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Research Article

Lesion Sterilization and Tissue Repair: A Comprehensive Review

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ABSTRACT
Lesion Sterilization and Tissue Repair (LSTR) is an innovative therapeutic approach designed to manage deep dental caries and necrotic pulp, particularly in pediatric patients. This review explores the fundamental principles, clinical applications, and effectiveness of LSTR in preserving natural tooth structure while promoting tissue regeneration. The technique involves the application of a combination of antimicrobial agents, such as metronidazole, ciprofloxacin, and minocycline, to eliminate pathogenic bacteria and create an optimal environment for healing. The review highlights the indications and contraindications of LSTR, as well as factors affecting its success. Collectively, the findings suggest that LSTR can significantly improve treatment outcomes in pediatric dentistry, providing a less invasive alternative to traditional methods. Ongoing research and clinical trials are essential for refining LSTR protocols and establishing its long-term efficacy and safety.

Keywords: LSTR, TAP, Infection

INTRODUCTION

In pediatric dentistry, treatment choices for deep dental caries are often limited, particularly when surrounding periodontal tissues are affected. The traditional approach typically involves tooth extraction, followed by the placement of space maintainers or regainers if necessary. It's widely recognized that a natural tooth serves as the best space maintainer in mixed and developing deciduous dentition, emphasizing the importance of preservation whenever possible. Additionally, the success of space maintainers and regainers heavily relies on patient cooperation, which can be challenging with young patients who may struggle to comply with treatment.[1,2]

This situation has led to the development of lesion sterilization and tissue repair (LSTR), a safer and less invasive alternative for managing deep carious lesions. In such cases, pulpectomy is often not an appropriate option due to concerns about root resorption or the risk of damaging the underlying developing tooth.[3]

The concept of Lesion Sterilization and Tissue Repair was developed in 2004 at the Cariology Research Unit, School of Dentistry, Niigata University, Japan. LSTR represents a groundbreaking therapeutic approach that transforms traditional methods for treating dental lesions. This innovative technique seeks to halt the progression of carious lesions using a non-invasive antimicrobial strategy that fosters tissue repair and regeneration.[1-3]

LSTR involves applying a specialized antimicrobial mixture, which includes antibiotics, reducing agents, and disinfectants, directly to the affected dental tissues. This intervention effectively targets the microbial causes of dental decay, eliminating the pathogens responsible for the damage while promoting an environment conducive to natural tissue healing.

This review will delve into the history, principles, and clinical applications of LSTR, highlighting its potential as a valuable asset in pediatric dentistry.

Concept of LSTR: The LSTR concept, developed in 2004 at the Cariology Research Unit, School of Dentistry, Niigata University, Japan, focuses on preserving natural tooth

structure as much as possible, in contrast to conventional treatments that often result in tooth extraction. By disinfecting the lesions, it is believed that injured tissues have a better chance of healing.

A single antibiotic is generally insufficient to disinfect a root canal due to the polymicrobial nature of infections present. Therefore, a combination of antibacterial agents is employed to effectively combat the diverse range of pathogens. In deciduous teeth, there remains a significant risk of persistent infection even after pulpectomy and endodontic treatment because of the intricate root canal anatomy and natural root resorption.

Inadequate apical sealing can lead to the leakage of microorganisms from the root tip, resulting in potential infection spread to surrounding periodontal tissues and the developing tooth bud. LSTR aims to address these challenges by offering a more effective means of treating deep carious lesions while minimizing the need for more invasive procedures.[4]

Triple Antibiotic Paste: The use of antibiotics in endodontic procedures dates back to 1951 when Grossman introduced a poly-antibiotic formula comprising penicillin, bacitracin, streptomycin, and caprylate sodium (PBSC). This combination was notably effective at the time. However, clinical evaluations revealed that PBSC was ineffective against anaerobic bacteria, which play a significant role in endodontic issues. Consequently, in 1975, the United States Food and Drug Administration banned PBSC for use in endodontic treatments due to concerns about hypersensitivity and the risk of penicillin allergy.

In response to these limitations, the Triple Antibiotic Paste (TAP) was developed specifically to enhance the rejuvenation process. Introduced by Divya et al., TAP was studied for its effectiveness in eliminating bacteria from root canals. This potent antimicrobial mixture is particularly useful for treating necrotic pulp in teeth with an open apex, showcasing its diverse applications in endodontics.[5,6]

Preparation of TAP: The preparation of Triple Antibiotic Paste is a critical step in the Lesion Sterilization and Tissue Repair process. One common formulation, as proposed by Takushige et al., includes metronidazole, ciprofloxacin, and minocycline.[7] **(Table 1)**

To prepare the paste, commercially available antibiotics are placed in separate dappen dishes. The enteric coating of tablets is removed by scraping with a blade, while the outer capsular material is taken off capsules. Each component is then ground separately using a clean mortar and pestle, ensuring that the powder remains dry. If the powder needs to be stored at this stage, it should be placed in tightly sealed porcelain containers, kept in a dark place or a refrigerator to avoid exposure to light and moisture.

After proper pulverization, the powdered components are combined on a clean glass slab or mixing pad. A part of the solvent is then added. For optimal effectiveness, the triple antibiotic mixture is typically prepared with a ratio of seven parts of the powdered antibiotics to one part of the solvent.[7-9]

Table 1. Various Combinations of TAP

Researcher	Combination of TAP
Doneria D et al. (2017)[10]	Ornidazole, ciprofloxacin, Cefaclor
Pinky C et al. (2011)[11]	Ciprofloxacin, Ornidazole, Minocycline
Nakornchai et al. (2010)[12]	Metronidazole, Ciprofloxacin, Minocycline
Windley W et al. (2005)[13]	Metronidazole, Ciprofloxacin, Amoxicillin
Shankar K et al. (2021)[14]	Ciprofloxacin, Metronidazole, Clindamycin

Factor Influencing LSTR: Several factors influence the effectiveness of Lesion Sterilization and Tissue Repair in the management of deep dental caries. One significant factor is the selection of the appropriate antimicrobial agents, as the combination used can impact the ability to eliminate pathogens effectively while promoting healing. The concentration and ratio of these agents, such as in the case of triple antibiotic paste, play a crucial role in their antimicrobial efficacy. Additionally, the extent of tissue damage and the presence of residual bacteria can affect treatment outcomes, as more extensive lesions may require more aggressive intervention. Patient-related factors, including age, cooperation, and overall health, also significantly influence the success of LSTR; younger patients may have varying levels of compliance that can hinder the process. Moreover, operator technique during application and the environmental conditions, such as

exposure to moisture and light, can affect the stability and potency of the antimicrobial agents used. Understanding and addressing these factors is essential to maximize the therapeutic potential of LSTR in pediatric dentistry.

Procedure of LSTR: The procedure for Lesion Sterilization and Tissue Repair begins with the preparation of the Triple Antibiotic Paste, which can either be freshly made just before the procedure or prepared in advance and stored in an airtight container, protected from sunlight and moisture. Once the TAP is ready, a local anesthetic agent (LA) is administered, often accompanied by a topical anesthetic to further minimize pain and discomfort. After the anesthetic takes effect, a rubber dam is placed to ensure complete isolation during the procedure.[1,9]

Next, an access cavity is prepared using a round bur to fully remove any necrotic pulp tissue present in the coronal area. It is essential to eliminate any existing restorations and decayed dental tissue at this stage. The cavity is then irrigated with saline and sodium hypochlorite to disinfect the area. To enhance cleaning, EDTA can be utilized, as it effectively removes the smear layer, allowing for clearer dentinal tubules, which enables deeper penetration of the antibiotics. If any bleeding occurs during this step, sodium hypochlorite is applied to control the hemorrhage and maintain a clean field for the subsequent placement of the antibiotic paste. The tooth should be permanently restored using glass ionomer cement and a stainless steel crown. Following the procedure, a postoperative follow-up is essential to monitor the reduction in earlier symptoms, such as pain and tenderness. Additionally, preoperative and postoperative radiographs should be compared to assess any changes in periapical and furcation radiolucency, as well as to check for signs of infection.[1,9]

Indications for LSTR[9]:

1. Necrotic Pulp: It is useful in cases of necrotic pulp in teeth with open apices where conventional endodontic treatments may not be suitable.
2. Pediatric Patients: Ideal for young patients where conserving natural tooth structure is critical for future dental development.
3. Revascularization Needs: Indicated when there is a need to regenerate pulp tissues and promote healing in immature teeth.
4. Infection Control: Effective for disinfecting infected root canals and enhancing healing outcomes.

Contraindications for LSTR[9]:

1. Severe Tooth Discoloration: Aesthetic concerns may necessitate alternative treatments in visible teeth.
2. Inadequate Patient Cooperation: Young patients or those unable to follow through with postoperative care may not be good candidates.
3. Allergies to Antibiotics: Patients with known allergies to any components of the triple antibiotic paste should not undergo this treatment.
4. Comorbid Conditions: Certain systemic health issues may counterindicate the use of antibiotics or specific antimicrobial agents in LSTR.

Advantages of LSTR: Advantages of LSTR include its simplicity and ease of use, short treatment time, cost-effectiveness, and relatively painless procedure. It requires no instrumentation or obturation, and uses non-irritating materials. Treatment can be completed in one visit, minimizing the burden on patients both physically and psychologically, while promoting bone regeneration.[15]

Disadvantages of LSTR: Disadvantages of LSTR include potential discoloration of oral hard tissues due to minocycline, which forms a blue-grey compound with calcium. Clindamycin may be used as an alternative, and adding iodoform can improve radiographic appearance. Risks associated with triple antibiotic paste include the development of antibiotic-resistant bacteria, side effects, possible abnormalities in permanent teeth from use in primary teeth, and cyst formation from unresolved infections. Concerns also exist regarding the "hollow tube" effect of empty roots in treated teeth, with uncertainty about its occurrence or prevention by host immunity.[15]

CONCLUSION

In conclusion, Lesion Sterilization and Tissue Repair (LSTR) offers a promising approach to managing deep dental caries and necrotic pulp in pediatric dentistry. By utilizing a combination of antimicrobial agents, LSTR effectively targets pathogens while promoting tissue regeneration and healing. This innovative treatment preserves natural tooth structure, reducing the need for invasive procedures such as extractions. Although LSTR shows significant potential, further research is necessary to

optimize protocols and assess long-term outcomes. As clinical understanding and techniques continue to evolve, LSTR may become an integral component of contemporary pediatric dental practice, enhancing patient care and improving overall treatment success.

REFERENCES

1. Sain S, J R, S A, George S, S Issac J, A John S. Lesion Sterilization and Tissue Repair-Current Concepts and Practices. Int J Clin Pediatr Dent. 2018 Sep-Oct;11(5):446-450.
2. Singh K, Reddy A, Arya A, Sridhar V, Ranjan M, Bulbule N. Lesion Sterilization Tissue Repair: A Review. J Pharm Bioallied Sci. 2024 Feb;16(Suppl 1):S75-S77.
3. Chakraborty B, Nayak AP, Rao A. Efficacy of Lesion Sterilization and Tissue Repair in Primary Tooth with Internal Resorption: A Case Series. Contemp Clin Dent. 2018 Sep;9(Suppl 2):S361-S364.
4. Achanta A, Reche A, Dakhale R, Bharate RR. A Comprehensive Review of Lesion Sterilization and Tissue Repair: An Alternative for Pulpectomy in Deciduous Teeth. Cureus. 2023 Nov 3;15(11):e48218.
5. Divya S, Retnakumari N: Lesion sterilization and tissue repair in primary teeth with periapical pathosis - a case series. J Dent Med Sci. 2014, 13:7-11.
6. Panchal KG, Virani K, Patel V, Ali Khan A, Pettiwala A, Puranik SS, Joshi S. Triple Antibiotic Paste: A Game Changer in Endodontics. J Pharm Bioallied Sci. 2024 Jul;16(Suppl 3):S1913-S1915.
7. Takushige T, Cruz EV, Asgor Moral A, Hoshino E: Endodontic treatment of primary teeth using a combination of antibacterial drugs. Int Endod J. 2004, 37:132-8.
8. Parhizkar A, Nojehdehian H, Asgary S. Triple antibiotic paste: momentous roles and applications in endodontics: a review. Restor Dent Endod. 2018 Jun 20;43(3):e28.
9. Malu K, Khubchandani M. Triple Antibiotic Paste: A Suitable Medicament for Intracanal Disinfection. Cureus. 2022 Sep 15;14(9):e29186.
10. Doneria D, Thakur S, Singhal P, Chauhan D, Keshav K, Uppal A. In Search of a Novel Substitute: Clinical and Radiological Success of Lesion Sterilization and Tissue Repair with Modified 3Mix-MP Antibiotic Paste and Conventional Pulpectomy for Primary Molars with Pulp Involvement with 18 Months Follow-up. Contemp Clin Dent. 2017 Oct-Dec;8(4):514-521.
11. Pinky C, Shashibhushan KK, Subbareddy VV. Endodontic treatment of necrosed primary teeth using two different combinations of antibacterial drugs: an in vivo study. J Indian Soc Pedod Prev Dent. 2011 Apr-Jun;29(2):121-7.
12. Nakornchai S, Banditsing P, Visetratana N. Clinical evaluation of 3Mix and Vitapex as treatment options for pulpally involved primary molars Int J Paediatr Dent. 2010;20:214–21
13. Windley W, Texeiera F, Trope M. Disinfection of immature teeth with a triple antibiotic paste. J Endo 2005;31 (6):439-43.
14. Shankar K, Ramkumar H, Dhakshinamoorthy S, et al. Comparison of Modified Triple Antibiotic Paste in Two Concentrations for Lesion Sterilization and Tissue Repair in Primary Molars: An In Vivo Interventional Randomized Clinical Trial. Int J Clin Pediatr Dent 2021;14(3):388–392
15. Singh N, Mallick RR, Patel S, Kashyap N, Seth S, Jaya. Lesion sterilization and tissue repair- A non-instrumental procedure: A systematic review. IP Int J Maxillofac Imaging 2023;9(4):167-171