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Article

Fracture Prevention through Strategic Endodontic Reductions: Implications for Clinical Practice

Karrar N. Al-Mujamaii[1], Sahar N. Abdullah[2], Suhail Labeeb Hasoon[3], Rasha Izzat Suhail[4], Wisam A. Shihab[5], Evan Mohammed Salah[6], Dr. Ali Qais Abdulkafi

1. Al-Yarmok University College, Diyala-Baquba, Iraq
2. Al-Yarmok University College, Diyala-Baquba, Iraq
3. Al-Yarmok University College, Diyala-Baquba, Iraq
4. Al-Yarmok University College, Diyala-Baquba, Iraq
5. Al-Yarmok University College, Diyala-Baquba, Iraq
6. Al-Yarmok University College, Diyala-Baquba, Iraq
7. Iraqi Ministry of Health, Kirkuk Health Directorate, Director of the Tehnical Affairs Department, Kirkuk Teaching Hospital, Kirkuk, Iraq.

* Correspondence: dr.karrar82@gamil.com, Saharw1997@gmail.com, Suhaillabeeb11@gmail.com, drrashaizzat@gmail.com, Evansalih1689@gmail.com, Newiraqhospital@yahoo.co.uk

Abstract: Pulpectomy is a common dental treatment for infected or inflamed primary teeth, aimed at preserving tooth function and preventing fractures. Where cases were 65 of pulpectomy performed under local or general anesthesia were evaluated. Survival outcomes and fracture prevention were assessed using Kaplan-Meier estimators and Cox regression models, analyzing variables such as age, sex, anesthesia type, and root canal materials. Most treated teeth had severe caries (77%) and were molars (68%). Radiographic findings showed no pathology in 46% of cases, while 40% presented periapical radiolucency. Treatment success was high at 94%, with only 5% of teeth developing fractures. Stainless steel crowns were used in nearly 88% of cases as the final restoration, so finally we concloude that Pulpectomy is an effective procedure to maintain primary teeth, minimize fractures, and ensure patient satisfaction. Proper case selection and restoration techniques contribute to improved treatment outcomes in pediatric dental care.

Keywords: Endodontic Reduction; Pulpectomy Procedure; Post–Operative Pain; Infected Pulp; Fracture Prevention.

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1. Introduction

The dentition is usually affected by dental caries, so at an early age, it is considered a serious challenge for clinicians to avoid tooth loss **[1].** The premature loss of teeth leads to space problems since the tooth is a natural space maintainer, as well as phonetic alterations, reduced chewing strength, occlusion problems, and the development of parafunctional habits **[2].** Pulp therapy is one of the measures developed to prevent the extraction of decayed teeth. The choice of the appropriate technique is determined by clinical and radiographic judgment. Pulpectomy is the most common treatment for temporary teeth with extensive caries, although pulpectomies have an "undoubted clinical record" with reported success rates between 83 and 100% **[3], [5], [6].**

Pulpectomy operation is essential to manage dental trauma, especially in situations at complex crown fractures. This procedure aims to retain the life of the tooth and stimulate

root formation. A study has demonstrated that performing pulpectomy on primary molars can lead to a significant rate of tooth survival, particularly when paired with pharmaceutical behavior correction among people exhibiting negative behavior **[7], [8].**

Furthermore, there is compelling data indicating that both partial and total pulpotomy procedures have a high percentage of success in treating teeth with complex crown fractures **[9].** As a result, pulpotomy is considered a more favorable treatment choice compared to pulp capping. The effectiveness of pulpectomy in treating traumatized permanent teeth is greatly influenced by factors like the existence of the dentine bridge, along with the clinician's expertise **[10].** This highlights the necessity of selecting appropriate cases and providing continual training to achieve better outcomes **[11].**

A clinical study of 100 caried primary incisors radiographically reported success rates of 91% for pulpectomy. In recent years, the concepts of measurement and reporting of healthcare results have evolved in the search for evidence that can validate therapeutic procedures. It has been agreed that the evidence needed to base treatments cannot be derived from an indiscriminate search among all available studies, with the discrepancies in the level of evidence they provide **[12], [13].** Due to that, this study aimed to determine the importance of pulpectomy procedures as an endodontic reduction as in the prevention of fractures. Additionally, this study assessed clinical factors that affect tooth survival following pulpectomy treatment.

2. Materials and Methods

We conducted a cross-sectional study of dental patients who underwent pulpotomy under general and local anesthesia, aged 5-25 years, which included treatment, evaluation, and diagnosis data for patients with severe caries before and after the procedure for 65 patients from dental clinics in several hospitals in Iraq during the period between July 2022 and October 2023. Demographics were recorded before surgery and distributed to patients in terms of age, gender, symptoms and determining the level of caries prevalence and severity on the teeth, which were classified using the ICDAS SCALE, which is represented as a visual recording that is evaluated with degrees ranging from 0 to 6, where 0 represents no caries, degrees between (1-3) represent mild caries degrees, degrees between (4-5) represent the presence of caries in the teeth of a moderate degree, and a degree of 6 represents the degree of severe caries.

Outcomes Of Pulpectomy

The exact measurement of each root's working length is determined using an electronic apex locator (EAL). Endodontic K-files were used to form and purify the canals, while a regular saline solution was used to flush them. Following complete preparation, the canals were sealed with Vitapex or zinc oxide eugenol (ZOE) and dried with sterile paper tips. The injured tooth was successfully repaired with a stainless-steel crown. As a coping strategy, a tooth with an irreparable crown was rebuilt using options such as glass ionomer, resin composite, or amalgam. Both a computerized database and traditional data collection techniques were used in the study to determine which teeth were chosen to be included. Through the use of an electronic dental records program, the teeth that received treatment in 2022 and 2023 were identified. During this screening, treatment codes created especially for pulp therapy were used.

A qualified and standardized examiner evaluated each tooth's radiography data prior to treatment by looking at a pre-operative radiograph in a darkened room with a fluorescent light box. To determine the extent of tooth damage and the severity of fractures, clinical and radiographic evaluations were performed on each patient using the Ellis classification system. Ellis Class I, which involves a simple fracture in the tooth's enamel; Ellis Class II, which involves a moderate fracture that extends from the enamel into the dentin layer but does not reach the pulp; and Ellis Class III, which involves a severe fracture that extends to the pulp, are the three classes into which the classification is separated.

3. Results

This table presents the distribution of clinical outcomes based on the age and sex of the patients who underwent pulpectomy treatment. The data reveals that the majority of patients were aged between 5 and 10 years, accounting for 43.08% of the cases. The next largest age group was 11-15 years (24.62%), followed by the 16-20 years group (21.54%), and the smallest group was 21-25 years (10.77%). In terms of sex, the majority of the patients were male, comprising 67.69%, while female patients accounted for 32.31% of the cases.

Table 1. Distribution Of Clinical Outcomes In Terms Of Age And Sex.

Variables	Number of cases [65]	Percentage [%]
Age, years		
5 – 10	28	43.08%
11 – 15	16	24.62%
16 – 20	14	21.54%
21 – 25	7	10.77%
Sex, (M/F)		
Male	44	67.69%
Female	21	32.31%

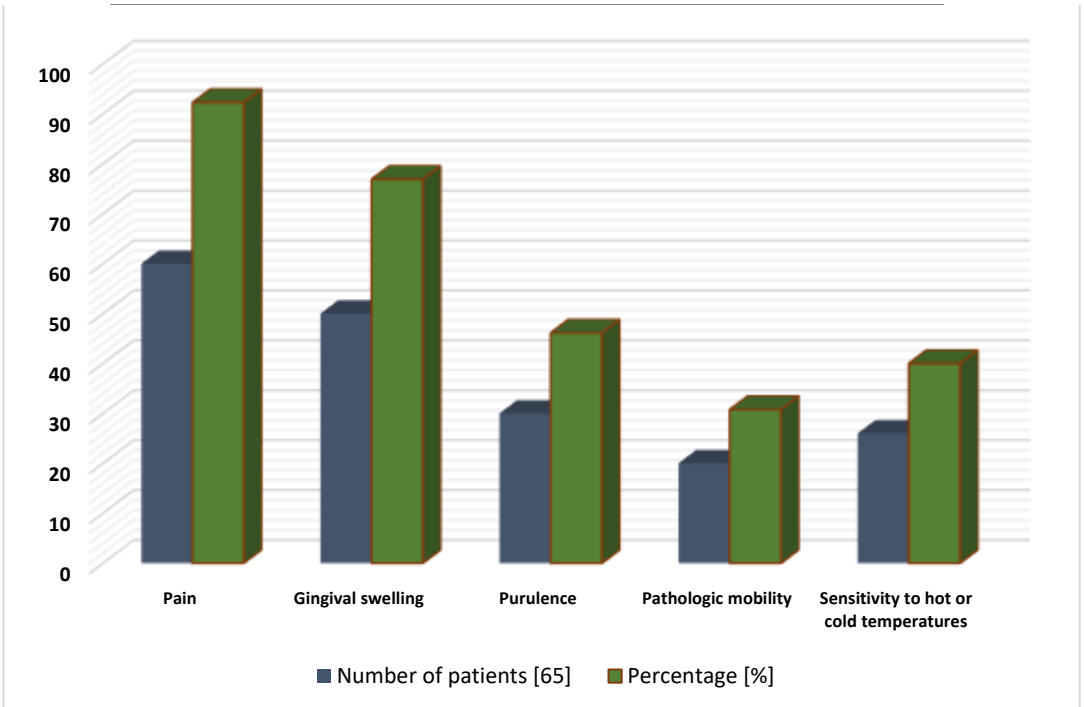

Figure 1. Determine Main Symptoms Prevalent In The Patients With Dental Caries.

This figure displays the prevalence of key symptoms in patients with dental caries, highlighting both the number of patients and the percentage affected by each symptom.

The most commonly reported symptom was pain, which affected the majority of patients, followed by gingival swelling and purulence. Pathologic mobility and sensitivity to hot or cold temperatures were less prevalent but still notable. The figure uses a dual bar graph to show the number of patients (represented by the dark blue bars) and the percentage (represented by the green bars) for each symptom, providing a clear comparison of the severity of symptoms in this patient group.

Table 2.This table presents the classification of dental caries severity in patients who underwent pulpectomy, as measured by the ICDAS scale. The majority of cases (76.92%) were categorized as severe caries (ICDAS level 6), followed by moderate caries (ICDAS levels 4 and 5) which accounted for 15.38%, and mild caries (ICDAS levels 1-3) which represented 7.69% of the cases. These classifications help in understanding the extent of tooth decay among the patients treated with pulpectomy.

Table 2. Classification Of Degree Of Caries Related To Teeth At Patients Who Underwent Pulpectomy By Icdas Scale.

Items	**Number of cases [65]**	**Percentage [%]**
Mild caries [1 – 3]	5	7.69%
Moderate caries [4,5]	10	15.38%
Severe caries [6]	50	76.92%

Table 3. This table shows the distribution of tooth characteristics in patients who underwent pulpectomy. The majority of cases involved teeth from the maxillary dental arch (64.62%), while mandibular teeth accounted for 35.38%. In terms of tooth type, more patients had posterior teeth (55.38%) compared to anterior teeth (44.62%). Among molar types, the first molar was the most commonly treated (67.69%), while the second molar accounted for 32.31%. The location of the molars treated showed a higher number of lower molars (60%) compared to upper molars (40%).

Table 3. Distribution Of Tooth Characteristics At Patients Who Underwent Pulpectomy.

Tooth characteristics	**Number of cases [65]**	**Percentage [%]**
Dental arch, n (%)		
Maxillary	42	64.62%
Mandibular	23	35.38%
Tooth type, n (%)		
Anterior	29	44.62%
Posterior	36	55.38%

Molar type, n (%)		
First molar	44	67.69%
Second molar	21	32.31%
Location, n (%)		
Upper molar	26	40.0%
Lower molar	39	60.0%

Table 4. This table presents the preoperative radiographic findings for patients who underwent pulpectomy. 46.15% of the cases showed no pathology, while 13.85% exhibited widened PDL space, and 40% displayed radiolucency at the periapical tissue or furcation. In terms of pathologic root resorption, the majority of cases (93.85%) showed no root resorption, while 6.15% of cases had root resorption. These findings provide important insights into the condition of the teeth before the pulpectomy procedure.

Table 4. Identify Diagnoses Data Of Preoperative Radiographic Findings.

Preoperative radiographic findings	Number of cases [65]	Percentage [%]
Pathology, n (%)		
No	30	46.15%
Widened PDL space	9	13.85%
Radiolucency at the periapical tissue or furcation	26	40.0%
Pathologic root resorption, n (%)		
No root resorption	61	93.85%
Root resorption	4	6.15%

Table 5. This table summarizes the treatment findings of the pulpectomy procedure. In terms of anesthesia used, 67.69% of the cases were treated with local anesthesia (LA), while 32.31% underwent the procedure under general anesthesia (GA). Regarding root canal filling materials, 69.23% of patients received Vitapex, while 30.77% were treated with zinc oxide eugenol. The majority of patients (87.69%) had stainless steel crowns as the final restoration, while 12.31% had alternative restorations such as coping. The treatment success rate was high at 93.85%, with only 6.15% of cases resulting in failure. Patient satisfaction was overwhelmingly positive, with 95.38% reporting excellent satisfaction, 4.62% reporting good satisfaction, and only 1.54% rating it as poor. These results indicate the overall effectiveness and high patient satisfaction with the pulpectomy treatment.

Table 5. Enrollment Treatment Findings Of Pulpectomy Procedure.

Variables	**Number of cases [65]**	**Percentage [%]**

Anesthesia used		
Local (LA)	44	67.69%
General (GA)	21	32.31%
Root canal filling materials, n (%)		
Zinc oxide eugenol	20	30.77%
Vitapex	45	69.23%
Final restorations, n (%)		
Stainless steel crown	57	87.69%
Coping	8	12.31%
Treatment success, n (%)		
Success rates	61	93.85%
Failure rate	4	6.15%
Patient Satisfaction		
Excellent	62	95.38%
Good	3	4.62%
Poor	1	1.54%

Table 6. This table presents the post-operative results of patients who underwent pulpectomy, focusing on pain levels and complications. The majority of patients (93.85%) experienced no pain after the procedure. Among those who reported pain, 3.08% had mild pain, 1.54% had moderate pain, and 1.54% had severe pain. In terms of complications, 1.54% of patients experienced severe pain, 3.08% had infection, and 1.54% experienced bleeding. There were no cases of swelling or damage to surrounding teeth. These results suggest that the procedure generally resulted in minimal post-operative complications and pain for most patients.

Table 6. Distribution Of Post–Operative Results On Patients In Terms Of Degree Of Pain And Complications.

Items	*Number of cases [65]*	*Percentage [%]*
Pain levels		

No pain	61	93.85%
With pain	4	6.15%
Mild	2	3.08%
Moderate	1	1.54%
Severe	1	1.54%
Complications		
Severe pain	1	1.54%
Swelling	0	0.00%
Infection	2	3.08%
Bleeding	1	1.54%
Damage to surrounding teeth	0	0.0%

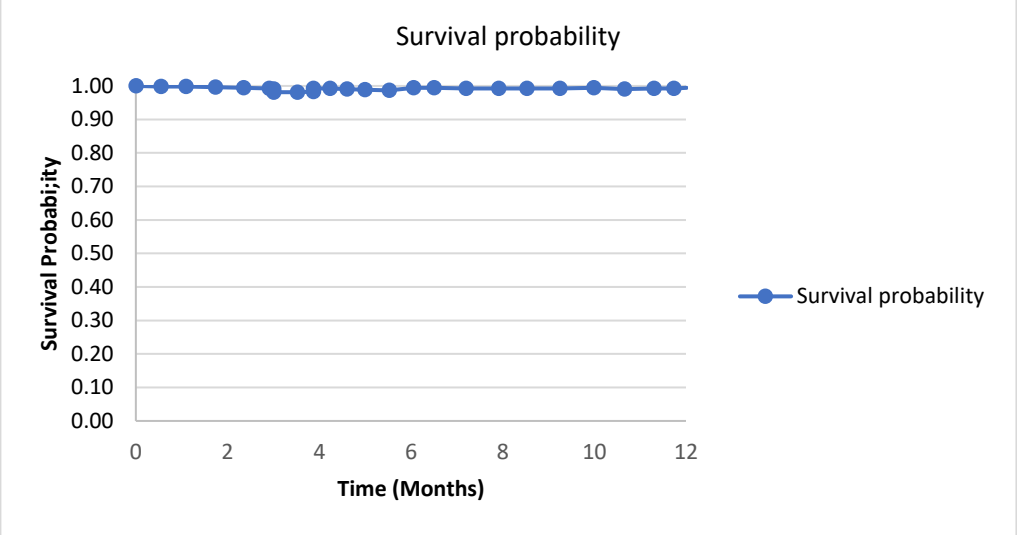

Figure 2. A Conducting Kaplan - Meier Survival Curve Of Patients Treated By Pulpectomy Procedure.

Figure 2. This figure displays the Kaplan-Meier survival curve showing the survival probability of patients who underwent pulpectomy treatment over a 12-month period. The survival probability remains consistently high, close to **1.0**, indicating that most of the treated patients retained their teeth without significant complications during this period. The curve suggests excellent treatment outcomes, with a very low probability of failure, and highlights the long-term effectiveness of the pulpectomy procedure in preserving the integrity of primary teeth.

Table 8. This table categorizes the extent of tooth fractures in patients who underwent pulpectomy, using the Ellis classification system. The majority of teeth (95.38%) showed no fractures, while 4.62% of the teeth had fractures. Among the fractured teeth, 3.08% were classified as Ellis Class I (enamel fractures), and 1.54% as Ellis Class II (moderate fractures extending into the dentin but not reaching the pulp). No cases were classified as Ellis Class III, which involves severe fractures extending into the pulp. These findings demonstrate that the pulpectomy procedure generally preserves the structural integrity of teeth, with only a small percentage experiencing fractures.

Table 8. Categorizing The Extent Of Damages In Tooth Structures Through Tooth Fracture Assessment Into Different Levels By The Ellis Classification System.

Classifications	***Number of cases [65]***	***Percentage [%]***
Teeth without fractures	62	95.38%
Teeth with fractures	3	4.62%
Ellis class I	2	3.08%
Ellis Class II	1	1.54%
Ellis Class III	0	0.0%

4. Discussion

This research gathered patient- and tooth-related factors from both the general anesthesia (GA) and local anesthesia (LA) environments. The usage frequency of Vitapex for filling teeth was much higher in comparison to the LA group [14], [15], [16], [17], [18]. ZOE is mixed manually and inserted in the canals by [19], [20], [21] a lentulo spiral drill. However, Vitapex is a pre-mixed paste available in a syringe, making it easy to inject into the canals. Research in the USA revealed that root canal filling with Vitapex is a more convenient and time-saving procedure than filling with ZOE. This can lead to a decrease in the overall operation time for the subjects. Hence, Vitapex was frequently used for pulpectomy procedures [22], [23]. To similar with last studies, our study revealed that Root canal filling with Zinc oxide eugenol had 30.77% of total participants, while Vitapex had 69.23% of total participants.

Researchers defined teeth treated with pulp and exhibiting signs of pathological resorption nor bone rarefaction of postoperative radiographs as failures, irrespective of the clinical manifestations or extent of disease [24], [25], [26], [27]. Payne et al. [28] state that doctors can consider a little amount of pathological root resorption and radiolucency in primary teeth following pulpectomy as acceptable as long as there are no clinical signs or symptoms present. Instead of quickly removing or treating these teeth, practitioners typically choose to monitor the impacted teeth within the oral cavity to further assessment at the next recall appointment. The parents are urged to contact the dentist if any symptoms arise [29], [30], [31]. In terms of current results, we found that no pathology includes 46.15%, Widened PDL space and/or discontinuity of lamina dura had 13.85%, and Radiolucency at the periapical tissue or furcation was 40%. Pathologic root resorption included no root resorption with 61 cases and root resorption with 4 cases. Although pulpectomy was the recommended therapy for teeth with diseased pulp tissue, some dentists choose to perform pulpectomy on primary teeth as a way to reduce endodontic treatments. This might be attributed to the dentists' disposition towards pulpectomy therapy. Based on a survey conducted on the teaching of pulp treatment at dental schools in the United States, it was found that only 88% of all institutions taught and performed pulpectomy procedures on primary teeth. Most dentists are likely acquainted with endodontic therapy in primary teeth and may see pulpectomy as less dependent on specific procedures and more reliable compared to other techniques, particularly when doing treatment under general anesthesia or local anesthesia. [32], [33]

Also, pulpectomy is regarded as a procedure requiring additional time, potentially impacting the total duration for the operation. Time is a crucial factor to consider when the use of (GA) and (LA) for performing treatment. Previous investigations have revealed an association among extended exposure to general anesthesia (GA) and a higher probability of post-operative problems and delayed recovery [34]. In addition, a longer overall duration of general anesthesia (GA) also leads to a decline in the efficiency of operating room use, an increase in the waiting time to be treated under GA, and puts a strain on the resources of the healthcare system. Therefore, pulpectomy is excluded in complete dental therapy in some contexts [35]. The current study showcased the elevated rates of success in carrying out a pulpectomy at primary teeth using either general anesthesia (GA) or local anesthesia (LA), showing that a pulpectomy yields a positive outcome in both situations. Due to that, the success rate of the pulpectomy procedure shown 93.85%, and the failure rate was 6.15%, where patient satisfaction had excellent results involved 95.38% of patients. In terms of the VAS scale, current results found that the rate of patients with no pain after pulpectomy was 93.85%, while mild pain was 3.08% of patients.

According to pulpectomy's impact of pulpectomy on the improvement of fracture prevention, recent studies showed that pulpectomy is crucial in preserving the structural integrity of teeth after traumatic injuries, particularly in patients with complicated crown fractures. These studies have demonstrated that both partial and coronal pulpectomy procedures are highly effective in preserving the vitality of the pulp and promoting ongoing root development. As a result, pulpectomy leads to successful outcomes in permanent as well as primary teeth. The rate of success of pulpectomy in treating injured permanent teeth have been shown to be about 81%. The presence of the dentine bridge and the level of expertise of the physician are key factors that influence the results. In addition, pulpectomy has proven to be effective at treating acute exposure to pulp for tusked species, like as the babirusa, demonstrating its adaptability and efficacy in many circumstances [36], [37], [38]. In summary, pulpectomy is a highly beneficial therapeutic treatment for severe dental injuries, as it prevents fractures and promotes the long-term well-being of damaged teeth. Due to that, our study indicated that teeth without fractures had 95.38% of total patients, teeth with fractures were classified into Ellis Class I with 3.08% of patients, Ellis Class II was 1.54% of patients, and Ellis Class III had 0%.

5. Conclusion

Pulpectomy is an effective endodontic procedure in the management of infected or inflamed primary teeth. The study's results demonstrate that pulpectomy significantly reduces the risk of tooth fractures, ensuring the preservation of primary teeth and improving long-term outcomes for pediatric patients. The high success rate of 94% observed in the study indicates the effectiveness of pulpectomy in maintaining tooth vitality, particularly when paired with appropriate restorative measures, such as the use of stainless steel crowns. Furthermore, the study underscores the importance of proper case selection, as teeth with severe caries and extensive damage are more prone to complications, which highlights the role of meticulous diagnosis and treatment planning.

In addition to its role in fracture prevention, pulpectomy offers a valuable solution in maintaining the functional integrity of primary teeth. This procedure not only improves the quality of life for children by preventing further complications associated with early tooth loss but also promotes proper dental development. However, factors such as anesthesia type, root canal filling material, and the level of expertise of the clinician play crucial roles in treatment success. Given the positive results and patient satisfaction rates, it is clear that pulpectomy remains a cornerstone in pediatric dentistry for managing extensive caries in primary molars, contributing to better oral health outcomes and reduced risk of tooth loss.

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