pressure is not likely, higher volumes (up to 1.0 mL of 2-3% solutions or up to 0.45 mL of 4% solutions) have also been recommended.

60 minutes depending on tooth location and type, agent administered, and operator technique.[5,10,28,35] The use of a larger quantity of anesthetic has been reported to improve duration of pulpal anesthesia.

SYRINGES AND DEVICES

ILIs can be administered successfully with a standard syringe, specialized syringe, or C-CLAD device; however, certain instruments may offer advantages and benefits during daily dental practice. A shift from the use of conventional anesthetic syringes for ILIs began in the late 1970s to early 1980s as new intraligamentary syringes were introduced. The two most often cited arguments against the use of a conventional/standard anesthetic syringe are: the difficulty in achieving the appropriate pressure needed for adequate injections and concern that the resultant extreme pressure can cause a breakage of the anesthetic cartridge and/or tissue damage during fluid deposition. It should be noted that Malamed has offered rebuttals to this ideology that the slow injections produced by the manual/conventional application of ILIs may reduce trauma, and he suggests eliminating a portion of the anesthetic solution (0.6 mL) prior to the injection.[1] The reduction decreases the surface area of an anesthetic cartridge subjected to the created pressure.

Many providers have found benefits with alternative syringes and computer controlled devices and regularly employ them in dental practice. The intraligamentary syringe (**Figure 3**) offers a mechanical advantage to the practitioner by using a trigger-grasp or click apparatus to employ a gear or lever that enhances control and results in increased force to more easily push the anesthetic cartridge's rubber stopper forward for fluid deposition. Most ILI syringes provide the deposition of 0.2 mL with each squeeze or click of the trigger. There has been concern that the mechanics result in such a high level of user ease that the resultant high pressure (up to 1,200 psi) and speed of injection can result in unwanted complications such as tissue damage and the possibility of tooth avulsion or extrusion (although extremely rare).[1, 33] The majority of adverse events that occur with ILI processes relate to the high pressures that result in traumatic force to the tissues involved.[36] The desire to have more control over flow of anesthetic and injection pressure, as well as decreased trauma from injection, has led to the development of technology assisted devices.

Figure 3: Manual intraligamentary syringes: hand-grasp trigger release (left) and click-activated (right)

Computer controlled local anesthetic delivery devices (C-CLADs) have slowly increased in popularity since their introduction at the start of the current millennium (**Figure 4**). C-CLADs utilize computer microprocessors to manage fluid dynamics and anesthetic deposition once activated by an operator. The use of technology assisted delivery has reduced subjective flow rates and variability in pressure that can result in a significant pain experience for patients. With ILIs, the fluid dynamics of C-CLAD systems produce lower pressures (225–375 psi versus 450–1,200 psi with intraligamentary syringes) with little to no variability, which allows for a better hydrodynamic diffusion of solution into bone or the desired area of deposition.[3,37-38] This can allow for a larger volume of anesthetic solution to be delivered during ILIs without increased tissue damage, which some report may result in a longer duration of anesthesia effect or improved success rates.[3,27,39-40] New generation C-CLAD devices utilize dynamic pressure sensing mechanisms to optimize needle placement and accuracy of fluid deposition.[3,41] These systems give real-time feedback to providers on excessive force and if the flow of anesthetic is impeded or blocked.[3,42] The utilization of similar devices in medicine during epidural anesthetic administration is in early stages with improved success and fewer adverse events proposed as a possible outcome of use.[43-44] Additionally, C-CLAD devices have been associated with ergonomic benefits especially as they relate to the nonconformities of the wrist and hand as well as providing advantages to practitioners with small hands.[3,42, 45-46] C-CLAD syringe devices allow for a penlike grasp (**Figure 5**) and utilize a computer driven system to deposit the anesthetic solution. When incorporating a C-CLAD system into practice, training and education are necessary, and the need for in-practice learning exists. Difficulties with the operation of the foot rheostat for syringe activation/operation has been reported, and improved coordination requires repetition of use to more easily apply the device to daily dental care operation.[47] In addition, patients will need to be educated and comfortable with the device prior to use. While patient reports of pain on injection decrease, C-CLAD devices do not completely eliminate the peri- or postoperative pain experience.

Figures 4a and 4b: C-CLAD devices: the Wand™ Single Tooth Anesthesia system (4a) and the Calaject™ Computer Assisted Local Anesthesia system (4b)

Figure 5:
Utilization of a penlike grasp

THE PATIENT EXPERIENCE OF CARE

The anesthetic injection is foremost on a patient's mind and one of the primary ways dental providers are judged.[48] Given the financial and professional impact patient opinion can have on providers and practices, the stress to achieve a high level of injection accuracy and have it result in patient satisfaction can heavily weigh on providers day-to-day. Because of this, many dental thought leaders propose a correlation exists between the increased popularity of ILIs and the difficulty in achieving the desired anesthesia effect with the IANB as well as patients' dissatisfaction with the resulting soft tissue anesthesia.[1,3,8] The ILI has been promoted as a technique that avoids both the IANB and decreases the negative aspects of soft tissue anesthesia. Malamed reported that a large portion (74%) of patients preferred a periodontal ligament injection due to the absence of soft tissue anesthesia.[33] Additionally, Oztaş and colleagues reported that children (6-10 years old) stated a preference for C-CLAD administered ILIs compared to a standard inferior alveolar nerve block technique.[11]

The level of pain experienced by patients during ILIs appear to vary based on individual patients and operator technique.[5,6] In a meta-analysis comparing IANB injections to ILIs, Shabazfar and colleagues found advantages with pain during injection for ILIs (1.5% to 41.6% compared to 10.0% to 47.3% for IANB injections).[10] Some analyses report that ILI postinjection pain can occur from 4% to 8% of the time, and the advancement of the needle may be a primary cause given that postinjection pain has been reported without solution deposition.[5,18,49-50] Inadequate anesthesia following the use of ILIs as primary injections has been reported, and the need for additional injections or the use of an IANB for rescue anesthesia can occur.[3,5, 10] Higher failure rates are associated with type and location of tooth, as well as the category of procedure. The highest success rates for ILI administration as a supplemental injection are associated with tooth extraction, and poorest success is found with root canal therapy.[28,33,47] Anesthesia failure with ILIs has been more commonly connected with mandibular lateral incisor (with success rates as low as 18.2%) and canine administration (with success rates as low as 46%).[28,51-53] Meechan proposed that a limited amount of cancellous bone space and a smaller number of perforations within the mandibular incisor tooth socket may relate to the occurrence of inadequate anesthesia.[5,54]

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INTRALIGAMENTARY INJECTION OF NONANESTHETIC AGENTS

Although limited in literature, the utilization of the ILI technique for the administration of agents other than local anesthetics in dentistry has been reported. The analyses focus on the use of anti-inflammatory agents intraorally at the local site of care. Inflammation is interconnected to oral pain, and prostaglandins are the mediators directly linked with the pathogenesis of pulpal and periapical diseases.[55-57] Anti-inflammatory agents such as nonsteroidal anti-inflammatory drugs (NSAIDs) and corticosteroids serve as inhibitors of prosta-

glandin synthesis. The use of these agents intraorally, at the site of care, is being explored to improve oral pain management. In an analysis of postendodontic pain perception with irreversible pulpitis and dental care with the intraligamentary injections, subjects who received 0.4 mL of 20 mg mL^{-1} of piroxicam (a nonselective nonsteroidal anti-inflammatory drug) reported a lower intensity of pain (Visual Analogue Scale) compared to a group that received 0.4 mL of a 2% lidocaine with 1:80,000 epinephrine cartridge.[58] An evaluation of periapical ketorolac (the first available NSAID for intramuscular injection) for endodontic pain management in dental emergency patients was completed at the University of Minnesota Dental School.[55] The investigators reported that the "mandibular infiltration injection of ketorolac produced about twice as much pain relief compared with intramuscular injection of the same dosage of ketorolac." Additionally, the evaluation found that ketorolac was well tolerated by the tissues involved during the injection process. In a comparison study of slow-release methylprednisolone (a corticosteroid employed to decrease inflammation), 3% mepivacaine, and placebo, investigators found that methylprednisolone reduced the frequency and intensity of postoperative pain after root canal treatment.[59] While the utilization of anti-inflammatory agents locally during dental care shows promise, further research may be warranted to achieve professional consensus and universality of use.

CONCLUSION

Intraligamentary injections are a crucial anesthesia technique with a long history of use in dentistry. The ILI provides the dental practitioner an injection technique that rapidly creates pulpal anesthesia in an isolated area and results in less soft tissue anesthesia. While more commonly employed as a supplemental or secondary injection, technological advances and promotion have resulted in ILIs being employed as a primary injection with various levels of success. ILIs have advantages and disadvantages that need to be determined and discussed with patients. Ultimately, provider and patient preference, the operative procedure, and medical/dental history impact the use of ILIs.

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AUTHOR PROFILE

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Dr. Sean G. Boynes is a Dentist Anesthesiologist who received his D.M.D. from the University of Pittsburgh and completed a three-year residency in anesthesiology from the University of Pittsburgh Medical Center. He currently serves as Director of Interprofessional Practice at the DentaQuest Institute, Expert Advisor for Safety Net Solutions, and Senior Dental Advisor for CareSouth Carolina. Prior to taking his current position, Dr. Boynes was Director of Dental Medicine at CareSouth Carolina, a federally qualified health center in the Pee Dee Region of South Carolina. He has authored or co-authored over sixty publications relating to dentistry, public health, pharmacology, or anesthesiology. He is owner and Chief Consultant of Dental Medicine Consulting, a consulting firm that assists organizations and programs with quality evaluations, chart auditing, and integrating dental and medical disciplines. Dr. Boynes has been recognized by many organizations and the National Health Service Corp recently featured him as one of the 40 top clinicians for their 40th Anniversary Celebration and the National Children's Oral Health Foundation lists him as a Dentist of Distinction. In addition, he remains an active clinician providing services to special needs populations in South Carolina.

AUTHOR DISCLOSURE

Sean G. Boynes, DMD, MS has no commercial ties with the sponsors or the providers of the unrestricted educational grant for this course. The author of this course receives an honorarium.

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QUESTIONS

1. **Intraligamentary injection can also be referred to as which of the following?**
   a. Peridental injections
   b. Periodontal injections
   c. Interosseous injections
   d. All the above
2. **Which of the following statements accurately describes the area of anesthesia that most often occurs following an intraligamentary injection?**
   a. Cheek, tongue and lip numbness
   b. Adjacent teeth and gums
   c. Tongue and lip numbness
   d. None of the above
3. **Intraligamentary injections are often employed as _____ injections when other mandibular injections result in inadequate or unsatisfactory anesthesia.**
   a. Secondary
   b. Primary
   c. Tertiary
   d. None of the above
4. **Which type of device is most likely to allow for a larger volume of anesthetic administration?**
   a. Standard syringe type
   b. Peripress syringe type
   c. C-CLAD syringe type
   d. All the above.
5. **Which of the following characteristic is most likely to impact the success of anesthesia following an intraligamentary injection?**
   a. Needle bevel orientation
   b. Type of anesthetic
   c. Needle gauge
   d. Presence of a vasoconstrictor
6. **Although needle gauge/type does not impact the success of an intraligamentary injection, which needle type is most often employed?**
   a. 27 gauge short
   b. 33 gauge ultra-short
   c. 25 gauge ultra-short
   d. 30 gauge long
7. **When a patient presents with ____mm of periodontal attachment loss, administration of an intraligamentary injection is not recommended.**
   a. 3
   b. 5
   c. 7
   d. 9
8. **Which of the following statements correspond correctly to the site of administration for an intraligamentary injection?**
   a. Two sites of injection for single rooted teeth – buccal and lingual
   b. Two sites of injection for single rooted teeth – mesial and distal
   c. Four sites of injection for single rooted teeth – buccal and lingual and mesial and distal
   d. One site of injection for single rooted teeth – lingual
9. **The intraligamentary injection utilizes the periodontal ligament space to access natural perforations in _____ bone to diffuse anesthetic.**
   a. Cortical
   b. Cancellous
   c. Singular
   d. All the above
10. **Which of the following may influence dental providers to utilize intraligamentary injections as primary injections?**
    a. Area of anesthesia
    b. Elimination of pain
    c. Slow onset
    d. None of the above
11. **The onset of anesthesia has been described to occur within ____ minutes.**
    a. 0.5
    b. 1.0
    c. 5.0
    d. 2.0
12. **Which device has been proposed to provide better advantages for practitioners with a shorter hand grasp (smaller hands)?**
    a. Standard syringe
    b. Intraligamentary syringes (e.g. peripress type syringes)
    c. C-CLAD devices
    d. All the above
13. **Which mandibular injection technique has received professional consensus as the superior injection technique?**
    a. Intraligamentary injection
    b. Mental nerve block
    c. Inferior alveolar nerve block
    d. None of the above
14. **Which of the following topical anesthetics have been found to consistently decrease pain on injection for intraligamentary injections.**
    a. Etidocaine
    b. Lidocaine
    c. Benzocaine
    d. None of the above
15. **The recommended angulation of the needle during advancement during an intraligamentary injection is:**
    a. 15°
    b. 30°
    c. 45°
    d. 90°
16. **The recommended volume of solution deposition per root for a standard intraligamentary injection is:**
    a. 0.1 mL of a standard anesthetic cartridge
    b. 1.0 mL of a standard anesthetic cartridge
    c. 0.2 mL of a standard anesthetic cartridge
    d. 2.0 mL of a standard anesthetic cartridge
17. **Which of the following more accurately approximates the time of pulpal anesthesia following an intraligamentary injection?**
    a. 15 minutes
    b. 2 hours
    c. 4 hours
    d. 30 minutes
18. **The most often cited argument against the use of a conventional/standard anesthetic syringe:**
    a. difficulty in achieving the appropriate pressure needed for adequate injections
    b. concern that the extreme pressure can cause a breakage of the anesthetic cartridge
    c. tissue damage during fluid deposition
    d. All of the above
19. **Which of the following describes possible observations during intraligamentary injection administration?**
    a. Solution leaking from the gingival sulcus
    b. Blanching of gingival tissue
    c. None of the above
    d. A and B

QUESTIONS (CONTINUED)

20. Which of the following statements below are false:
a. Plaque and/or calculus should be removed prior to intraligamentary injection administration
b. Anesthesia has been reported to occur around 30 seconds after administration of an intraligamentary injection
c. The intraligamentary injection is not a recommended injection type for patients with hemophilia
d. None of the above

21. All the following are considered disadvantages of the intraligamentary injection technique EXCEPT:
a. Possibility of tissue damage
b. Possibility of bacteremia
c. Quick anesthesia onset
d. May damage un-erupted teeth

22. Please select the injection types in which rescue injections have been necessary to improve the patient experience.
a. Inferior alveolar nerve block administration
b. Intraligamentary injections
c. Mandibular infiltration injections
d. All the above

23. Post-injection pain reports following intraligamentary injection have been reported to occur _____ % of the time.
a. 1-6
b. 10-15
c. 3-8
d. 13-16

24. Intraligamentary injection techniques were first introduced in:
a. Early 1900's
b. Late 1940's
c. Late 1970's
d. Early 2000's

25. Intraligamentary injections utilize _____ bone type to allow for anesthetic spread and anesthetic success.
a. Trabecular
b. Compound
c. Cancellous
d. None of the above

26. Success rates at _____ have been reported for intraligamentary injections when used following standard anesthesia technique failures.
a. 20%-
b. 50-60%
c. 30-45%
d. 90%+

27. What injection pressure range is associated with C-CLAD devices during intraligamentary injections?
a. 125-160 psi
b. 625-775 psi
c. 450-1200 psi
d. 225-375 psi

28. It has been recommended during C-CLAD intraligamentary injection processes to administer a lower volume of _____ anesthetic solution.
a. plain
b. 4%
c. 3%
d. 2%

29. All of the following represent appropriate bevel orientation of the needle during an intraligamentary injection EXCEPT:
a. Bevel oriented toward the root
b. Bevel oriented toward the bone
c. Twisting the apparatus to have the bevel change orientation from toward root to toward bone
d. None of the above

30. Intraligamentary injections are a category of _____ injection methodology.
a. Intraosseous
b. Nerve block
c. Soft tissue
d. None of the above

NOTES

PUBLICATION DATE:	JUNE 2018
EXPIRATION DATE:	MAY 2021

ANSWER SHEET

Intraligamentary Injections in Dentistry

Name: Title: Specialty:

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EDUCATIONAL OBJECTIVES

1. Develop an understanding of the methodology employed during an Intraligamentary injection (ILI)
2. Discuss various armamentarium employed with an ILI
3. Discuss the risk and benefits associated with the administration of an ILI

COURSE EVALUATION

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Please evaluate this course by responding to the following statements, using a scale of Excellent = 5 to Poor = 0.

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6. Please rate the instructor's effectiveness.	5	4	3	2	1	0
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10. Do you feel that the references were adequate? Yes No

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4.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	19.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
5.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	20.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
6.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	21.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
7.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	22.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
8.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	23.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
9.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	24.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
10.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	25.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
11.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	26.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
12.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	27.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
13.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	28.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
14.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	29.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
15.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	30.	Ⓐ	Ⓑ	Ⓒ	Ⓓ

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