Pulpectomy versus Extraction for the Treatment of Nonvital Primary Second Molars: A Retrospective Chart Review

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Objectives: *The current investigation evaluated parameters leading to the utilization of pulpectomy versus extraction for treatment of nonvital primary second molars.* ***Study design:*** *This retrospective chart review identified patients up to 8-years of age with primary second molars treated by pulpectomy or extraction. Patients in the extraction group were age and gender-matched to the pulpectomy group. Demographic, clinical, radiographic and behavioral data were extracted for comparison. Chi-square, Fisher and T-test were performed for statistical analysis.* ***Results:*** *There were 23 patients in each group, with a mean age of 5 years (ranging 3-8 years, ±1.5 for pulpectomy and ±1.3 for extraction). Significantly more pulpectomies were performed in the mandible (p=0.002), specifically on the left side (p=0.0035). Internal and external root resorption were significantly higher in the extraction group (p=0.033 and p=0.007 respectively). Restorability was significantly lower in the extraction group (p<0.0001). Pre-procedural pain was reported by 76.5 percent of all patients, but pharmacologically treated in 15.2 percent. Nitrous oxide was administered to 73.9 percent of patients for behavior guidance.* ***Conclusion:*** *Pathologic root resorption and non-restorability were significantly higher in the extraction group. Behavior and pathologic bone resorption did not influence treatment choice. A higher proportion of children reported pre-treatment pain and needed adjunctive behavior guidance than children who did not have pre-treatment pain or did not need adjunctive behavior guidance.*

Keywords: Pulpectomy, extraction, primary teeth, children

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INTRODUCTION

Primary second molars are strategically important in the primary dentition since they guide the permanent first molars into occlusion, maintain space for the second premolars and facilitate dental arch development by maintaining the E-space.[1] When the pulpal integrity of primary second molars is compromised due to decay, infection, inflammation and/or necrosis, treatment is focused to preserve these strategic primary teeth whenever clinically feasible.[2]

Reversible pulpitis in primary teeth is treated with vital pulp therapy.[2] On the other hand, irreversible pulpitis and necrotic pulpal tissue necessitate more invasive treatment for primary teeth. The options have traditionally been either extraction with consideration for space maintenance or pulpectomy followed by full coverage restoration.[2-4] Lesion sterilization and tissue repair is another technique which has been reported in literature.[5] The determining factors for choosing between pulpectomy and extraction as the treatment modality rests on age of the child, caries risk, practitioner preference, restorability of the tooth involved, pathologic root resorption and systemic medical factors specific to the individual patients.[3,6]

Pulpectomy entails extirpation of the necrotic pulp tissue, irrigation, cleaning and shaping of the root canals followed by obturation with a resorbable material and a well-sealed restoration, such

as a preformed stainless steel crown (SSC).[2,3] Length of procedure and patient behavior make pulpectomy a complex procedure.[7,8] Extraction followed by placement of a space maintainer can prevent space loss, although masticatory function is not restored.[2] Pulpectomy preserves arch integrity by having the natural tooth guide the eruption of the first permanent molar.[2,8,9] It also enables masticatory function, which influences food choices, growth and development.

There are various subjective factors influencing clinicians' decisions to treat nonvital primary second molars with pulpectomy versus extraction.[3] These include behavior of the pediatric patient[3], length of procedure[10], preprocedural pain[6] and infection and the need for adjunct techniques for behavior guidance. Specifically, radicular instrumentation during pulpectomy is a factor noted along with disruptive behavior in children and influences treatment planning.[3,7]

An analysis of pre-treatment factors related to the decision to choose either of the two treatment modalities, namely extraction and pulpectomy, have not been previously investigated. Published studies have evaluated the follow-up outcomes of pulpectomy in primary molars[11]; however, these outcomes have not been compared to a parallel extraction group.

The paucity of scientific information on pre-procedural and intra-operative factors comparing pulpectomy and extraction for primary second molars prior to eruption of the permanent first molars formed the basis of this retrospective research project.

The purpose of this retrospective chart review of pulpectomy and extraction of nonvital primary second molars was to 1. Identify and statistically compare pre-treatment pathologic root resorption and bone resorption in each group 2.Identify and statistically compare patient-centered parameters (pain, infection, behavior, health status and medications) in each group

MATERIALS AND METHOD

This research project comprised of a retrospective chart review of existing electronic dental health records (EHR) at the LSUHSC-NO School of Dentistry Department of Pediatric Dentistry. The institution utilized the academic dental software AxiUm® (Portland, Oregon) for documentation and billing of dental services provided to pediatric patients. A chart audit was performed to identify children up to eight years of age who had received pulpectomy and extraction to treat primary second molars from August 2010 through July 2019. The services of an AxiUm® analyst (EHR specialist for dental records) were utilized to identify the patients whose charts documented a) completion of pulpal therapy (resorbable filling) for posterior, primary tooth (excluding the final restoration) and b) extraction of erupted tooth or exposed root with elevation and/or forceps removal. Patients in the extraction group were age- and gender- matched to children in the pulpectomy group by the Axium analyst.

The patients' age and gender were collected as baseline demographic data. Pre-treatment clinical findings were collected from both treatment groups. This included extraction of documented information on behavior, pain, infection, medications and restorability of tooth. Behavior was tabulated as cooperative if the treating dentists had rated patient behavior as Frankl 3 or Frankl 4, and as uncooperative if the behavior was rated as Frankl 1 or Frankl 2. The behavior rating extracted from EHR was for the overall appointment. Infection was recorded to be present if it was documented that the patient presented with a dental abscess or swelling. Presence or absence of pre-treatment radiographic findings, namely, furcation radiolucency, periapical radiolucency, pathologic internal root resorption, pathologic external root resorption and restorability of tooth were extracted from both treatment groups. The American Society of Anesthesiologists physical status classification (ASA status)[12] of patients in both groups was extracted for comparison to ascertain if the patients' health contributed to treatment choice. The ASA status classification is presented in Figure 1. The ASA status of all patients was routinely recorded in EHR at the institution.

Intra-operative behavior and utilization of inhalational nitrous oxide or advanced behavior guidance techniques (protective stabilization, moderate sedation or general anesthesia) was extracted from both treatment groups.

Immediate post-treatment radiographs in the pulpectomy group were reviewed by the researchers for adequacy of fill. Post-treatment prescription of pain medication(s) and antibiotics was extracted from both treatment groups.

The research project was reviewed and approved for ethical conduct of research by the institutional review board of the Louisiana State University Health Sciences Center (study ID: IRB19-1127).

ASA PS Classification	Definition
ASA I	A normal healthy patient
ASA II	A patient with mild systemic disease
ASA III	A patient with severe systemic disease
ASA IV	A patient with severe systemic disease that is a constant threat to life
ASA V	A moribund patient who is not expected to survive without the operation
ASA VI	A declared brain-dead patient whose organs are being removed for donor purposes

Figure 1: American Society of Anesthesiologists physical status classification

Statistical analysis

For this project, summary statistics for each variable separated by groups was reported first. Fisher's exact test and Chi-square statistics was utilized to compare group differences among categorical variables; and ANOVA and t-tests was utilized among continuous variables. The significance level was set *apriori* at 0.05. All analyses were performed using SAS 9.4 (SAS Institute, Inc., Cary, NC, USA).

RESULTS

Twenty-three patients were identified for inclusion in the pulpectomy group. The same number of corresponding age and gender matched patients were included in the extraction group, from the report generated by the AxiUm analyst, resulting in a 1:1 case- control ratio. The mean age of children in both groups was five years (range 3-8 years) with a standard deviation of ±1.5 in the pulpectomy groups and ±1.3 in the extraction group. Age distribution of the patients is shown in Figure 2. Patient demographic

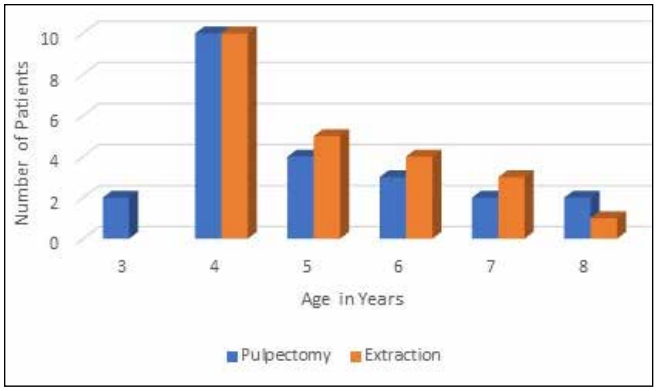

Figure 2: Age distribution of patients in pulpectomy and extraction groups.

information, site of treatment and ASA status for pulpectomy and extraction groups are tabulated in Table 1. Where differences were statistically significant, p values are indicated in the table. Within the pulpectomy group, the most frequently treated tooth was the lower left primary second molar (p=0.0035). In both treatment modalities, patients classified as ASA I formed the largest group (p<0.0001) when compared to patients who were in the ASA II category.

Pre-treatment clinical and radiographic parameters for both treatment groups are listed in Table 2 along with p values, when the difference was statistically significant. The proportion of children experiencing pain prior to treatment in the pulpectomy and extraction groups was not statistically different. However, upon combining both groups, 76.5 percent of children reported pain preoperatively, which was significantly higher than the proportion of children who did not report pain (p<0.0001). In stark contrast, only 15.2 percent of all patients received analgesics, which was significantly lower than children who did not receive analgesics (p<0.0001).

Upon combining patients from both treatment groups, 28.3 percent of patients presented with pre-treatment infection, which was a significantly smaller proportion than patients who did not present with infection (p<0.0001). Overall, 8.7 percent patients received antibiotics for management of infection pre-operatively.

Cooperative behavior was exhibited by 75.6 percent of all patients during the pretreatment appointment. During the appointment for treatment, 63 percent of all patients exhibited cooperative behavior. Although there was a slight decrease in proportion of cooperative patients during the treatment appointments, this difference was not statistically significant. Overall, the behavior of 11 patients (24.4 percent) changed from cooperative to uncooperative during the treatment appointment.

Table 1: Patient demographic information, site of treatment and ASA status

	Pulpectomy N (%)		Extraction N (%)	
Gender				
Male	12 (52.2)		11 (47.8)	
Female	11 (47.8)		12 (52.2)	
Mean Age (SD)	5 (1.5)		5.1 (1.3)	
Side				
Right	7 (30.4)	P=0.0085	12 (52.2)	
Left	16 (69.6)		11 (47.8)	
Jaw				
Maxilla	3 (13)	P=0.002	13 (56.5)	
Mandible	20 (87)		10 (43.5)	
Tooth: Primary second molar				
Maxillary right	0		7 (30.4)	
Maxillary left	3 (13)		6 (26.1)	
Mandibular left	13 (56.5)	P=0.0035	4 (17.4)	
Mandibular right	7 (30.4)		6 (26.1)	
ASA Status				
I	16 (69.6)	P=0.0035	20 (87)	P<0.0001
II	6 (26.1)		3 (13)	
III	1 (4.4)		0	

Table 2: Preoperative clinical and radiographic features

	Pulpectomy N (%)	Extraction N (%)	P-value
History of pain	15 (71.4)	11 (84.62)	
Infection (abscess/ swelling)	7 (30.4)	6 (26.1)	
Medication			
Analgesics	5 (21.7)	2 (8.7)	
Antibiotics	3 (13)	1 (4.4)	
Restorability of tooth			
Clinical	23 (100)	4 (17.4)	p<0.0001
Radiographic	23 (100)	4 (17.4)	p<0.0001
Radiographic pathology			
Furcation radiolucency	11 (50)	15 (71.4)	
Periapical radiolucency	7 (35)	12 (60)	
Pathologic root resorption			
Internal root resorption	3 (13.6)	9 (42.9)	p=0.0327
External root resorption	3 (14)	11 (52.4)	p=0.0067
Dentition			
Erupted first permanent molar	6 (26.1)	10 (43.5)	
Second premolar developing	21 (100)	22 (100)	
Cooperative behavior	19 (82.6)	15 (68.2)	
Pre-treatment pain			
Yes	76.5		p<0.0001
No	23.5		
Pre-treatment analgesics			
Yes	15.2		p<0.0001
No	84.8		
Pre-treatment infection			
Yes	28.3		p<0.0001
No	71.7		

There were no statistical differences in the use of adjunctive behavior guidance techniques (inhalational nitrous oxide, general anesthesia, protective stabilization and moderate sedation) between the pulpectomy and extraction groups. However, overall, nitrous oxide was utilized in a significantly higher number of patients compared to general anesthesia, protective stabilization and moderate sedation combined ($p<0.0001$).

Eruption status of the first permanent molar eruption and presence of the developing second premolar did not differ between the two treatment groups.

Immediate post-obturation radiographs were taken for 47.8 percent of patients in the pulpectomy group. Adequacy of obturation could be radiographically assessed for 12 patients. Underfilled canals were identified in 5 (41.2 percent) cases, adequate fill in 5 (41.2 percent) cases and overfilled in 2 (16.7 percent) cases. Overfilled canals formed a significantly smaller groups than underfilled and adequately filled canals ($p=0.0014$).

DISCUSSION

The investigators anticipated uncooperative pre-treatment behavior, non-restorability, pathologic root resorption and pathologic bone resorption to influence clinical decision to extract rather than perform pulpectomy for primary second molars. Data collected and analysis showed that behavior and pathologic bone resorption were not significantly higher in the extraction group, but non-restorability and pathologic root resorption was.

The highest number of pulpectomy procedures were performed on mandibular left primary second molars and none were performed on maxillary right primary second molars. Another retrospective study reported higher number of pulpectomies performed in mandibular primary molars than in maxillary primary molars, although this was not discussed by the authors.[11] Similarly, prospective trials comparing different types of instrumentation for pulpectomies only utilized mandibular primary molars in the study samples.[7,9]

All the procedures in the current investigation were performed by postgraduate students in pediatric dentistry, under faculty supervision. The ease of access and direct visualization may have influenced tooth selection to learn the pulpectomy technique. Prior to commencing training, the postgraduate students would have clinical experience in extractions, but none to negligible experience in performing a pulpectomy. A survey conducted in 2005 found that the teaching of pulpectomy in dental education and its practice by diplomates of the American Board of Pediatric Dentistry has decreased compared to 1997.[6] The authors of the survey postulated that extractions may have been considered a more predictable procedure than pulpectomy, especially in uncooperative patients.[6] A prospective trial comparing instrumentation techniques for pulpectomy in primary molars also reported that some pediatric patients exhibited uncontrolled movements during the procedure necessitating the use of passive restraint.[7]

A significant proportion of children (76.5 percent) reported pre-operative pain. Yet, only 15.2 percent of children had received analgesic medications. In this specific patient population, dental pain appears to be overrepresented and undertreated. This contrast highlights the dynamics of pain involved with primary teeth with irreversible pulpitis or pulp necrosis. The progression of inflammation and infection, naturally, leads to pain.[3] Parents and healthcare providers should be cognizant of the need to adequately manage pain in these young patients to reduce suffering. The treating dentists should also assess if additional strategies for analgesia and anesthesia may be necessary, such as pre-treatment acetaminophen or ibuprofen.[13]

In the current patient sample, 28.3 percent of patients presented with clinical signs and symptoms of a localized dental infection. Systemic antibiotics were prescribed for 8.7 percent of the patients. The conservative utilization of antibiotic therapy is in congruence with the current practices aimed at reducing antibiotic resistance.[14] The best practice guidelines by the AAPD also recommend definitive treatment, such as pulpectomy or extraction, rather than antibiotic therapy, in the absence of systemic signs of infection.[15] Antibiotic therapy usually is not indicated nor effective if the dental infection is contained within the pulpal tissue or the immediate surrounding tissue.[15]

Among relevant pathologic radiographic findings, periapical and furcation radiolucency did not influence the decision to perform pulpectomy or extraction. However, internal and external root resorptions were found to be significantly higher in the extraction group. This finding is comparable to another study which also identified pathologic root resorption to decrease the success rate of pulpectomy.[11] Greater than 1mm of root resorption led to a 59.7 percent reduction in success rate in this retrospective study of pulpectomies obturated with zinc oxide eugenol.[11] Pathologic bone resorption was less critical than pathologic root resorption when considering pulpectomy as a treatment option in the current investigation. Treatment of the dental infection leads to healing of infected bone due to the inherent vascularity and cellular architecture of bone.[16] However, resorptive changes in root are irreversible and may compromise clinical outcomes, due to the inability to regenerate cementum and dentin after onset of resorptive process.[16] Further, primary teeth have thin radicular dentin and cementum.[3,8] When pathologic root resorption is detected on radiographs, the likelihood of root perforation is elevated, which in turn increases the chances of failure of treatment.[11]

In our study populations, children with ASA I status comprised a larger group than ASA II or ASA III patients. The institutional set up of the current study provides dental care for medically complex patients as well, who would be classified as ASA II or ASA III status. The fewer number of ASA II and ASA III patients in the pulpectomy group conforms to the AAPD best practice recommendations on pulp therapy for children who are at an elevated risk for infection.[4] Prospective trials evaluating pulpectomy have categorically excluded medically complex pediatric patients.[9] It can be inferred that the ASA status of patient also influences treatment choice for necrotic primary second molars.

Assessment of clinical and radiographic restorability is imperative and should be determined before implementing pulp therapy. After the completion of pulpectomy, placement of a well-sealed restoration, such as stainless steel crowns, to prevent microleakage in the region of the coronal access preparation, is critical to ensure longevity of the treated tooth.[3] In the current investigation, post-treatment radiographs in the pulpectomy group could be obtained in 47.8 percent of cases. This proportion is comparable to that reported by diplomates of the American Board of Pediatric Dentistry, 41 percent

of whom reported obtaining immediate post-treatment radiographs after pulpectomy.[6]

Inhalational nitrous oxide was utilized for delivery of treatment in 82.6 percent of patients treated with pulpectomy and in 66.2 percent of patients who received extractions. There was no significant change noted between pre-operative and intra-operative behavior in either group, although the behavior of 24.4 percent patients changed from cooperative to uncooperative during the procedures. The utilization of nitrous oxide as an adjunct to behavior guidance in this patient population, who have a higher incidence of dental pain, can facilitate anxiolysis, improve pulpal anesthesia and extend the working time.[17] Inhalational nitrous oxide has been shown to improve pulpal anesthesia in children who had pulpitis and had received ibuprofen.[18] Clinical judgement is necessary in considering inhalation nitrous oxide for patient comfort when treating symptomatic primary molars.[13] Authors have reported that due to longer procedural time and complexities entailed in performing pulpectomy[9], pediatric patients may exhibit uncooperative behaviors and uncontrolled movements.[7,8] Hence, adjuncts to behavior guidance should be considered in the treatment planning phase when considering pulpectomy as a treatment modality.

There are inherent limitations in this retrospective study. The data extracted was limited by accuracy of data entry into the electronic health records. Interventions could not be tested nor additional radiographs be obtained to study the adequacy of fill. The longevity of teeth in the pulpectomy group and factors influencing longevity could not be evaluated due to limited follow-up durations and small sample size. The procedures in the current investigation were performed by postgraduate students in pediatric dentistry over multiple years, leading to operator variabilities as well as variations in documentation.

CONCLUSIONS

Based on the data collected and analyzed in this retrospective study, the following conclusions can be drawn:

Pathologic root resorption and non-restorability were significantly higher in the extraction group.

Behavior and pathologic bone resorption did not influence treatment choice between pulpectomy and extraction.

A higher proportion of children reported pre-treatment pain and needed adjunctive behavior guidance than children who did not have pre-treatment pain or did not need adjunctive behavior guidance.

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