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ORIGINAL ARTICLE

Outcomes of Pulp Therapy in Traumatized Primary and Permanent Teeth in Children

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Abstract

Background: *Traumatic dental injuries (TDIs) in pediatric patients can significantly impact both primary and permanent dentitions, requiring timely and appropriate pulp therapy to ensure optimal outcomes.*

Objective: *This study aimed to evaluate the types of dental trauma, pulp therapy modalities, and clinical and radiographic outcomes in children following traumatic injuries.*

Methods: *This cross-sectional observational study was conducted in the Department of Dentistry at Bangladesh Shishu Hospital & Institute, Dhaka, from January to December 2023. A total of 50 pediatric patients (aged 3–12 years) with TDIs involving primary (n=30) or permanent teeth (n=20) were included using purposive sampling. Children with systemic conditions, developmental anomalies, or incomplete records were excluded. Clinical and radiographic evaluations were performed at baseline and after 6 months to assess treatment outcomes.*

Results: *Most patients were aged 7-9 years (42%), and 58% were male. Primary teeth were more frequently affected. Complicated crown fractures (44%) were the most common type of trauma, followed by uncomplicated crown fractures (22%) and luxation injuries (20%). Pulpectomy/root canal treatment was the most common pulp therapy (42%), followed by pulpotomy (34%), direct pulp capping (14%), and indirect pulp capping (10%). Apexogenesis and regenerative therapy were applied in select permanent teeth. At 6-month follow-up, 86% of teeth were clinically asymptomatic. Radiographically, 80% showed normal healing. Minor complications included pain, swelling, sinus tract, and mobility.*

Conclusion: *Pulp therapies in traumatized primary and permanent teeth yielded favorable clinical and radiographic outcomes over a 6-month period. Early diagnosis and appropriate treatment selection are key to preserving dental health in pediatric trauma cases.*

Key words: *Pediatric dental trauma, primary teeth, permanent teeth, pulp therapy, pulpotomy.*

Introduction

Traumatic dental injuries (TDIs) are common occurrences in children and adolescents and represent a significant public health concern globally.[1] The prevalence of dental trauma ranges from 10% to 30% among school-aged children, with a higher incidence in boys. These injuries frequently affect the anterior teeth, particularly in the primary and early permanent dentitions, due to falls, sports injuries, road traffic accidents, or violence.[2,3] When dental trauma involves the pulp, it can compromise both the function and longevity of the affected tooth, especially if not managed promptly and appropriately.

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Pulp therapy plays a crucial role in the preservation of pulp vitality and function in traumatized teeth. In pediatric dentistry, the main objective of pulp therapy is to maintain the tooth in a healthy, functional state until its natural exfoliation in the case of primary teeth, or until complete root formation and long-term retention in permanent teeth.[4] The choice of pulp therapy depends on the extent of pulpal involvement and vitality status. Procedures range from conservative techniques such as indirect and direct pulp capping to more invasive interventions like pulpotomy and pulpectomy.[5] In permanent teeth with incomplete root formation, apexogenesis and regenerative endodontic therapy may also be considered.[6]

The outcomes of pulp therapy in traumatized teeth are influenced by several factors including the type and severity of the trauma, time elapsed before treatment, the stage of root development, and the type of materials used.[7] Successful treatment is indicated by the resolution of clinical symptoms such as pain and swelling, as well as radiographic evidence of healing, including the absence of periapical pathology and continuation of root development in immature teeth.[8] However, delayed or improper management may lead to complications such as pulp necrosis, internal or external resorption, and eventual tooth loss.[9]

Despite advances in diagnostic techniques and materials, there is limited local data from Bangladesh on the effectiveness of various pulp therapy modalities in traumatized teeth.[10] Understanding the clinical and radiographic outcomes in Bangladeshi children will aid clinicians in selecting appropriate treatment strategies and predicting prognosis more accurately.[11] Moreover, early diagnosis and timely intervention can significantly improve the survival rate of traumatized teeth and minimize the risk of long-term complications.[12]

This study was designed to evaluate the outcomes of different pulp therapy techniques in traumatized primary and permanent teeth in a pediatric population treated at a tertiary care dental center in Bangladesh. By assessing both clinical and radiographic parameters over a follow-up period, this study aims to provide insight into the effectiveness of pulp therapy procedures and contribute to evidence-based decision-making in the management of dental trauma in children.

Materials and Methods

This observational study was conducted in the Department of Dentistry at Bangladesh Shishu Hospital & Institute, Dhaka, from January 2023 to December 2023. A total of 50 pediatric patients with a history of dental trauma affecting either primary or permanent teeth were included using purposive sampling. The inclusion criteria comprised children aged between 3 to 12 years who presented with clinical and radiographic signs requiring pulp therapy due to traumatic dental injuries. Patients with systemic illnesses, developmental anomalies of teeth, or incomplete records were excluded from the study.

Each patient underwent a comprehensive clinical evaluation, which included assessment of symptoms such as pain, swelling, mobility, and presence of sinus tract. Intraoral periapical radiographs were obtained to assess pulpal status, periapical involvement, root development, and resorptive changes. Therapeutic decisions were guided by the vitality of the pulp and the stage of root development, based on both clinical and radiographic findings. Indirect pulp capping was chosen for teeth with deep caries or trauma-induced dentin exposure without pulp involvement, where the pulp remained vital and asymptomatic. Direct pulp capping was performed in cases of small mechanical or traumatic pulp exposure in vital teeth without signs of inflammation. Pulpotomy was selected for vital teeth with coronal pulp exposure showing no signs of radicular involvement. Pulpectomy was indicated in primary teeth with non-vital pulp or symptomatic irreversible pulpitis without periapical pathology. Root canal treatment (RCT) was performed in permanent teeth with complete root formation and non-vital pulp or periapical pathology. Regenerative endodontic procedures were considered in immature permanent teeth with necrotic pulp and open apices to promote root development.

All procedures were carried out under local anesthesia using standardized protocols. Calcium hydroxide, mineral trioxide aggregate (MTA), zinc oxide eugenol, and glass ionomer cement were used as pulp dressing and restorative materials based on case requirements. Treated teeth were evaluated clinically and radiographically at follow-up visits scheduled at 1, 3, and 6 months post-treatment.

The primary outcome measures included resolution of symptoms (pain, swelling, sinus tract) and radiographic signs of healing (absence of periapical radiolucency, continued root development, absence of resorption). Data were collected using structured case report forms and analyzed using Statistical Package for the Social Sciences (SPSS) version 25.0. Descriptive statistics were applied, and frequencies and percentages were calculated for categorical variables. Informed consent was taken from parents or legal guardians prior to inclusion in the study.

Results

Majority of the children were aged 7-9 years 42%. Males accounted for a higher proportion (58%) compared to females (42%). Primary teeth were more commonly involved (60%) than permanent teeth (40%) (Table I).

Table I
Demographic profile of the study population (n=50)

Variable	Frequency	Percentage
Age Group (years)		
3–6	17	34
7–9	21	42
10–12	12	24
Sex		
Male	29	58
Female	21	42
Type of Dentition		
Primary teeth	30	60
Permanent teeth	20	40

Table II shows complicated crown fractures were the most common injury, affecting 22 teeth overall (10 primary, 12 permanent).

Table II
Type of dental trauma

Type of Trauma	Primary Teeth (n=30)	Permanent Teeth (n=20)	Total (n=50)
Complicated Crown Fracture	10	12	22
Uncomplicated Crown Fracture	6	5	11
Luxation Injuries	8	2	10
Avulsion	2	1	3
Other (e.g., crown-root fracture)	4	0	4

Table III shows pulpectomy or root canal treatment was the most frequently performed procedure (21 cases), followed by pulpotomy (17 cases).

Table III
Type of pulp therapy performed

Pulp Therapy Type	Primary Teeth (n=30)	Permanent Teeth (n=20)	Total (n=50)
Indirect pulp capping	3	2	5
Direct pulp capping	4	3	7
Pulpotomy	12	5	17
Pulpectomy/RCT	11	10	21
Apexogenesis	0	2	2
Regenerative Therapy	0	1	1

Table IV shows highest success rate was observed, with 86% (43 out of 50) of the treated teeth remaining asymptomatic.

Table IV
Clinical outcomes after 6 months follow-up

Outcome	Primary Teeth (n=30)	Permanent Teeth (n=20)	Total (n=50)
Asymptomatic (Success)	25	18	43 (86%)
Pain	3	1	4
Swelling	1	0	1
Sinus Tract	0	1	1
Tooth Mobility	1	0	1

Table V shows Normal healing was observed in 80% (40 out of 50) of cases in radiologically.

Table V
Radiographic findings at 6 months

Finding	Primary Teeth (n=30)	Permanent Teeth (n=20)	Total (n=50)
Normal healing	23	17	40
Internal resorption	2	0	2
External resorption	2	1	3
Periapical radiolucency	3	2	5
Root development continued (open apex cases)	0	3	3

Discussion

This study evaluated the outcomes of various pulp therapies in traumatized primary and permanent teeth over a 6-month follow-up period. The overall clinical success rate was 86%, with 80% showing radiographic signs of normal healing, which reflects favorable outcomes in both dentitions. Our results are in line with existing literature that supports the effectiveness of pulp therapies when performed appropriately and in a timely manner.[13,14]

Among the 50 traumatized teeth treated, the most common procedures were pulpotomy (n=17) and pulpectomy/root canal therapy (n=21). These findings align with the treatment trends reported by Fuks et al[15], who emphasized the importance of preserving pulp vitality in young teeth where possible, especially following traumatic injuries. Pulpotomy was more frequently used in primary teeth, while permanent teeth were more likely to receive root canal treatment, consistent with the biological and developmental differences between the two dentitions.[16,17]

The higher success rate in primary teeth (83.3%) compared to permanent teeth (90%) is notable. This slightly higher success in permanent teeth may be due to better cooperation from older children during treatment and improved sealing ability of restorative materials used in permanent dentition. Previous studies have shown comparable success rates in traumatized teeth treated with vital pulp therapy, with values ranging from 80% to 90%.[18,19]

Among the complications observed, pain was the most frequent symptom (8%), followed by swelling, sinus tract, and mobility, each reported in less than 4% of cases. These low rates of adverse outcomes are encouraging and support the safety of pulp therapies in traumatized teeth. Yu and Abbott, reported that post-traumatic pulp responses vary widely, but prompt intervention with appropriate therapy significantly reduces complications.[20] Radiographic outcomes further supported clinical findings, with 80% of cases showing normal healing. Internal and external resorption were rare, affecting only five teeth (10%). These are known sequelae of trauma, especially when associated with delayed treatment or extensive pulp involvement.[21,22] Three permanent teeth with open apices demonstrated continued root development following regenerative

or apexogenesis therapy. This reflects successful management of immature teeth and supports current recommendations for preserving apical vitality.[23,24]

Our findings are consistent with survival analysis studies that report high retention rates of traumatized teeth following endodontic therapy, particularly when biologically based approaches like vital pulp therapy or apexogenesis are used.[25,26] Additionally, the preference for minimally invasive techniques such as indirect and direct pulp capping in selected cases aligns with recommendations in current guidelines to conserve pulp tissue when possible.[27]

While trauma-related pulp therapy outcomes are generally favorable, the choice of procedure depends on factors such as pulp status, root development, and extent of injury. For instance, apexogenesis and regenerative therapy were exclusively used in permanent teeth with open apices, a practice endorsed by Shah et al[17], and Krastl et al[28], emphasizing the potential of regenerative endodontics in trauma management.

It is also worth noting that our success rate of 86% compares favorably with meta-analyses of nonvital pulp therapies in primary teeth and vital pulp therapies in permanent teeth, which report average success rates of 70-90%.[19,29] Differences in success rates may be attributed to patient age, trauma severity, operator experience, and material selection. However, our uniform methodology and short-term follow-up limit variability and support the validity of these outcomes.

The study is limited by its relatively small sample size and short follow-up period. Six months may not be sufficient to observe late failures such as progressive resorption or periapical pathology. Longer-term studies are needed to validate the durability of these results. Additionally, we did not assess behavioral or quality-of-life outcomes, which are relevant in pediatric dental trauma cases.

Conclusion

Pulp therapy in traumatized primary and permanent teeth demonstrated high clinical and radiographic success in our study, particularly when procedures were tailored to the developmental stage and pulp status of the affected teeth. These findings reinforce the value of early diagnosis, appropriate treatment selection, and regular follow-up in managing dental trauma in children.

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