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The floss lifeline: A novel tethering technique using dental floss to prevent accidental aspiration of endodontic hand files in pediatric patients

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Abstract
Background and Objectives: Accidental aspiration or ingestion of small endodontic instruments, particularly hand files, constitutes a well-documented and potentially life-threatening complication in dental practice. Children undergoing pulpectomy procedures present an exceptionally high-risk population due to their limited cooperation, exaggerated gag reflex, and the inherent difficulty in achieving adequate patient control. This paper describes an innovative, simple preventive technique in which waxed dental floss is tied to the handle of hand files prior to use, creating a reliable safety tether that arrests instrument displacement should accidental drop or release occur.
Technique: A length of waxed dental floss (approximately 25–30 cm) is looped and secured with a surgeon's knot around the neck of the file handle before instrumentation commences. The free end is secured to the hair band placed on child's head by the clinician or assistant throughout the procedure. The technique requires no additional armamentarium, adds minimal procedural time, and is applicable to all ISO-sized stainless steel hand files (K-files, H-files, reamers) used in primary tooth pulpectomy.
Discussion: Current guidelines recommend rubber dam isolation as the primary barrier against instrument aspiration, however, rubber dam placement in uncooperative pediatric patients is frequently impractical. The floss-tethering technique serves as an effective adjunct or substitute in such scenarios, providing a physical safety net without modifying the tactile feedback critical for canal instrumentation.
Conclusion: Dental floss tethering of endodontic hand files is a simple, inexpensive, and readily implementable innovation that may substantially reduce the risk of instrument aspiration and ingestion in pediatric endodontics. Wider adoption and formal prospective evaluation of this technique are recommended.

Keywords: Endodontic hand files, aspiration, ingestion, pediatric dentistry, pulpectomy, safety, dental floss, file retrieval, accidental swallowing

Introduction

Endodontic treatment of primary teeth — commonly performed as pulpectomy — is one of the most frequently executed procedures in pediatric dental practice. The procedure involves the use of small metallic hand instruments, including K-files, H-files, and reamers. Despite their diminutive size, these instruments carry significant morbidity risk if accidentally dropped, swallowed, or aspirated during treatment.

Airway aspiration of endodontic files is an uncommon but serious and well-documented adverse event. Consequences range from transient coughing and airway irritation to bronchial obstruction, pulmonary abscess, and — in extreme cases — death. Ingestion, though less immediately life-threatening, risks gastrointestinal perforation given the sharp, pointed morphology of files. A systematic review identified endodontic hand files as among the most commonly aspirated or ingested dental instruments in reported cases.

Children are disproportionately affected due to several compounding factors: (1) limited cooperation and unpredictable movements, (2) heightened gag reflex, (3) smaller oral cavity providing less spatial control for the operator, (4) frequent mouth breathing resulting in wider pharyngeal aperture, and (5) the inability to comprehend and comply with operator instructions during critical instrument exchange moments.These factors collectively create an environment in which instrument release — and subsequent aspiration — is far more likely than in adult endodontic practice.

The gold standard preventive measure endorsed by endodontic and pediatric dental societies worldwide is rubber dam (RD) isolation, which physically partitions the oral cavity from the oropharynx. However, the practical implementation of rubber dam in uncooperative pediatric patients — particularly those with strong gag reflexes, behavioral challenges, or treated under conscious sedation — is frequently incomplete, premature, or altogether omitted. A survey-based study found that rubber dam usage rates among general dentists performing endodontic procedures on children can be as low as 29–47%, highlighting a significant gap between guideline recommendations and clinical reality. Alternative safety measures described in the literature include the use of gauze throat screens, molar biting blocks, suction systems, and surgical retrieval techniques post-incident. However, none of these provide a proactive, fail-safe mechanism that

directly arrests an instrument at the moment of accidental release.

We describe herein a novel dual-anchor tethering technique in which one end of a length of waxed dental floss is tied to the handle of the endodontic hand file and the other end is secured to the child's own hair band, worn on hair. The hair band serves as a soft, elastic, always-available patient-worn anchor that provides a continuous hands-free safety tether throughout instrumentation. This modification represents a significant practical advance over previously described floss-securing approaches.

Background: Aspiration and Ingestion of Endodontic Instruments

1. Epidemiology

The true incidence of endodontic instrument aspiration and ingestion is likely underestimated due to underreporting. Retrospective analyses of emergency department records and published case series indicate that hand files are among the most commonly aspirated dental instruments. In a landmark review, Susini *et al*. (2007) [1] documented 56 published cases of endodontic instrument aspiration or ingestion, with files constituting the majority of implicated objects. Aspirated files typically lodge in the right main bronchus due to its more vertical anatomical orientation, requiring bronchoscopic retrieval under general anesthesia — a procedure carrying its own morbidity risk including bronchial mucosal trauma, post-obstructive pneumonia, and anesthesia-related complications.

2. Risk Factors in Pediatric Patients

Children present unique anatomical and behavioral risk factors. The proportionally larger tongue-to-oral-cavity ratio in children reduces the operator's working space and increases the probability of instrument contact with posterior oral structures. Sudden movement of the head during file manipulation — a common occurrence in anxious or uncooperative children — can displace an instrument from the operator's fingers with no advance warning. Additionally, pediatric patients are more likely to swallow reflexively in response to pharyngeal stimulation, accelerating instrument transit.

3. Limitations of Current Prevention Strategies

While rubber dam is universally advocated as the gold standard for isolation, its practical challenges in children are well recognized. Studies have reported that around 64 to 80% of children complain of pain and discomfort associated with rubber dam clamp placement, which can cause higher levels of dental anxiety, negatively affect acceptance of treatment, and create challenges in patient behaviour control. The placement of the rubber dam clamp is known to be painful and requires local anesthesia, since clamp placement without anesthesia causes significant discomfort. Ahmad (2009) highlighted that many clinicians cite concerns over patient acceptance, time required for application, and difficulty in use as reasons for inconsistent rubber dam adoption in practice.

The Hair-Band-Anchored Dental Floss Tethering Technique

1. Conceptual Basis

The fundamental principle of this technique is the creation of a dual-anchor tether: the file (proximal anchor) connected by a continuous length of floss to the patient's hair band on the head (distal anchor). This patient-worn anchor system has two critical properties that distinguish it from operator-held system:

- **Patient-movement compliance:** Because the distal anchor is worn on the patient's head, any head or body movement that might otherwise displace a file is automatically accommodated — the tether moves with the patient rather than creating a counter-tension that could dislodge an instrument in situ.
- **Hands-free operation:** Both the operator's hands and patient's remain entirely free for instrumentation, irrigation, and tissue management throughout the procedure, with no requirement for the dental assistant to hold or monitor the tether.

2. Armamentarium

No additional clinical materials are required beyond those normally present:

- Waxed dental floss (any commercially available brand; waxed preferred for tensile strength and reduced fraying)
- Endodontic hand files (K-file, H-file, or reamer of appropriate ISO size)
- The child's own hair band or if not one given by clinician
- Scissors (for measuring and cutting floss lengths pre-procedurally)

3. Step-by-Step Procedure





1. **Pre-procedural Setup:** At the beginning of the appointment, confirm that the child is introduced with the hairband
2. **File Selection:** Select the appropriate ISO-sized hand file for the instrumentation step.
3. **Floss Measurement and Cutting:** Cut a length of waxed dental floss of approximately 20–25 cm. This length is calculated to: (a) allow the operator full range of wrist motion during filing without tension, and (b) ensure the file cannot reach the oropharynx in the event of accidental release.
4. **Tying the File End:** Fold the floss at approximately one-third of its length from one end, creating a loop. Pass the loop around the neck of the file handle — the narrow junction between the plastic handle and the metal shank. Thread the shorter free end through the loop, then secure firmly with a double surgeon's knot. Tug gently to confirm the knot does not slip. The knot must not restrict handle rotation or protrude into the operator's grip area.
5. **Tying the Hair-Band End:** Take the remaining free (longer) end of the floss and loop it twice around the child's hair band. A hair band offers a soft, elastic, circular anchor point that distributes tether tension evenly. Secure with a double surgeon's knot. The elasticity of the hair band naturally cushions any sudden tug, preventing an abrupt jerk on the file during unexpected patient movement.
6. **Tether Verification:** Before intraoral placement, perform a tug test on the assembled tether — pull gently on the file while the hair band remains on head to confirm both knots are secure and the tether holds without slipping. Check that the floss length is appropriate: the file should rest comfortably at the working site.
7. **Intraoral Instrumentation:** Proceed with canal instrumentation in the standard manner. The floss tether trails from the file handle, exits the oral commissure, and runs to the child's wrist. The operator's hands are completely free. The dental assistant is not required to hold or monitor the tether.
8. **Instrument Exchange:** When changing file sizes, withdraw the current file, snip the floss at the file end, and discard the used portion. Pre-tie replacement files before the appointment, or tie a new length of floss to the next file prior to intraoral insertion. The hair-band anchor end may be retained and re-used for successive files, provided the knot remains secure.
9. **Procedure Completion:** At the conclusion of all instrumentation, withdraw the final file while confirming tether integrity. Snip the floss from the hair band.

4. Floss Length Calibration

The recommended 20–25 cm tether length is derived from the typical distance between the child's oral commissure and head in a reclined dental chair position, plus a working allowance of 5 cm to accommodate operator hand movement without creating tether tension. Clinicians treating younger children or those with shorter arms may reduce this length proportionally. The key calibration principle is: tether length must not allow the file to reach the posterior oropharynx (approximately 5–7 cm from the oral commissure in a child) if fully released.

Discussion

1. The Hair Band as an Anchor: Key Advantages

The most clinically significant innovation in the technique described here — relative to other reported file-tethering approaches — is the use of the child's own hair band as the distal anchor. This seemingly simple choice confers several interlocking advantages:

- **Always Available:** Hair bands are worn by the majority of pediatric female patients and as a matter of routine. Unlike bib clips, artery forceps, or suction tubing, no additional preparation or procurement is needed.
- **Zero Additional Cost:** The only consumable cost is the floss
- **Elastic Compliance:** The inherent elasticity of a hair band provides a forgiving, shock-absorbing distal anchor. If the patient moves suddenly, the hair band stretches slightly before transmitting force to the tether, significantly dampening the force transmitted to the file in the canal. This prevents the tether itself from becoming an instrument of iatrogenic canal disruption.
- **Hands-Free for the Operator:** Unlike techniques requiring the non-dominant hand or an assistant to hold the floss, the hair-band anchor frees both the operator's hands entirely. This is particularly valuable during single-handed irrigation, placement of the apex locator probe, or radiographic film positioning.
- **Patient Movement Accommodation:** The wrist naturally follows the child's body during positional shifts in the dental chair. As the anchor travels with the patient rather than remaining stationary, the effective tether length self-adjusts, maintaining appropriate tension without risk of inadvertent file dislodgement from within the canal.
- **Psychologically Gentle:** Children often observe the procedure with curiosity. A tether connected to their own familiar hair band — a personal object — may be

less intimidating than a clinical clip or forceps arrangement, potentially contributing positively to patient cooperation.

2. Clinical and Educational Implications

We recommend that the hair-band-anchored floss tethering technique be formally incorporated into the standard pre-procedural checklist for pediatric pulpectomy, particularly in cases where rubber dam placement is challenging or cannot be completed. Documentation of its use in the clinical record provides medicolegal evidence of enhanced safety precaution and due diligence.

From an educational standpoint, the technique is easily taught, requires no skill acquisition beyond simple knot-tying, and can be introduced as a routine safety habit. Its adoption as standard practice would be a meaningful step toward reducing the preventable adverse event of instrument aspiration in children.

Conclusion

The hair-band-anchored dental floss tethering technique describes a simple, innovative, and highly practical method to prevent accidental aspiration or ingestion of endodontic hand files during pediatric pulpectomy. By tying one end of a measured length of waxed dental floss to the file handle and anchoring the other end to the child's hair band worn, the clinician establishes a continuous, hands-free, patient-worn safety tether that requires no additional armamentarium and imposes no burden on the operator or assistant.

The elastic, compliant nature of the hair band as an anchor point represents a meaningful advance over previously described tethering approaches, offering movement accommodation, shock absorption, and universal availability in the pediatric dental setting. The technique is applicable as a primary safety measure when rubber dam cannot be used, or as an adjunct to rubber dam for double protection.

We advocate for the formal adoption of this technique in pediatric endodontic practice and its inclusion in undergraduate and postgraduate dental curricula. Prospective clinical studies evaluating near-miss incident rates before and after technique adoption would significantly strengthen the evidence base for its universal recommendation.

Declarations

Conflict of Interest: The authors declare no conflict of interest.

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Ethical Approval: Not applicable (technique description). Patient consent was obtained for all clinical observations described herein.

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