PULPOTOMY TO STAINLESS STEEL CROWN RATIO IN CHILDREN WITH EARLY CHILDHOOD CARIES: A CROSS SECTIONAL ANALYSIS

A Thesis
Presented in Partial Fulfillment of the Requirements for
The Degree Master of Science in the
Graduate School of The Ohio State University

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2009

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Objective: The purpose of this study was to evaluate factors affecting pulpotomies in primary teeth and determine a pulpotomy: stainless steel crown (SSC) ratio.

Methods: This retrospective chart review was performed by five calibrated reviewers using a standardized radiographic index. Pulpotomy: SSC ratios were assessed by age, pain scale, ASA status, radiographic score, and operator preference.

Results: A total of 1,365 SSC’s from 521 patients were reviewed. Most radiographic caries were confined to dentin (70%). Increase in radiographic score (p<.0001) and pain scale (p=.0001) had strong associations with pulpotomy treatment. The overall ratio of pulpotomy: SSC was 1:2.8. The most common ASA II diagnosis from this study was Asthma (32%) followed by ASD and ADHD (19.5%).

Conclusion: There was a significant association between the pain scale and the radiographic score and pulpotomies being performed. The overall ratio of pulpotomy to crown was 35.7%, which falls within national benchmark
I would like to thank my advisor, Dr. Thikkurissy, for intellectual and moral support on my thesis. Without his encouragement, enthusiasm, and patience, this thesis would not been completed. Dr. Thikkurissy is surely one of the most wonderful pediatric dentists and brilliant teachers in the profession.

I thank Debbie Weatherby, a dental assistant and my research assistant, for being such a wonderful helper in this project.

Last, but not least, I wish to thank my husband, Jeff, for standing by my side during this exciting journey in our lives, and for his patience with my research and writing. Without his love and sacrifice, I would have not have made it thus far in my studies.
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INTRODUCTION

Early Childhood Caries (ECC) is one of the most serious public health issues facing children today. This chronic infectious disease is found in nearly 30% of all US population \(^1\), with a higher prevalence in families with lower socioeconomic status \(^2, 3\). Children who experience ECC as infants/toddlers are more likely to have subsequent caries in their primary and permanent dentition \(^4\). Caries in the primary molars is the most reliable predictor of caries in permanent teeth \(^5\). Untreated ECC not only affects the dentition, but also influences the general health of the young children \(^4\). Children affected by ECC demonstrate: insufficient physical development, frequent hospitalization, increased emergency room visits, loss of school days and diminished oral health-related quality of life when compared to healthy children \(^6\). In addressing the direct morbidity of ECC, the American Academy of Pediatric Dentistry (AAPD), recommends immediate interventions including; home care, alternative restoration treatment (ART) techniques, appropriate use of topical fluoride, and judicious use of full coverage (e.g. stainless steel crown restorations) of carious teeth \(^1\). Deep interproximal caries in primary molars is an indication for vital pulp therapy, followed by the placement of stainless steel crowns to preserve arch perimeter, and maintain arch health.
The pulpotomy is the most widely used vital pulp treatment of primary molars and involves the “amputation of the coronal portion of the dental pulp affected by deep caries” \(^7\). Treatment of the affected coronal pulp and treatment of the remaining vital radicular pulp with a medicament, allows for the preservation of the vitality and function of the primary teeth \(^7\). A pulpotomy is typically indicated on a deep tooth with a deep carious lesion, where complete removal of caries may cause pulp exposure. The contraindications for the pulpotomy procedure include: swelling on mucosa, pathologic mobility, resorption, interadicular or periapical radiolucency, pulp calcification, or history of spontaneous pain \(^8\). After the pulpotomy the tooth may become brittle and prone to cracks or fracture \(^9\). Therefore, placing a full coverage restoration, such as a stainless steel crown (SCC), is strongly recommended following a pulpotomy in order to prevent the fracture, provide strength to the devitalized teeth, and reduce microorganism invasion.

The overall failure rate for SSCs (8%) is significantly lower than the failure rates of amalgam (21%) and composite (30\%) \(^10\). The common reason for SSC failure is due to the loss of a crown, which may need to be re-cemented. Amalgam and composite restoration often fail because of recurrent caries and fracture \(^11\). Additional advantages of using SSC include: less reported technique sensitivity during dental restoration and better long-term cost effectiveness compared to other dental materials. Considering the risk involved with general anesthesia, its associated cost, the high post-operative recurrent caries rate, and
the documented longevity of restorative materials, it is strongly recommended to use SSC in children who undergo general anesthesia for dental rehabilitation \textsuperscript{11}. Assessing pulpotomy to crown ratio is important in understanding how certain dental interventions are deployed in children with high caries risk. This numeric value represents how many teeth being pulpotomized per teeth with SSCs. The average mean of pulpotomy to crown ratio in most dental practices has been shown to be about 37\% \textsuperscript{12}. Although this may not represent the absolute ratio of pulpotomy to crown in pediatric dental practices it has been utilized by insurance companies as a marker of potential 'over-treatment' by dental providers.

AAPD guidelines state that a tooth requiring a pulpotomy should be vital. Often, obtaining a precise pulpal diagnosis in children is a significant challenge for the dentist, primarily due to issues of cooperation and behavior management \textsuperscript{13}. Children have been shown to be poor historians when reporting the severity of the pain \textsuperscript{14} and this may be an obstacle for receiving an accurate pulp diagnosis. Any test that may induce unpleasant stimuli, such as an EPT or thermal test is subject to behavior problems, and may lead to an inaccurate pulp diagnosis. Children are not good at describing subjective symptoms of pain, and if the dentist asks the child a leading question, false positive and false negative results may occur \textsuperscript{15}. Children tend to adapt their behavior in order to avoid painful stimuli \textsuperscript{16} and this includes inaccurate response to a pulp test.

Most of the diagnostic tests used in conventional endodontic therapy have questionable diagnostic value in evaluating primary teeth \textsuperscript{17}. Electric pulp
tests and thermal test are not normally conducted on primary teeth because the child’s response is not reliable. Thermal test and EPT are difficult to administer to children, and often times generate inconclusive results. In order for both methods to be effective, the pulp must contain a sufficient number of mature A delta neurons (which conveys sharp pain), and both primary and immature permanent teeth are not yet fully innervated with the mature neurons.

Response to a pulp vitality test can also vary depending on the stage of root development and resorption of primary teeth.

To this date, there is no totally reliable method to determine the histopathologic status of the primary pulp with 100% certainty. Therefore, a treating dentist needs to collect comprehensive information based on medical/dental history, history of pain, radiographic findings, clinical examination, and pulp tests to deliver successful pulp therapy. Many variables may influence the decision making process of treating primary teeth that require pulp therapy. Those variables include: the presence and characteristics of pain, radiographic findings (such as proximity of caries to the pulp and presence/absence of pathologic radiolucency), operator preference, operator experience, age of the patient, and the location (outpatient/ inpatient) where the dental care is delivered.

The presence and nature of pain is an important factor to consider before finalizing a treatment for the symptomatic tooth. Most often an endodontic treatment is performed on carious painful vital molars, and teeth without symptoms may be infrequently treated. It is recommended that the history of
pain be assessed by a dentist before initiating pulp therapy, and symptoms compatible with reversible pulpitis treated with vital pulpotomy \(^\text{20}\). Reversible pulpitis is a provoked pain by thermal, chemical and mechanical irritants, and once the causative irritants are removed, the pain theoretically ceases \(^\text{17}\). This usually indicates minor inflammatory changes of pulp \(^\text{17}\) and should be distinguished from irreversible pulpitis.

Spontaneous or irreversible pulpitis is a constant or throbbing pain without stimulation, and it may last a long time even after the causative irritants are removed \(^\text{17}\). A positive history of spontaneous irreversible pain is classically associated with extensive degenerative changes extending into the root canal, and is usually treated with a pulpectomy or extraction \(^\text{7, 21}\). Treating some primary molars that have irreversible pulpitis with a vital pulpotomy may result in a lower success rate of pulp therapy \(^\text{20}\).

Radiographs are a useful tool for diagnosing caries, and this diagnostic method helps a dentist decide which teeth with deep caries need a pulpotomy. Schroder’s study in 1977 shows that there is 80% correlation between the clinico-radiographic evaluation of a symptomatic primary tooth and histopathologic findings in the pulp \(^\text{22}\). It is reported that if more than 4 mm of the marginal ridge of a primary molar is destroyed by caries, there is a high likelihood of pulpal involvement \(^\text{23}\). Radiographic signs of internal or external root resorption, widened PDL, or pathologic radiolucency in the periapical or furcation areas are signs of advanced pulpal pathosis, and, in the absence of other extenuating circumstances, the recommended treatment is typically extraction \(^\text{17}\).
Treatment decisions may also vary with operator preference and experience. There has been no clear agreement among pediatric dentists regarding the optimal treatment recommendation for deep proximal caries of primary molars. In the United Kingdom (UK), the national clinical guideline in pediatric dentistry recommends a pulpotomy when more than two-thirds of the marginal ridge of primary molars is compromised with caries. Fuks et al strongly recommend an Indirect Pulp Capping (IPC) as the most appropriate treatment for symptom-free primary teeth with deep proximal caries. Coll et al suggest not performing the pulpotomy procedure when the pulp is already exposed from caries, due to the chance of radicular pulp being already infected, and a low likelihood of being totally vital of the teeth. Depending on the dentist’s educational background and work experience, the recommended restorative procedure for deep proximal caries in primary molars can be different.

The treatment plan recommended by a dentist is often influenced by the practitioner’s experience in dental materials and techniques. There is a lack of evidence to support the most appropriate technique for pulpotomies in primary teeth, and often times, a dentist chooses techniques and materials based on their educational background and individual preference. Various pulpotomy techniques and pulp dressing materials have been proposed to maintain the vitality of radicular pulp. Formocresol is still the most widely used pulp therapy medicament, but there is a new trend away from using formocresol in pulpotomy due to the concern of systemic absorption of formaldehyde. Instead, ferric
sulfate has been favored as an alternative intrapulpal medicament due to its high success rate and negative carcinogenic potential. Clinical and radiographic success rates for ferric sulfate pulpotomy is compatible or slightly higher than formocresol, but the differences were not statistically significant.

The age of the patient can also influence on the decision making of primary teeth pulpotomies. The earlier the child is affected by the cariogenic bacteria, the greater risk of caries that exists in the child. In such a high-risk population, more aggressive treatment, such as pulpotomies followed by stainless steel crowns, may be recommended in order to arrest deep proximal caries. Depending on the settings where the dental care is delivered, either at a clinic or under general anesthesia, the treatment decision on pulpotomies may vary. Due to cooperation issues and the extent of dental diseases, often times children are placed under general anesthesia (GA) to receive comprehensive dental care. This is a costly procedure and there is a risk involved in putting the child to sleep. Considering the cost, the health risk, and the low level of compliance with a follow-up, an aggressive approach to dental rehabilitation under general anesthesia should be considered.

The purpose of this study is

i). to examine predictors for vital pulp therapy in primary teeth

ii). to determine pulpotomy to Stainless Steel Crown ratio in a pediatric population with Early Childhood Caries (ECC), treated in a large, urban hospital-based dental clinic.
MATERIALS AND METHODS

This retrospective quality assurance included retrospective chart review of patients treated at Nationwide Children’s Hospital Dental Clinic Columbus, Ohio, over a 6 month period. The data were collected from 521 patients who received either stainless steel crowns or pulp treatment with stainless steel crowns on at least one primary molar or canine. Children were categorized by age into one of three subgroups: 0-36 months old, 37-72 months old, and older than 72 months. The data collected also included; patient’s medical history, medications, the FACES pain scale score (from 0 to 10), and location of treatment whether the patient was treated in the outpatient dental clinic or under general anesthesia in the Dental Surgery Center. History of over-the-counter pain medication usage and the names of medication was also obtained from the chart review. A standardized radiographic template and scoring system were established, and calibration of all examiners was conducted. The scoring scale was an ordinal 0-4 based on the following; 0=Clinical decalcification (white spot), no radiographic caries noted, 1=Radiographic caries confined to enamel, 2=Radiographic caries confined to outer ½ dentin, 3=Radiographic caries extends to inner ½ dentin, 4=Radiographic caries contacting pulp chamber.
The total numbers of teeth treated at the time of each visit and tooth type were also evaluated. Five calibrated examiners evaluated the radiographic findings on the treated primary teeth, and the extent of caries was determined according to the radiographic scoring. The type of treatment, whether stainless steel crowns only or pulpotomies plus stainless steel crowns, and any records of repeated visit for the same teeth, were also assessed. All pulpotomies were performed using ferric sulfate as an intrapulpal medicament. Following removal of the coronal pulp tissue IRM was placed in the pulp chamber. Stainless steel crowns (3M) were used to restore the pulpotomized teeth, and all SSC were cemented with Ketac cement, a glass-ionomer luting cement. Exclusion criteria included any primary teeth with a history of swelling, resorption, pathologic mobility, and periapical or furcal radiolucency. Collected data were entered into a data base (Microsoft excel) from a data collection sheet (this will need to be attached in Appendices). Data analysis of categorical variables was done using Fishers exact est, and ordinal variables using two-tailed t-test. Finally multivariate linear regression was used to detect significant association. Statistical significance was established at $p \leq .05$. 
RESULTS

Demographic Information

Data from a total of 521 patient charts were collected between July 2008 and December 2008, representing 1,365 stainless steel crowns placed over the period of six months. The majority of the children treated, 66.3% (901) were classified as healthy according to the American Society of Anesthesiologists, with the remaining 33.7% (458) ASA Class II. One thousand and eleven crowns (76.5%) were placed by one of six pediatric dentistry faculties while the child was under general anesthesia. The remaining 23.5% (350) were placed by pediatric dental residents with faculty supervision. Of all the crowns placed, 44.7% (610) were on maxillary teeth and 55.3% (755) on mandibular primary teeth.

Multivariate linear regression was performed and the associations are presented in Table 1. Significant demographic associations as to whether a tooth received a pulpotomy existed with parental report on the FACES pain scale (p<.0001). Children reporting a higher pain level were more like to have a pulpotomy performed. Additionally if a child’s medical status was ASA II, there appeared to be a mildly significant association with pulpotomy therapy (p=.05).
<table>
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<tr>
<th>Predictor Variable</th>
<th>p-value</th>
<th>R2</th>
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<tbody>
<tr>
<td>Age</td>
<td>0.133</td>
<td>0.02</td>
</tr>
<tr>
<td>FACES pain scale score</td>
<td>.0001*</td>
<td>0.05</td>
</tr>
<tr>
<td>ASA Status</td>
<td>.05*</td>
<td>0.006</td>
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<tr>
<td>Maxillary or Mandibular</td>
<td>0.28</td>
<td>0.007</td>
</tr>
<tr>
<td>Radiographic Score</td>
<td>&lt;.0001*</td>
<td>0.03</td>
</tr>
<tr>
<td>Operator</td>
<td>0.143</td>
<td>0.578</td>
</tr>
<tr>
<td>Location of treatment</td>
<td>0.312</td>
<td>0.578</td>
</tr>
<tr>
<td>Repeat visit</td>
<td>0.09</td>
<td>0.007</td>
</tr>
<tr>
<td>Use of Over the Counter Meds</td>
<td>0.235</td>
<td>0.002</td>
</tr>
</tbody>
</table>

Table 1. Regression Analysis of Predictors for Treatment

*Age of the patient.

Out of 521 patients, 9.9% (135) of the children were ages 0-36 months, 54.7% (747) were 37-72 months, and 32.4% (442) were older than 72 months. The mean age of the children from this study was 5.1 years (SD=1.9). Referring Figure 1, the highest percentage of SSC and pulpotomies were performed with children 36-72 months, and this comprised 60.8% (775) of the total treatment for all ages. Only 9.7% (123) of all the teeth treated in this dental clinic or surgery center were performed on children from 0-36 months. Children older than 72 months had 29.6% (377) of the total teeth treated with either SSC or pulpotomies. There was no significant association between the age of the patient and the overall number of teeth being treated (p=1.133).
The pulpotomy to SSC ratio based on various age groups is represented in Figure 2. The highest ratio of pulpotomy to SSC (3.28) was observed in the oldest age cohort (>72 months), followed by ages 0-36 months (2.67), and finally 36-72 months (2.58). The difference in the ratios between those 0-36 months and 36-72 months was insignificant.
Figure 2. The ratio of pulpotomy to SSC based on different age groups.

**Radiographic Score**

Radiographs were present for 98.3% (1,343) of all stainless steel crowns placed. A weighted kappa of 0.86 was obtained for the examiners indicating a good level of inter-rater reliability. Less than 1% (12) of the teeth were radiographically scored as a “1”, meaning no radiographic decay noted by the examiners, and clinical decalcification noted in the chart progress notes / treatment plan. A total of 51 teeth (3.8%) were scored as having radiographic caries confined to enamel. Radiographic caries into dentin was noted in 942 teeth (70.2%), and this was further subdivided into caries in the outer ½ of dentin (233/17.4%) and inner ½ of dentin (709/52.8%). Finally, 337 of the teeth (25.1%)
had caries which radiographically contacted the pulp chamber. There was a strong association between an increase in radiographic score and a pulpotomy being performed (p<.0001). A graphic representation of the relationship between radiographic score and treatment performed is presented in Figure 3.

Figure 3. Overall numbers of teeth with stainless steel crowns and pulpotomies based on radiographic score

**Ratios of Stainless Steel Crowns to Pulpotomies**

When all 1,343 teeth are considered, the overall stainless steel crown to pulpotomy ratio (SSC:P) was 1:2.8. The remaining SSC: P ratios are presented in Table 2. Using regression analysis to determine the association between
treatment and radiographic score, we found teeth with higher radiographic scores more likely to result in pulpotomy therapy ($p<.0001$).

<table>
<thead>
<tr>
<th>radiographic score</th>
<th>SSC</th>
<th>Pulp</th>
<th>Number of SSC per pulpotomy</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>12</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>1</td>
<td>51</td>
<td>3</td>
<td>17</td>
</tr>
<tr>
<td>2</td>
<td>234</td>
<td>9</td>
<td>26</td>
</tr>
<tr>
<td>3</td>
<td>709</td>
<td>197</td>
<td>3.5</td>
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<tr>
<td>4</td>
<td>337</td>
<td>264</td>
<td>1.2</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>1343</td>
<td>474</td>
<td>2.8</td>
</tr>
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Table 2. Stainless Steel Crown: Pulpotomy ratios based on radiographic score

When patient health status was considered, there was a marginally significant association between medical status and whether the tooth received pulp therapy ($p=.05$). Within the ASA II group the most common diagnosis was Asthma (32.0%) followed by behavior disorders (Autism Spectrum Disorder=10.2%, ADD/ADHD=9.3%). The breakdown of pulp therapy and ratios based on ASA status is presented in Table 3.

<table>
<thead>
<tr>
<th>ASA Status</th>
<th>SSC</th>
<th>Pulpotomy</th>
<th>Ratio</th>
</tr>
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<tbody>
<tr>
<td>I</td>
<td>899</td>
<td>335</td>
<td>2.6</td>
</tr>
<tr>
<td>II</td>
<td>458</td>
<td>142</td>
<td>3.2</td>
</tr>
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</table>

Table 3. Stainless Steel Crown: Pulpotomy ratios based on ASA Status
DISCUSSION

The results from our study revealed that radiographic finding was a significant diagnostic predictor for primary pulp treatment (p<.001) in our population. Expectedly, as the caries involvement became more extensive, the radiographic score increased. Diagnostic radiographs can provide information regarding caries depth, pulpal involvement, restoration depth, periapical pathology, root resorption or inflammatory changes, such as external resorption. Interpretation of pre-operative radiographs helps dentists diagnose pulpal conditions more accurately, and therefore, whenever possible, it is strongly recommended to order radiographs before any treatment.

Based on current literature, the reported sensitivity and specificity using conventional radiographs to detect proximal caries are 0.48-0.80 and 0.84-1, respectively. When the occlusal surfaces are analyzed with conventional radiographs, the range of sensitivity and specificity are 0.50-1 and 0.48 to 1. Occlusal caries are more difficult to detect with intraoral radiographs only, so a visual examination needs to be added in order to obtain an accurate caries diagnosis. Our findings are consistent with AAPD recommendations with respect to treatment planning pulpally involved primary teeth. After reviewing individual medical/dental history and clinical findings, radiographs were ordered.
In our study radiographs were available for 98.3% of all stainless steel crowns placed (1,342).

The FACES pain scale score was a strong predictor of pulpal treatment in primary teeth (p=.0001). A significant association was observed between the pain scores reported by parents and whether a tooth received a pulpotomy. A patient with an increased pain score was more likely to receive a pulpotomy. This corresponds to existing literature which reports that carious painful permanent molars often receive more endodontic treatment than asymptomatic teeth. Deep caries may induce reversible and or irreversible inflammatory changes in the pulp with or without pain. The pain associated with reversible pulpitis can be treated successfully either with the vital pulpotomy or Indirect Pulp Capping (IPC). There is some potential variance in the reliability of the FACES scores. The pain score can be influenced by the child behavior such that parents of a screaming/kicking kid may report the higher pain score than the true value. The FACES scores may produce a questionable response from children with cognitive impairment.

The operator type did not seem to affect the decision-making process of a pulpotomy (p=.143). The type of dental practitioners and their experience in particular restorative materials or technique can cause inconsistencies in the preferred treatment. A potential weakness of our study is that resident preferences are largely based on attitudes and experiences of attendings. Residents accounted for 23.5% of all crowns placed.
Pediatric dentists may have more experience with a risk-assessment tool such as the caries risk. General dentists tend to recommend more amalgam restoration in proximal restoration in primary teeth while many pediatric dentists recommend a higher percentage of Stainless Steel Crowns (SSC)\(^\text{30}\). Since most general dentists have very little experience with SSC they tend to restore proximal lesions more with amalgam, while pediatric dentists most often use SSC for the same lesions\(^\text{30}\). Historically, the decision-making process has been also influenced by the gender of the practitioners and the characteristics of their practice. Female dentists recommend more pulp treatment in deep carious molars than males, and the dentist who treat an average of 6-16 children per week in their practices more likely to recommend restoration with pulp therapy than those who were not currently involved in treating children\(^\text{24}\). Since all the operators who performed the pulp therapy in this study were pediatric dentists or dental residents, and most of them were trained with the similar curricular/clinical guideline as mentioned before, it may be difficult to detect operator preferences in this study.

Based on multivariate regression findings the age of the patient was not a reliable indicator for pulp therapy in primary teeth \((p=.133)\). However, the data from this study indicated that the majority of primary teeth were treated in children 36 to 72 months (3 to 6 years). Over a thousand crowns were placed with this age group. This indicated that more than 62% of the children under 6 years old, who presented to either the out patient dental clinic or a Dental Surgery Center, were treated with SSC, or SSC plus pulpotomy. This finding
corresponds with the current state of literature regarding the treatment of young primary molars. Seale (2002) strongly recommends restoring multisurface caries in primary molars with SSC when the patient is younger than 6 years of age, or when the restoration lifespan is required to be longer than 2 years. It is the chronological age of the patient, as well as size of the carious lesion, that should be considered when determining restoration options for primary teeth. There is a high degree of consensus that the longevity of SSC is superior to amalgam restoration (the average life expectancy of Class II amalgam is about 2 years), so the best treatment option for primary molars, especially first primary molars, in young children, would be placing a SSC.

The pulpotomy to crown ratio is a clinical indicator that may show how certain dental procedures are deployed in high risk populations. This numeric value shows the ratio between the total number of teeth treated with pulpotomy and the total number of teeth treated only with SSC. A higher ratio indicates that more teeth are being treated with pulpotomies. In unstable socioeconomic populations where caries prevalence is high and timely recall visits are low, dentists may treat deep carious primary teeth with more aggressive and definitive pulp therapy. This may result in an increase in the ratio of pulpotomy to crowns. The opposite may be true that dentists practicing in stable socioeconomic populations may perform less pulpotomies because the caries rate is much lower in these patient pools. This may be reflected as a low pulpotomy to crown ratio.
There is some debate as to the utility of this figure, in so far as there is a scant literature on this topic. Data from university-based dental clinics or hospital-based clinics in urban settings have reported the percentages of pulpotomies somewhere between 30 to 46%\textsuperscript{12}. The average mean from these clinics is 37%\textsuperscript{12}. The methodology used to obtain these values is unclear, and often based on year-end production figures. Although this may not represent the absolute figure of what a pulpotomy to crown ratio should be, it may still imply the practice habits of specific dental providers. Based on their specialty training and treatment philosophy, some pediatric dentists may treat interproximal caries with more pulp therapy than others, and so far there has been no consensus regarding when to perform pulpotomies. However, there is the possibility of insurance companies reimbursement agencies attempting to use these figures to imply ‘over-treatment’ or ‘under-treatment’ by certain dental providers. This may create a dispute between the treating dentists and insurance companies, and careful assessment and interpretation of the value of the ratio is critical.

From this study, pain assessment and radiographic involvement greatly influenced a dentist decision-making process on pulpotomy of primary teeth. More pulpotomies were performed when there was a high pain score and radiographic decay. These two factors positively impacted the pulpotomy to crown ratio. According to our study, the overall ratio of pulpotomy to crown was 35.7% at Nationwide Children’s Hospital, and this falls within reported normal benchmarks of pulpotomy to crown ratio performed in urban pediatric populations.
There are several clinical implications of this study. The treatment indications for pulpotomy and indirect pulp capping (IPC), an alternative vital pulp treatment, are identical according to AAPD guideline. IPC are placed in deep carious teeth either with no or reversible pulpitis. During IPC procedure a dentist removes the carious dentin incompletely to avoid a pulp exposure, and treats the decay process with a biocompatible material. The advantages of IPC are; avoiding the use of formocresol, known as a carcinogenic and mutagenic agent; eliminating internal resorption caused by ferric sulfate, and minimizing discomfort during the procedure. The success rate of IPC is higher (93%) than in formocresol pulpotomy (74%). During a 2007 American Academy of Pediatric Dentistry (AAPD)-American Association of Endodontists (AAE) joint symposium on pulp therapy 47% of pediatric dentists and 58% of endodontists agreed that IPC is the “best treatment of choice for a reversibly inflamed primary molar with a large carious lesion encroaching on the pulp.”

There were several limitations/weaknesses in this study. This was a retrospective chart review from dental treatment performed over a period of six months. Retrospective studies tend to examine the variables ‘in a vacuum’ and ignores specific clinical presentations. The study design relied on information purely from patient charts, and so detailed follow up was not possible. The operative treatment was performed by a number of dentists including pediatric dental faculty members and pediatric dental residents at Nationwide Children’s Hospital Columbus. Each dentist uses slightly different techniques in performing the same dental procedure, and this small difference may impact the treatment
outcome. Five examiners reviewed the treatment notes/charts. Although all examiners were calibrated in a standardized way and had a good inter-rater reliability, there were still some possibilities of examiner variance.

It should be noted that the range of the correlation coefficient (R²) values associated with the regression analysis was .002-.578. This demonstrates that even while the overall statistic was significant, the amount of variance of the outcome variable explained by the predictor variable(s) was small. No other studies examining the pulpotomy:SSC ratio have been conducted on this magnitude, and it is entirely possible that this study was inadequately powered, but the inadequacy was masked through a sizeable sample size.

If this study was repeated limiting the number of operators to reduce potential bias would be recommended. Furthermore, collapsing the radiographic categories 2 +3, which were most often the cause of question, could simplify rating scale. This would potentially reduce rater-variance although doing this would reduce the sensitivity of results. The inter-rater Kappa was 0.84 which demonstrated good agreement.

Our results were intuitively what would be expected, namely practitioner based decisions for vital pulp therapy of radiographic and a pain assessment. The overall ratio we obtained 1:2.8 (35.7%) fell well within normal benchmarks.
CONCLUSIONS

There was significant association between the pain scale ($p=0.0001$) and the radiographic score ($p<0.0001$) and pulpotomies being performed. The operator type ($p=0.143$) and the location of the treatment ($p=0.312$) had no significant association with treatment performed. The overall ratio of pulpotomy to crown was 35.7% at Nationwide Children’s Hospital, and this falls within reported normal benchmarks.
APENDIX

Ratio of Stainless Steel Crowns: Pulp Therapy
CQA Review-Ratio of stainless Steel Crowns: Pulp Therapy

Exclusion Criteria
*No history of swelling
*No history of resorption
*No pathologic mobility

Subject _______________________
MR # _______________________
DOB _______________________

Age Group (Circle Appropriate Group)
0-36 months old 37-72 months old >72 months old

Pain Scale

Medical Hx Findings ________________________________
Medications________________________________________

Operator (Circle Appropriate Group)

Group 1 Group 2 Group 3
Amini Griffin Residents
daFonseca McTigue
Kumar Thikkurissy

Setting (Circle Appropriate Location)
Clinic operating Room/DSC
Teeth Treated _____________ Teeth Treated _____________

**If multiple teeth are treated using 2nd primary molars as standard**
**If primary 2nd molars and permanent first molars – use both *****

<table>
<thead>
<tr>
<th>Tooth</th>
<th>Radiographic Score (0-4)</th>
<th>Treatment</th>
<th>Repeat Visit?</th>
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Radiographic Scoring

0 = Clinical decalcification (white spot), no radiographic caries noted
1 = Radiographic caries confined to enamel
2 = Radiographic caries confined to outer ½ dentin
3 = Radiographic caries extends to inner ½ dentin
4 = Radiographic caries contacting pulp chamber

Any record of over-the-counter pain medication usage? Yes No
If yes, what medication?

25
REFERENCES


