



Comparative evaluation of efficacy of Physics Forceps versus conventional forceps in pediatric dental extractions: a prospective randomized study

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Background: This study aimed to determine the efficacy of Physics Forceps in pediatric dental extractions.

Methods: This was a double-blind, randomized controlled trial with a parallel-arm design and identical allocation ratio (1:1). Children (n=104) were randomly divided into two groups for extraction of mandibular primary teeth (group I: Physics Forceps; group II: conventional forceps). The outcome variables assessed in the study were the time taken for extraction, pre- and postoperative anxiety (using RMS pictorial scale), incidence of fractured teeth, and postoperative pain on the first and third days (using the Wong-Baker faces pain scale).

Results: A significant reduction ($P < 0.001$) in intraoperative time, anxiety, and incidence of tooth fracture was confined to group I. The pain significantly reduced from the first to the third postoperative day in both groups, but the mean reduction in RMS scores in the physics forceps group was far better than that in the conventional forceps group.

Conclusion: Physics Forceps aid in extraction of primary teeth with minimal trauma to supporting structures, as well as reducing anxiety in the pediatric population.

Keywords: Beak and Bumper; Conventional Forceps; Physics Forceps; Primary Teeth.



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INTRODUCTION

Children are vulnerable to dental caries throughout their childhood, which are the prime source of oral pain and tooth loss [1,2]. Caries lie on a continuum with varying degrees of severity and tooth destruction, ranging from sub-clinical to sub-surface changes at the molecular level to lesions with dentinal involvement, either with an intact surface or visible cavitation [3,4]. The extensive fissure system in the morphology of primary teeth

enhances their susceptibility to caries because of their predisposition to be colonized by bacteria related to dental caries [5].

Pain, infection (local and systemic), and abscess are the expected consequences of untreated dental caries in primary teeth if parents of children with carious teeth have not determined adequate dental treatment at an earlier phase [6]. Extraction of primary teeth is a traditional aspect of pediatric dental practice that is part of the treatment strategy predicated by caries, trauma, and orthodontic considerations. Regardless of the dramatic

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advancement in pediatric oral care over the past decades, caries and pulpal disease often necessitate extraction of primary teeth (53%), which are untreatable through pulp therapy [7].

The idea behind exodontia is to permit effective and safe removal of teeth, focusing primarily on minimizing complications and maximizing comfort for both patients and providers [8]. Failure to appreciate the physics and instrumentation principles being employed results in iatrogenic injury to the patient, prolonged operative time, and unnecessary fatigue and/or injury to the provider [9]. Thus, tooth extraction and postoperative discomfort after extraction can be perceived as unpleasant experiences by children, consequently leading to development of anxiety and interfere with the acceptance of dental treatment during future visits [10,11].

The techniques employed during tooth extraction also result in the sudden destruction and loss of adjoining alveolar bone and soft tissues [12]. To date, dentists still exercise modified versions of this extraction technique by employing scalpels, elevators, and forceps, which are the most common instruments [13]. Two equal forces applied through the beaks of the forceps combined with a third force, movement of the operator's arm and wrist, cause further compression and expansion of the alveolar bone, ultimately resulting in the release of the tooth from its socket. Application of excessive force for compromised dental structures due to caries results in "snapped roots" and broken bone as these forces exceed those that can be withstood [14].

A paradigm shift in completing the procedure without the prerequisite gingival retraction gave rise to minimally traumatic extraction methods. These methods are intended for the removal of a tooth by maintaining harmony with the surrounding soft and hard tissues. Thus, extraction of the tooth with minimal injury may reduce the effect of the traumatic episode during tooth extraction in children. Because the emotional quality of the incident plays a more important role than the number of visits, children without negative dental experiences may be less apprehensive in future visits [15].

Physics Forceps are one of the latest innovations among instruments that aid in achieving dental extraction in a less traumatic fashion [16]. Physics Forceps works through a class 1 lever, creep, and a shear component of force by applying a biomechanical rationale during the tooth extraction process. Thus, it is a dental extractor, rather than a forceps, that uses class 1 lever mechanics. Creep is a phenomenon where a material/tissue continues to modify its shape over a period under constant load. Creep develops in the bone and periodontal ligament during extraction, resulting in the release of hyaluronic acid, which in turn severs the periodontal ligament. Many studies have reported that this breakdown occurs much faster with Physics Forceps than with conventional methods of extraction in permanent teeth [17-19], but no such studies on primary teeth have been reported in the literature.

Therefore, we hypothesized that Physics Forceps is more advantageous than conventional forceps in extraction of primary mandibular teeth.

METHODS

This randomized controlled trial had a parallel-arm design with an identical allocation ratio. Ethical clearance was obtained from the Institutional Ethical Committee. Informed consent was obtained from the parents/guardians of the children after explaining the treatment procedure to be performed, followed by assent from the child. The study duration was three months.

This prospective, double-blinded trial was executed in the Department of Pediatric and Preventive Dentistry by recruiting children meeting the following selection criteria:

Inclusion criteria:

- Aged 5-12 years
- Frankl behavior rating of 3 or 4
- Un-restorable primary mandibular teeth
- Primary mandibular teeth indicated for serial extraction

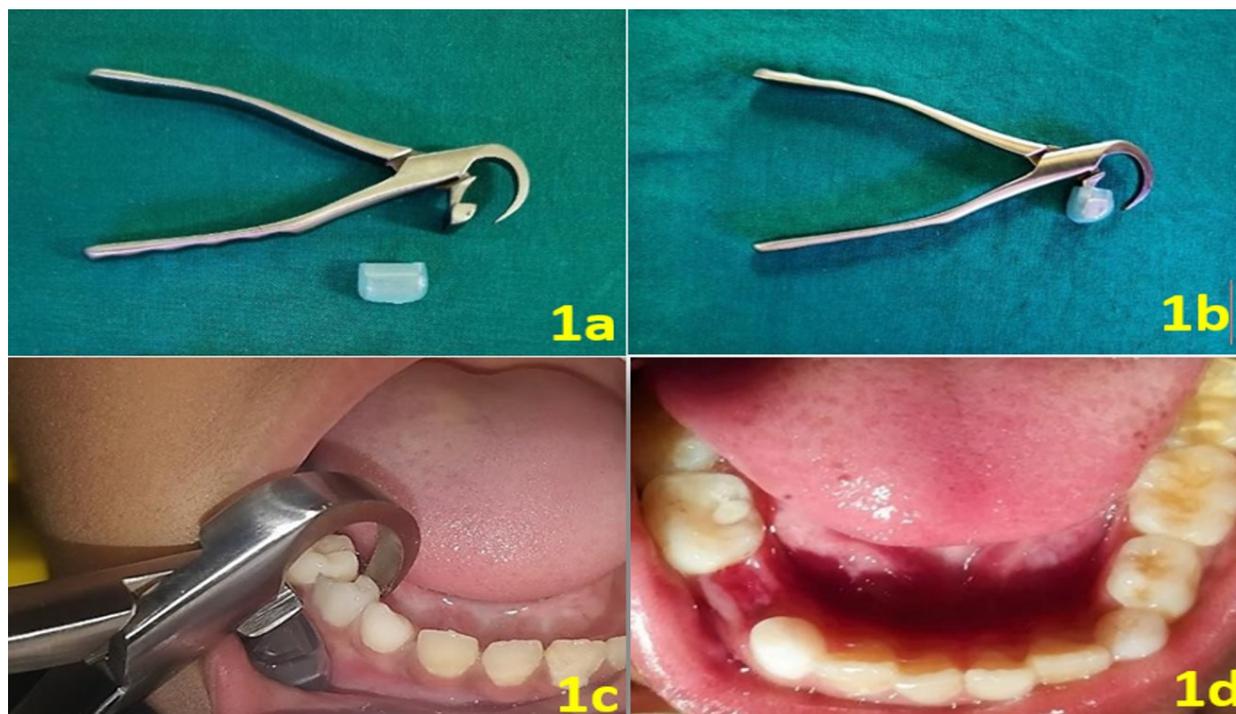


Fig. 1. (1a, 1b) Physics Forceps with a plastic bumper; (1c) extraction of tooth (84) using Physics Forceps in group 1; (1d) post-extraction site with minimal trauma in group 1.

- Retained primary teeth in the mandibular arch with at least $\frac{3}{4}$ root length.

Exclusion criteria:

- Special healthcare needs
- Frankl behavior rating 1 /2
- Pre-shedding/pathological mobility of teeth
- Primary mandibular teeth with less than $\frac{3}{4}$ root length
- Teeth with large carious lesions and crown fracture

Sample size determination

Based on the findings of the pilot study executed in eight children (four in each group), with an alpha error 0.05% and power 90%, a sample size 94 (47 in each group) was determined. After estimating a dropout rate of 5%, a sample size of 104 was obtained.

Randomization and blinding

Initially, 884 children attending the Department of Pediatric and Preventive Dentistry were examined; children (n = 104) who met the inclusion criteria were randomly allocated into two groups (group I treated with Physics Forceps as an experimental group and group II

treated with conventional forceps as a control group) using alternating numbers (odd and even numbers method). To prevent selection bias, a centralized assignment was used as an allocation concealment mechanism. Children recruited in the trial were unaware of the type of intervention, i.e., with which forceps extraction of the tooth was performed.

After recruitment of children in the trial, local anesthesia (2% xylocaine, 1:80,000) was administered before extraction of the intended tooth. For children allocated to group I, extractions were performed using the Physics forceps (Fig. 1a and 1b). A continuous and controlled buccal traction force was applied to the tooth by placing the beak of the physics forceps on the lingual aspect of the tooth at or just below the cementoenamel junction (CEJ). Contrastingly, the plastic-covered bumper was positioned at the mucogingival junction on the buccal alveolar ridge until the primary mandibular tooth was dislodged from its socket (Fig. 1c and 1d). A periosteal elevator was not employed to reflect the gingiva while working with the Physics Forceps.

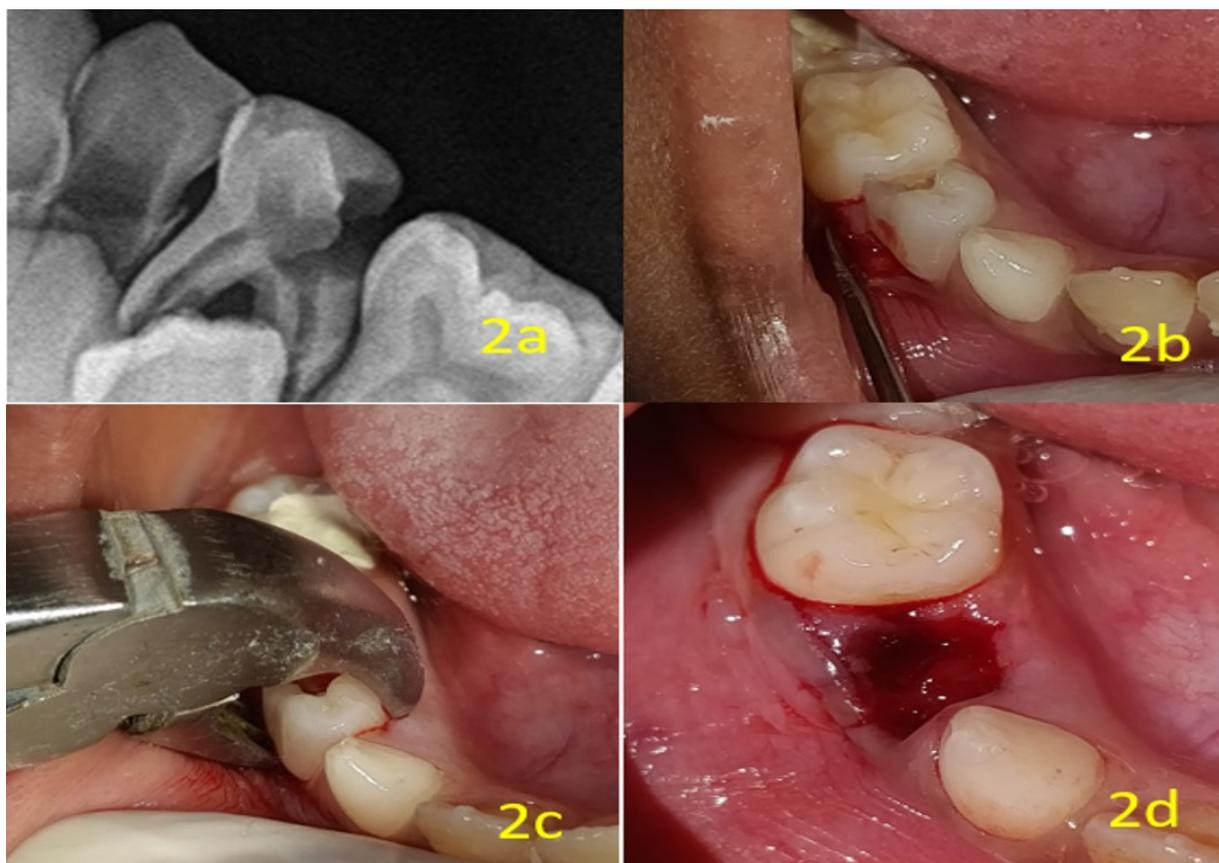


Fig. 2. (2a) IOPA of tooth with caries; (2b) periosteal elevator used for reflecting the tissue; (2c) conventional forceps used for extraction of the tooth; (2d) extraction socket after extraction of the tooth.

For extractions in group II, a periosteal elevator was initially utilized to reflect the mucoperiosteal flap (Fig. 2a and 2b). Later, tooth-specific conventional forceps were employed, wherein beaks were positioned at the CEJ of the intended tooth, and the tooth was extracted from the socket by applying tooth-specific movements (Fig. 2c and 2d). Extractions in both groups were performed under aseptic conditions, a pressure pack was placed, and postoperative instructions were given along with the prescription of analgesics for the day of extraction. Patients were advised to take an analgesic on the following days if there was intolerable pain.

In both groups, intraoperative time was recorded in seconds using a stopwatch. In group I, the time taken for extraction was recorded from the placement of the physics forceps until completion of extraction, whereas in group II, the time taken was measured from the installation of a periosteal elevator until the removal of

the tooth from its socket. A single operator performed all extractions. Pre- and postoperative anxiety was assessed using the RMS pictorial scale and recorded by a dentist who was not taking part in the procedure. A simple yes/no format was used to assess the fracture of the tooth and recorded. The patients were educated about the Wong-Baker faces pain scale for the evaluation of postoperative pain and were followed up on 1st and 3rd postoperative days to record pain scores.

Outcomes

Primary outcome: time taken for extraction of a tooth from its socket.

Secondary outcomes: fracture of the tooth, pre- and postoperative anxiety, and pain on the 1st and 3rd postoperative days.

Statistical analysis

Data were recorded using the Microsoft Excel spreadsheet 2016, and statistical analysis was performed

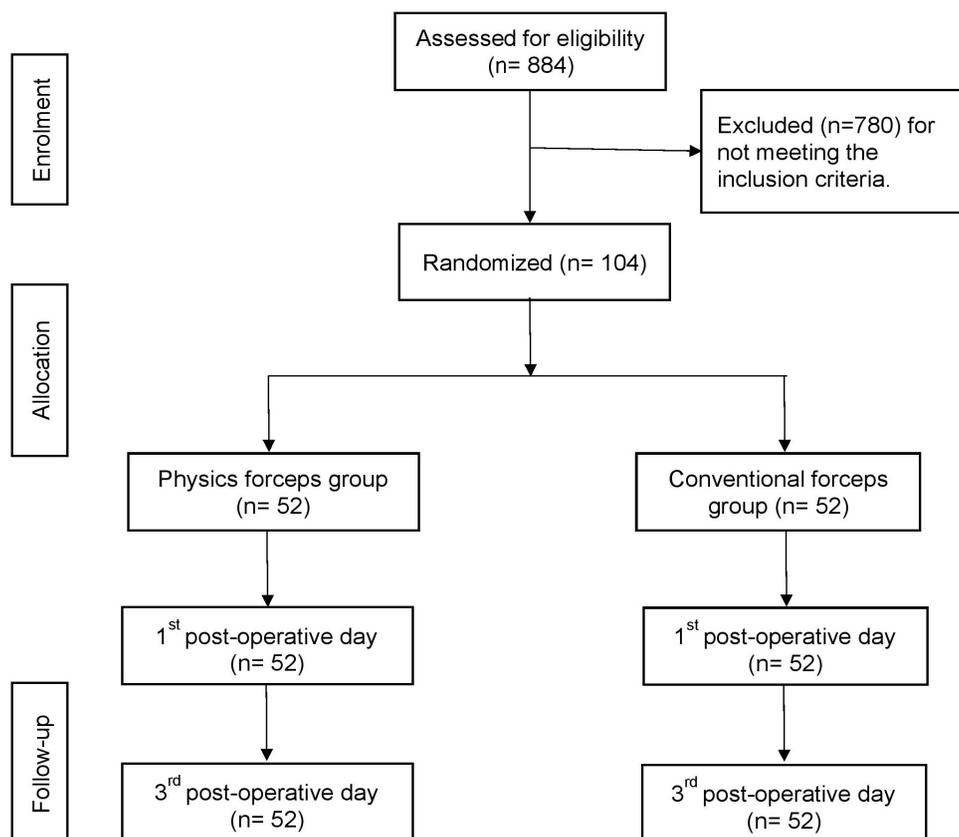


Fig. 3. Consolidated standards of reporting trials (CONSORT) flow diagram.

using SPSS 17.0, for Windows (Chicago, III, USA). A paired t-test was used to assess the difference in time taken for extraction between the two groups. The intergroup comparison of RMS scores and postoperative pain was performed using the Mann-Whitney test, whereas for intragroup comparison, the Wilcoxon signed rank test was employed. The chi-squared test was used to assess the incidence of tooth fractures across the groups. The level of significance was set at $P < 0.05$.

RESULTS

Figure 3 shows a flow diagram of patients. Overall, 104 participants were recruited with a sex ratio of 1.6:1 (65 boys/39 girls) and mean age of 8.92 ± 1.80 years in group I and 8.55 ± 1.45 years in group II, but there was no significant difference.

1. Extraction time

The mean time taken for extraction using Physics Forceps was 11.85 ± 3.77 s, whereas that with conventional forceps was 77.88 ± 14.86 s. The intergroup comparison of the mean time taken to extract the teeth elicited a statistically highly significant difference ($P < 0.001$), which was preserved even when the time taken for gingival retraction in the conventional group was not taken into consideration (Table 1).

2. Anxiety score

For intragroup comparison, the pre- and post-RMS scores for children in group I were 3.58 ± 1.00 and 1.25 ± 0.43 , respectively, which illustrated a significant difference ($P < 0.001$). Such a significant difference was not observed in group 2 (3.12 ± 1.00 and 2.86 ± 1.07 , respectively). Intergroup comparison of preoperative RMS scores elicited a slight significant difference ($P =$

Table 1. Intergroup comparison of operative time taken for extraction

Time	Mean \pm SD		P value
	Group I	Group II	
GR Time	-	43.9 \pm 7.086	-
Extraction Time	11.85 \pm 3.774	33.98 \pm 12.286	< 0.001**
Total Time	11.85 \pm 3.774	77.88 \pm 14.863	< 0.001**

GR Time, Time taken for Gingival retraction; SD, Standard deviation. **P < 0.001- Highly significant

Table 2. Intragroup and intergroup comparison of pre-operative and post-operative RMS scores

Groups	Mean \pm SD		P-value
	Pre-op	Post-op	
Group 1	3.58 \pm 1.008	1.25 \pm 0.434	< 0.001**
Group 2	3.12 \pm 1.013	2.86 \pm 1.077	0.294; NS
Pre- vs Post-op RMS Score	3.58 \pm 1.008 vs 1.25 \pm 0.434	3.12 \pm 1.013 vs 2.86 \pm 1.077	< 0.001**

NS, P > 0.05 - Not significant; SD, Standard deviation. **P < 0.001- Highly significant

Table 3. Intergroup and Intragroup comparison of post-operative pain on 1st and 3rd days

Post-operative pain	Mean \pm SD		P-value
	Group 1	Group 2	
Day 1	0.6 \pm 0.927	4.82 \pm 1.506	< 0.001**
Day 3	0	1.61 \pm 1.387	< 0.001**
Day 1 vs Day 3	0.6 \pm 0.927 vs 0	4.82 \pm 1.506 vs 1.61 \pm 1.387	< 0.001**

**P < 0.001 - Highly significant

0.020), whereas postoperative RMS scores demonstrated a significant difference (P < 0.001) (Table 2).

3. Incidence of tooth fracture

The intergroup comparison in terms of frequency of the tooth fracture revealed a significant difference (P < 0.05), with only one fractured tooth in group I and six fractured teeth in group II.

4. Postoperative pain

The intragroup and intergroup comparison of pain on the first and third postoperative days in both groups showed a significant difference (P < 0.001). Although there was a notable difference in the reduction of postoperative pain for both groups, the mean pain score on the first postoperative day in group I (0.60 \pm 0.92) was much lower than that in group II (4.82 \pm 1.50) (Table 3).

DISCUSSION

For centuries, biomechanical forces have been employed in tooth extraction. Conventional dental extraction forceps constitute a class 1 lever, comprising a handle and beaks, through which forces are applied. The two levers are coupled through a hinge, which acts as a fulcrum. Thus, the mechanical advantage of employing conventional forceps allows the clinician to grasp the crown of the tooth, rather than extracting it [18,20].

Hence, traditional methods of tooth extraction may often result in complications such as gingival tissue laceration, loss of the buccal bony plate, and postoperative pain, which delays the natural healing process of the tooth socket. These complications may not only result in postoperative distress, but also in the decline of oral health-related quality of life [21].

The use of conventional forceps for dental extraction procedures in children can be quite complicated if the child is anxious, and the anatomy of the primary teeth differs from that of permanent teeth [22]. In primary molars, root fractures are frequent because of the small diameter and divergent roots, as well as the possible weakening of the roots initiated by the eruption of their successors along with physiological resorption of primary teeth [23].

Oosterink et al. stated that invasive dental procedures were the most anxiety-provoking in a dental setting [24]. It has also been suggested that children who underwent extraction during their first dental visit or were younger were highly anxious during subsequent visits [25]. Schneider et al. revealed that past negative dental experiences might have a detrimental effect on future dental visits through undesirable anticipation, which in turn results in avoidance behavior [26]. The postoperative dental pain encountered by children on the day of extraction and the first and third postoperative days were the most common post-extraction dental morbidities following bleeding [27].

Physics Forceps (Golden Dental Solutions, formerly known as Golden and Misch, devised by Dr Richard Golden, 2004) differs from conventional extraction forceps by having a beak and bumper design. The extraction technique with Physics Forceps utilizes only wrist movement based on class I lever mechanics; thus, it eliminates the need to grasp firmly, twist, rock, push, and pull with an arm. As these forceps wholly modify the physics behind dental extraction, they are designated as Physics Forceps [28]. While the beak grasps the tooth, the bumper provides stability and leverage, applying only one controlled force against the lingual aspect of the tooth or its root until internal force or creep builds up. Thus, only buccal rotation allows slow expansion of the bone and subsequent release of the tooth from the periodontal ligament (PDL).

The benefits of Physics Forceps include attaining minimally traumatic extractions rapidly by eliminating the need for the reflection of the mucoperiosteal flap or

an elevator before extraction and by reducing operator and patient stress [20]. Extraction of a tooth using physics forceps requires a unidirectional constant traction force. Conversely, conventional forceps demand forces in both buccal and lingual directions to luxate the tooth, followed by twisting or rotating force based on the tooth to be removed, which in turn may increase the intraoperative time [29]. Hence, aspects such as the time taken for tooth extraction, patient anxiety, postoperative pain on the 1st and 3rd days, and incidence of tooth fracture were taken into consideration to assess the effectiveness of Physics Forceps in pediatric dental extractions. To our knowledge, this is the first study performed on extraction of primary teeth using Physics Forceps; hence, direct comparison with other studies is not possible. As studies related to the use of Physics Forceps in the literature were available only for permanent teeth, the study results were compared with results of those studies.

The mean time taken for extraction of the tooth using Physics Forceps (group I) was significantly less than that of the counterpart because the time required for gingival retraction was eliminated when using the Physics Forceps. This finding was agreed with the results of El-Kenawy et al., Mandal et al., and Lingaraj et al. [30-32].

Without consideration of the gingival retraction period, the time taken for group I was still less than that for group II, which could be due to the biomechanical advantage of Physics Forceps along with biochemical reactions in the tissues. The biochemical breakdown of the periodontal ligament by hyaluronidase was evident when it was traumatized with the help of elevators and forceps [20,24]. Hyaluronidase is an enzyme that catalyzes the hydrolysis of the interstitial barrier, hyaluronan (hyaluronic acid), which is the cement substance (extracellular matrix) of all human tissues [33]. As Physics Forceps produces constant trauma to the periodontal ligament, there is a greater release of hyaluronidase quantitatively than with a conventional forceps or elevator because conventional systems only cause intermittent trauma [20,24].

Herein, the RMS pictorial scale [34], which comprises five original facial photographs of a boy and girl child in a row, ranging from very happy to very unhappy, was utilized to assess the anxiety of children. Regarding the intra- and intergroup comparison of mean RMS scores, there was a significant reduction in anxiety scores for children where extractions were accomplished using Physics Forceps. The lower anxiety scores might be due to the reduced intraoperative time. It is essential to maintain an equilibrium between the extent of the procedure and efficient behavioral management. For pediatric patients, shorter appointments have been suggested as an approach to enhance cooperation [35,36]. Herein, postoperative pain experienced by children was evaluated using the Wong-Baker faces pain scale. A review suggested that age-appropriate self-report tools for pain assessment could elicit meaningful outcomes [37]. Herein, there was a significant difference in mean pain scores on the first and third postoperative days for both groups. However, the mean pain score noted in the physics forceps group was much lower, which could be attributed to the relatively less traumatic extractions performed using the Physics Forceps as the elevation of the mucoperiosteal flap was circumvented. These results are in agreement with those of some previous studies [31,38,39]. Thus, minimally traumatic extractions result in negligible pain in children, which can prevent negative feedback regarding dental treatment, which in turn, may lead to a reduction in subjective dental fear/anxiety in the peer groups.

In terms of the incidence of fractured teeth, the results of the present study revealed a more significant number of fractured teeth in group II where patients were treated using conventional forceps. In group I, the force applied by the bumper of the physics forceps was disseminated over a larger surface area as a compressive force and simultaneously led to creep, allowing the bone to expand slowly and PDL to release. Moreover, there are no squeezing forces applied by the beak to the tooth, which minimizes the fracture incidence [20,24].

Thus, the use of Physics Forceps for extraction of

primary mandibular teeth is faster, more efficient, and less traumatic physically and psychologically for pediatric patients than conventional forceps. However, this study had certain limitations. Physics Forceps is expensive. Moreover, there is a chance of accidental slippage of the tooth after extraction within the oral cavity because there was only one beak coupled with a bumper, which has less retentive capacity. This accidental slipping may increase the chance of aspiration of the extracted tooth. Hence, clinicians should be careful in preventing such adverse events. Further studies involving maxillary teeth are necessary, as this study was confined to mandibular teeth.

Conclusions:

1. The intraoperative time taken for extraction of the primary mandibular teeth using Physics Forceps was less than the time taken for extraction using conventional forceps.
2. Physics Forceps aid in the reduction of anxiety regarding tooth extraction procedures in pediatric patients.
3. Extraction performed with Physics Forceps has a lower incidence of tooth fracture than that when using conventional forceps.
4. Reduction of postoperative pain was significant in both groups, with remarkably lower pain in the Physics Forceps group.

Thus, the use of Physics Forceps can be beneficial in children undergoing extraction, especially at an early age or in their initial visits, as it decreases the anxiety that they may experience during subsequent visits.

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Sujatha Bandi: Data curation, Writing - original draft

Mahesh Nunna: Data curation, Writing - review & editing

Kanamarlapudi Venkata Saikiran: Conceptualization, Writing - review & editing

Varada Sahithi: Formal analysis, Supervision

Sivakumar Nuvvula: Formal analysis, Supervision, Writing - review & editing

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