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RESEARCH ARTICLE

LESION STERILIZATION AND TISSUE REPAIR THERAPY IN PRIMARY TEETH

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ABSTRACT

Aim: This study was conducted for the evaluation of the outcome of "Lesion Sterilization and Tissue Repair" in primary teeth using two combinations of antibacterial drugs which comprised of ciprofloxacin, metronidazole and minocycline in one group (Group A) and ciprofloxacin, ornidazole, and minocycline in the other group (Group B).

Materials and Methods: 38 children ranging between 5 to 10 years of age group having 80 infected carious teeth were selected and randomly divided into two groups, viz. groups A and B with 40 teeth in each group. In Group A, antibacterial paste containing ciprofloxacin, metronidazole, and minocycline and in Group B, antibacterial paste containing ciprofloxacin, ornidazole, and minocycline mixed with propylene glycol were used. Medication cavities were filled with antibiotic pastes, depending on the groups followed by Glass Ionomer restorations and stainless steel crown placement. Clinical and radiographic evaluation was carried out at 3, 6, and 12 months intervals.

Results: Both the groups showed considerable clinical and radiographic success. There was no statistically significant difference between Group A and B. However, group B showed better results clinically and radiographically compared with group A.

Conclusions: Both the antibacterial pastes, i.e., combination of ciprofloxacin, metronidazole, and minocycline and ciprofloxacin, ornidazole, and minocycline mixed with propylene glycol have shown good clinical and radiographic success in treating necrotic primary teeth.

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INTRODUCTION

Teeth with infected root canals, particularly those in which the infection has reached the peri-radicular area, are a common problem in primary dentition. (Reddy and Ramakrishna, 2007) Early loss of primary teeth can cause problems such as space loss, ectopic eruption, disturbance in eruption sequence, development of aberrant habits such as tongue thrusting, mouth breathing, altered phonation, and impairment of function. (Takushige *et al*., 2004; Cohen and Burns, 2002 An intact tooth successfully disinfected and with a restored clinical crown is a superior space maintainer than an appliance. (Takushige *et al*., 2004) Thus, it is important that primary dentition be maintained in the dental arch, in its functional form, for proper dental, skeletal, and psychologic development of child. (Finn, 1995) To accomplish this, many treatment procedures have been proposed such as indirect pulp capping, direct pulp capping, partial pulpotomy, pulpotomy, and pulpectomy.

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(Fuks, 2000; Kubota *et al*., 1992) Bacteria play an important role in the initiation, progression, and persistence of apical periodontitis. (Peters *et al*., 2001; Nair *et al*., 2005) Previous studies have shown that bacteria in infected root canals and periradicular tissues are capable of invading and residing deeply within dentin and in cementum around the periapex. Microorganisms in fins and isthmuses can remain viable despite ultrasonic irrigation and sodium hypochlorite irrigation, largely contributing to endodontic failure. (Cruz *et al*., 2002) Endodontic therapy is aimed at the elimination of bacteria from the infected root canal and at the prevention of reinfection. (Sato *et al*., 1996) These bacteria should be eliminated to ensure a successful outcome. (Peters *et al*., 1995) Root canals, especially those of primary teeth at the stage of physiologic root resorption, cannot always be prepared and obturated. (Takushige *et al*., 2004) In recent years, the Cariology Research Unit of Niigata University School of Dentistry has developed the concept of lesion sterilization and tissue repair (LSTR) therapy that employed a mixture of antibacterial drugs for disinfection. Repair of damaged tissues can be expected if lesions are disinfected. (Takushige *et al*.,

2004) The infection of the root canal system is considered to be a polymicrobial infection, consisting of both aerobic and anaerobic bacteria. Because of complexity of the root canal infection, it is unlikely that any single antibiotic could result in an effective sterilization of the canal. More likely, a combination would be needed to address the diverse flora encountered. The combination that appears to be promising consists of metronidazole, ciprofloxacin, and minocycline. Alone, none of these drugs resulted in complete elimination of the bacteria. However, in combination, these drugs were able to consistently sterilize all samples. (William *et al*., 2005) The aim of the present study was to compare two drug combinations used for noninvasive endodontic therapy in necrotic primary molars. One combination was metronidazole with ciprofloxacin and minocycline, and other combination being ornidazole with ciprofloxacin and minocycline.

MATERIALS AND METHODS

Patients and teeth involved in the study

A total of 38 children aged between 5 and 10 years with 80 infected primary teeth were selected from the outpatient Department of Pedodontics and Preventive Dentistry. General physical examination of the children was performed prior to beginning of the study to rule out patients with systemic condition contraindicating pulp therapy. An informed consent was taken from patient's parents prior to carrying out the study.

Clinical and radiographic criteria for case selection

The teeth were selected following clinical and radiographic examination (Reddy and Ramakrishna, 2007) (Table 1). Teeth with perforated pulpal floor, radiographic evidence of excessive internal root resorption/external root resorption, excessive bone loss in the furcation area involving underlying tooth germ, and nonrestorable teeth were excluded from the study.

Table 1. The teeth were selected following clinical and radiographic examination

Clinical criteria	Spontaneous pain
	Intraoral abscess
	Extraoral abscess
	Tender to percussion
	Excessive tooth mobility
Radiographic criteria	Presence of radiolucency in the bifurcation

Preparation of antibacterial paste

Commercially available chemotherapeutic agents such as ciprofloxacin, metronidazole, minocycline, and ornidazole were used in the study. After removal of enteric coating, these drugs were pulverized using sterile porcelain mortar and pestle. These powdered drugs were mixed into two different combinations in the ratio of 1 : 3 : 3, i.e., one group being one part of ciprofloxacin, three parts of metronidazole and minocycline and other group being one part of ciprofloxacin with three parts of ornidazole and minocycline, kept separately to prevent exposure to light and moisture. One increment of each powdered drug was mixed with propylene glycol to form an ointment just before use. The selected 80 teeth were randomly divided into two groups, A and B, with 40 teeth each. As the selected teeth in the study were all nonvital, they did not require anesthesia to be administered prior to procedure. The cavity was prepared depending on the extent of the lesion. All carious dentin was excavated with the help of spoon excavator and with a large round bur. Access to the pulp chamber was gained using a round bur with an airotorhandpiece. The cavity was extended using safe end bur to incorporate all carious lesions and roof of the pulp chamber was removed, making sure that no overhang was left behind. This was done to ensure proper access to canal orifices. Then, the necrotic pulp was removed with a sharp spoon excavator. The pulp chamber was thoroughly irrigated with saline and dried using cotton pellets in order to properly visualize the canal orifices. In both the groups, canal orifices were enlarged to receive medicament termed as "medication cavity." This was accomplished using a round bur, following which cavities were cleaned and irrigated with the help of saline and dried. Then, the medication cavities were filled with one of the undermentioned pastes and given a temporary dressing with zinc oxide eugenol.

Group A

Antibacterial paste containing ciprofloxacin, metronidazole, and minocycline was placed in the "medication cavity."

Group B

Antibacterial paste containing ciprofloxacin, ornidazole, and minocycline was placed in the "medication cavity." Patients were recalled after 15 days for resolution of clinical signs and symptoms, following which permanent restoration was done with glass ionomer cement. At 30 days, following successful treatment, stainless steel crowns were placed and radiograph taken. From then on, patients were recalled at 3, 6, and 12 months interval for clinical and radiographic follow-up. The treated cases were considered clinically successful if there was absence of spontaneous pain, tenderness to percussion, abnormal mobility, and signs of pathology like intraoral or extraoral abscess. The cases were considered successful radiographically when radiolucency decreased compared with preoperative status or remained same. Increase in radiolucency at subsequent visit was considered a radiographic failure.

Statistical analysis

Categorical data are presented as numbers and percentages and are analyzed by Fisher's Exact Test (Table 2) A *P* value of 0.05 or less was considered statistically significant.

$$\text{Probability, } P = \frac{(a+b)!\,(c+d)!\,(a+c)!\,(b+d)!}{N!a!b!c!d!}$$

If $P<0.05$ - Significant difference between A and B

$P>0.05$ - Not significant

Table 2. Fisher's Exact Test

	Before	After	
Group A	a	B	(a+b)
Group B	c	d	(c+d)
	(a+c)	(b+d)	N = a+b+c+d

RESULTS

The observations were based on clinical and radiographic evaluation; the data were tabulated and subjected to statistical

analysis using Fisher's Exact Test. The results were summarized as follows:

Preoperative clinical and radiographic findings

In group A, of 40 teeth selected, all teeth (100%) exhibited pain and tenderness, 25 teeth (62.5%) had intraoral abscess, 12 teeth (30%) had extraoral abscess, 10 teeth (25%) exhibited mobility, and all teeth (100%) showed presence of interradicular radiolucency. In group B, of 40 teeth selected, all teeth (100%) exhibited pain and tenderness, 26 teeth (65%) had intraoral abscess, 14 teeth (35%) had extraoral abscess, 12 teeth (30%) exhibited mobility, and all teeth (100%) showed presence of interradicularradiolucency.

DISCUSSION

Pulp therapy in primary teeth remained controversial for numerous reasons. The perceived difficulty of behavior management in pediatric population, differences in morphology of primary and permanent teeth, desired timely resorption of primary teeth, and difficulties with root canal filling materials have added to the reluctance among dentists to carry out the procedure. (Finn, 1995) Zinc oxide eugenol was the first root canal filling material to be recommended for primary teeth as described by Sweet in 1930. However, according to several studies, Zinc oxide eugenol fails to meet many of these criteria; for example, there are many reports about the slow rate of resorption of cement when forced beyond the apex, there is risk

Table 3. Evaluation of bone changes between Groups A and B at various time periods

		Pain		Abscess IO		Abscess EO		Mobility		Tenderness	
		A	B	A	B	A	B	A	B	A	B
Pre-op	+	40(100)	40(100)	25 (62.5)	26(65)	12(30)	14(35)	10(25)	12(30)	40(100)	40(100)
	-	-	-	15(37.5)	14(35)	28(70)	26(65)	30(75)	28(70)	-	-
3-MONTHS POST-OP	+	-	-	-	-	-	-	-	-	-	-
	-	40(100)	40(100)	40(100)	40(100)	40(100)	40(100)	40(100)	40(100)	40(100)	40(100)
6-MONTHS POST-OP	+	-	-	-	-	-	-	-	-	-	-
	-	40(100)	40(100)	40(100)	40(100)	40(100)	40(100)	40(100)	40(100)	40(100)	40(100)
12-MONTHS POST-OP	+	2(5)	-	-	-	-	-	2(5)	-	2(5)	-
	-	38(95)	40(100)	40(100)	40(100)	40(100)	40(100)	38(95)	40(100)	38(95)	40(100)

IO- INTRAORAL; EO- EXTRAORAL '+'- PRESENT '-'- ABSENT FIGURES IN PARENTHESIS ARE IN PERCENTAGE

Table 4. Evaluation of bone changes between Groups A and B at various time periods

TIME-INTERVAL	BONY-CHANGES	GROUP A			GROUP B			A Vs B
PRE-OP	+	40(100)			40(100)			
	-	-			-			
6-MONTHS POST-OP	REGENERATION STATIC BONE	INCREASED BONE	LOSS		14(35)	26(65)	0	P= 1.0 NS P= 1.0 NSP= 1.0 NS
12-MONTHS POST-OP	REGENERATION STATIC BONE	INCREASED BONE	LOSS		22 (55)	14 (35)	4 (10)	24 (60) 16 (40) 0 P= 0.48 NSP= 1.0 NSP= 1.0 NS

Postoperative clinical and radiographic findings and 3-month postoperative clinical evaluation

Three months postoperatively, there was complete resolution of clinical findings, such as pain, tenderness, mobility, and abscess in both the groups.

6-month postoperative clinical and radiographic evaluation

In Group A, all teeth remained asymptomatic, 14 (35%) teeth showed bone regeneration, and 26 (65%) teeth showed no change. In Group B also, all teeth remained asymptomatic clinically, 12 (30%) teeth showed bone regeneration, and 28 (70%) showed no change.

12-month postoperative clinical and radiographic evaluation

In Group A, four (10%) teeth exhibited pain and tenderness, 22 (55%) showed bone regeneration, 14 (35%) showed no bony changes, and 4 (10%) teeth exhibited bone loss. In Group B, all teeth were clinically asymptomatic, 24 (60%) teeth showed bone regeneration, and 16 (40%) teeth showed no changes.

No statistically significant difference was found between both the groups.

of deflection of erupting succedaneous teeth because of its hardness and also with limited antibacterial action. (Mortazavia and Mesbahi, 2004) In human beings, the essential role of anaerobic bacteria for the development of apical periodontitis was established by Sundquist (1976). He documented that pulpal necrosis was insufficient by itself to cause apical periodontitis; when anaerobic Gram-negative species, particularly of the *Bacteroides* and *Fusobacterium* genera, infected the necrotic pulp, then apical periodontitis almost invariably ensued. Several studies have revealed that the microbiota associated with pulpal abscesses are usually polymicrobial, with the mean number of species ranging from <3 to 8.5/specimen. (Orstavik, 1988) The reason many teeth do not respond to root canal treatment is because of procedural errors that prevent and control intracanal endodontic infection. The clinician is often misled by the notion that procedural errors such as broken instruments, perforations, overfilling, underfilling, ledges, and so on are the direct causes of endodontic failure. In most cases, procedural errors do not jeopardize the outcome of endodontic treatment, unless a concomitant infection is present. (Sequiera, 2001) Sterilization of root canal and periradicular region results in good healing of the periradicular region. Bacteria which are present mainly in the root canals and superficial layer of infected root canal walls may be easily removed by conventional root canal treatment. But the bacteria which remain in the deep layers of root canal

dentin may leak out to periapical region. Hence, such bacteria should be eliminated to ensure a successful outcome. Various medicaments, including nonspecific antiseptics and antibiotics, have been used in root canal treatment. (Sato *et al*., 1996) Since the overwhelming majority of bacteria in the deep layers of infected dentin of root canal wall consist of obligate anaerobes, metronidazole was selected as first choice among antibacterial drugs. Metronidazole even at high concentration cannot kill all the bacteria, indicating the necessity of combining it with other drugs. Thus, ciprofloxacin and minocycline were combined with metronidazole to sterilize infected root dentin. (Sato *et al*., 1996)

However, bacteria which invade and reside deeply within dentinal tubules may survive if the medicaments introduced into the root canals are not delivered efficiently. Hence, use of an efficient vehicle like propylene glycol may be helpful to allow this medicament to more effectively penetrate such areas and thus kill the remaining bacteria. (Cruz *et al*., 2002) The procedure performed in group A was similar to one performed by Takushige *et al.*, procedure in Group B also was similar to Group A, except that metronidazole was replaced by ornidazole. However, our observations in Group A were different from the study made by Takushige *et al.* (2001) who reported 100% success rate. These differences may be attributed to the fact that they have reported retreatment of few cases which were clinically symptomatic after the treatment. In our study, we have not performed retreatment for those teeth which exhibited clinical failure. Group B showed 100% success rate, which may be attributed to use of ornidazole instead of metronidazole. Ornidazole has been reported to have a longer duration of action, with better efficacy and slower metabolism compared with metronidazole, and hence the better results. (Croll and Killian, 1992) Yacobi *et al.* reported a technique for pulpotomy that uses zinc oxide eugenol paste with a reasonable success rate. A stainless steel crown is the restoration of choice for the tooth that has undergone pulpotomy, as it protects against leakage at margins of the pulpal space restoration. (Tripathi, 2005) The exact reaction of these drugs in the pulp is not known. Hence, some of the histologic studies revealing the effects of these medicaments on the pulp tissue are required.

Hence, within the limitations of the study, the primary teeth with the periradicular lesions, including those at various stages of physiological root resorption, can be conserved by the LSTR therapy.

Conclusion

The following conclusions were drawn within the limitations of this study:

Endodontic treatment using two different antibacterial pastes, i.e., a combination of ciprofloxacin, metronidazole, and minocycline as one combination and ciprofloxacin, ornidazole, and minocycline mixed with propylene glycol being the other combination in infected primary teeth, has shown good clinical and radiographic success. However, we advocate further clinical and histological studies with longer follow-up till the period of tooth exfoliation to ascertain the efficacy of this novel treatment modality.

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