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Minimally Invasive Vertical Incision Subperiosteal Tunnelling Technique for Targeted Endodontic Surgery: Technical Overview and a Case Report

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ABSTRACT

Aim: This technical review and case report describes the Minimally Invasive Vertical Incision Subperiosteal Technique (MIVIST) for use in specific targeted endodontic surgical cases.

Summary: The proposed MIVIST technique includes a vertical incision along with auxiliary vertical release incisions to enhance soft tissue healing during targeted endodontic surgery for teeth with small periapical lesions. The technique is described in a case report where a patient presented with persistent periapical periodontitis associated with a previously root canal treated tooth (#15). Based on the preoperative intraoral scan and cone beam computed tomography (CBCT) three-dimensional surgical guides were printed. A vertical main incision and additional release incisions were placed in the buccal mucosa of tooth 15 over healthy bone, with subperiosteal tunnelling then being performed to provide adequate access to the lesion and root apex. A guided osteotomy was carried out using the surgical template, followed by root-end cavity preparation and filling. The patient was followed up over 24 months, when excellent soft tissue healing as well as radiographic healing was apparent.

1 | Introduction

For over a century, single vertical incisions have been used during mucoperiosteal flap elevation in endodontic surgery (Buckley 1911; Weaver 1949). However, this approach is no longer considered best practice for two main reasons: first, the limited flap reflection that results restricts access to larger lesions; and second, there is a heightened risk of post-operative infection in the periapical region (Setzer and Kratchman 2022). In contrast, a more recent technique—Vertical Incision Subperiosteal Tunnelling Access (VISTA)—has been gaining traction in the treatment of gingival recession, offering a minimally invasive alternative approach (Zadeh 2011; Sabri et al. 2023).

Currently, most flap designs employed in endodontic surgery incorporate either sulcular or submarginal incisions, often accompanied by vertical releasing incisions. Sulcular incisions are generally favoured for their association with minimal post-operative infection and favourable healing outcomes (Gutmann and Harrison 1991). However, when the gingival tissue is poorly keratinized, this approach may result in undesirable outcomes such as gingival recession and damage to the interdental papillae (Velvart 2002; Velvart et al. 2004). Submarginal incisions, on the other hand, have been shown to promote precise flap repositioning and effective wound closure; yet, they may contribute to scar formation, particularly when the width of attached gingiva is limited (Kramper et al. 1984).

The VISTA technique is based on principles from plastic surgery, with a focus on minimal invasiveness and the preservation of vascular integrity. The VISTA technique was first used in periodontal surgery for root coverage and has demonstrated more rapid healing and enhanced aesthetic results (Zadeh 2011). By placing a small, remote incision in the muco-buccal fold, this method allows for greater flap mobility with reduced tension, which significantly contributes to its effectiveness. Successful root coverage with VISTA was observed in 88% of patients in comparison to traditional surgical methods (Sabri et al. 2023).

The evolution of targeted endodontic microsurgery (EMS) has been rapid due to the development of new imaging technologies and software, especially the use of static surgical guides. Guided endodontic techniques offer numerous benefits, such as minimised trauma to adjacent vital structures, more conservative osteotomy techniques, and precise root-end resections. These methods are particularly advantageous for patients with thick buccal cortical plates (Benjamin et al. 2021; Ahn et al. 2018). Despite these advantages, conventional flap elevation remains the standard in most microsurgical procedures (Benjamin et al. 2021; Zhao et al. 2023; Ye et al. 2018). Recently, several case series have demonstrated the benefits of 3D templates when making small non-invasive incisions for targeted endodontic microsurgery to complement static and dynamic navigation (Popowicz et al. 2019; Guan et al. 2025). However, it should be acknowledged that small vertical incisions may create tension on tissues during the clinical procedure.

The purpose of this technical review and case report is to describe a minimal incision technique, utilising the concepts of VISTA, with additional auxiliary release incisions in specific targeted endodontic surgical cases.

2 | Steps for the Minimally Invasive Vertical Incision Subperiosteal Tunnel (MIVIST) Technique With Additional Auxiliary Release Incisions

The primary goal for MIVIST is to facilitate the placement of surgical guides in the periapical region, thereby minimising mucosal tissue damage. Additionally, it can be effectively applied in conventional endodontic surgery (without the use of 3D guides) for small periapical lesions. The technique is particularly beneficial for both maxillary and mandibular anterior and posterior teeth, especially when flap elevation is challenging.

- *Digital planning with cone beam computed tomography (CBCT) evaluation and the creation of surgical templates*

Surgical guides can be designed and machined as described previously (Iqbal et al. 2023). In brief, a defined preoperative planning protocol with CBCT and intraoral scan is essential. Limited Field of Vision (FOV) CBCT imaging with minimal voxel size (typically between 75 and 150 μm) of the teeth as well as an intraoral scan is performed to capture STL or PLY files. These data are then aligned with the DICOM data obtained from the CBCT scan. This registration or 'matching' process is crucial, as any misalignment will compromise the accuracy of the surgical guide. Advanced tools within the software allow for fine adjustments to optimise the overlay of anatomical landmarks. After alignment validation, virtual planning of the osteotomy trajectory based on the anatomical constraints and the desired surgical access is planned. Subsequently, the guide is digitally designed to conform with the patient's anatomy, incorporating channels or sleeves to direct instruments precisely.

The CAM (Computer-Aided Manufacturing) phase follows, where the final guide design is exported as an STL file and fabricated using 3D printing technology, typically with biocompatible resins. After printing, the guide undergoes post-processing, including cleaning, post-curing and verification for passive fit.

- *Planning for vertical incision placement*

The surgical procedure starts with topographical mapping to identify the optimal location for the vertical incision. This incision should be made over healthy bone, approximately 3 mm from the edge of the planned bone window and should be made sufficiently deep and wide to allow an adequate access margin for the subperiosteal tunnel, thereby preventing soft tissue tearing.

- *Vertical incision, tunnelling of flap and placement of auxiliary release incisions*

A vertical incision through the periosteum is made using a No. 15C scalpel blade or a microsurgical blade (Figure 1a). Subperiosteal tunnelling is then performed by inserting an elevator between the periosteum and the bone through the vertical incision, allowing for full-thickness tissue elevation. Fine periosteal elevators, such as the Hourigan (Medesy, Maniago, Italy) and papilla elevators, are preferred for this tunnelling technique. The length of the incision is determined by the location of the periapical lesion, but caution must always be exercised to avoid damaging the base of the papilla (Figure 1b). It is important to ensure that the surgical flap provides adequate access and visibility to the area of interest while maintaining the integrity of the surrounding soft tissue. In addition, two auxiliary incisions 3–4 mm in length through the full thickness up to the periosteum are made using a microsurgical 15C blade, which permits sufficient periosteal release and facilitates effective saline irrigation throughout the surgical site.

- *Surgical guide placement and osteotomy*

The sterilised surgical guide is introduced through the vertical incision. Osteotomy is then carried out using either a trephine or a piezoelectric insert, depending on the clinician's preference and the quality of the bone. A bone window is created approximately 3 mm from the lower border of the incision to provide access to the periapical area. Once the osteotomy is complete, the surgical template is removed. Apical root resection is then performed, followed by root-end cavity preparation and filling with a suitable biocompatible material.

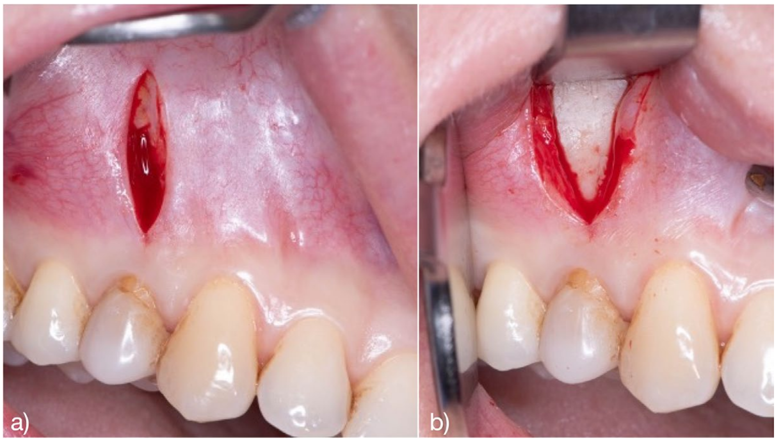

FIGURE 1 | Demonstration of placing a vertical incision in a case not detailed in the manuscript. (a) The incision length depends on the position of the periapical lesion, with care being taken to preserve the base of the papilla. (b) The surgical flap must allow sufficient access and visibility to the target area while preserving the integrity of the adjacent soft tissues.

- *Suturing*

The simple continuous suturing technique is preferred, using either resorbable or non-resorbable 5-0, 6-0, or 7-0 sutures, based on the clinician's preference and the required tissue response.

3 | Case Report

The PRICE 2020 guidelines were followed during the reporting of this case and the technical review (Nagendrababu et al. 2020) (Figure S1).

A 42-year-old male patient reported to a private dental clinic with the chief complaint of discomfort and pain in a previously root canal treated maxillary right second premolar (FDI tooth no. 15). Clinically, the tooth was restored and tender to percussion, and radiographic examination revealed the presence of a periapical radiolucency (Figure 2a,b). A diagnosis of previously root canal treated tooth with symptomatic apical periodontitis was made.

Tooth 15 had been restored with a fibre post and a full coverage crown; thus, a treatment plan involving targeted endodontic surgery aided by a 3D-printed surgical guide was proposed and accepted by the patient. A digital intraoral scan of the maxillary arch was obtained (Trios 3; 3Shape Dental Systems, Copenhagen, Denmark), and the data were saved in an STL format. CBCT imaging was performed using a ProMax 3D Mid unit (Planmeca Oy, Helsinki, Finland) with a minimum field of view (FOV) of 5 × 5 cm, operating at 90 kV and 10 mA, with a voxel size of 150 μm and an exposure time of approximately 12 s. STL data were superimposed with the DICOM files for integrated 3D planning.

The Digital Imaging and Communications in Medicine (DICOM) files from Cone-Beam Computed Tomography (CBCT) were transferred to specialised surgical planning software (Blue Sky Plan; Blue Sky Bio LLC, Libertyville, IL, USA). The lesion measured approximately 4 mm in diameter, and the distance from the lesion to the maxillary sinus floor was 2 mm, parameters that were essential for osteotomy planning and risk management (Figure 2c).

The surgical guide for the osteotomy was designed and printed using a biocompatible resin (NextDent SG; 3D Systems, Rock Hill, SC, USA) with a Digital Light Processing (DLP) printer (Figure 2c) (NextDent 5100; 3D Systems).

Before surgery, the site was disinfected with 0.12% chlorhexidine gluconate. Local anaesthesia was administered via buccal infiltration using 4% articaine with 1:100 000 epinephrine (Septodont, Saint-Maur-des-Fossés, France). The surgical guide was placed intraorally and verified for accuracy and fit (Figure 2d). A minimally invasive vertical incision was made in the muco-buccal fold adjacent to tooth 15 using a no. 15 surgical scalpel blade. The incision was made over sound bone approximately 3–4 mm away and below the planned bony window and was carried out down to the periosteum. In addition, two precise and minimally traumatic auxiliary incisions were prepared using a microsurgical 15C blade with a depth of approximately 3–4 mm, extending through the full thickness of the periosteum. The two auxiliary incisions were positioned approximately 2–3 mm mesial and distal to the main vertical incision. A full-thickness subperiosteal tunnel was then created using Hourigan and papilla elevators (Medesy, Maniago, Italy), allowing for at least 7 mm of working access. Haemostasis was achieved with aluminium chloride gel (Ultradent Products Inc., South Jordan, UT, USA), and a clean cortical bone surface was exposed. The surgical template was positioned (Figure 2e) and an initial 3 mm osteotomy was performed using a long-shank, round carbide surgical bur (H162 Lindemann Bur; Komet Dental, Lemgo, Germany) under copious irrigation at 40 000 rpm. The osteotomy window was subsequently enlarged to approximately 5 mm using a diamond-coated surgical bone bur (Meisinger HM 141A; Meisinger, Neuss, Germany) to allow direct visualisation of the root apex of tooth 15. Granulomatous tissue was curetted using Lucas curettes (Hu-Friedy, Chicago, IL, USA), and apical resection was performed. Root-end cavity preparation was achieved with ultrasonic tips (ET20D; Satelec, Acteon Group, Mérignac, France) under copious irrigation with sterile saline. Biodentine (Septodont, Saint-Maur-des-Fossés, France) was used to fill the

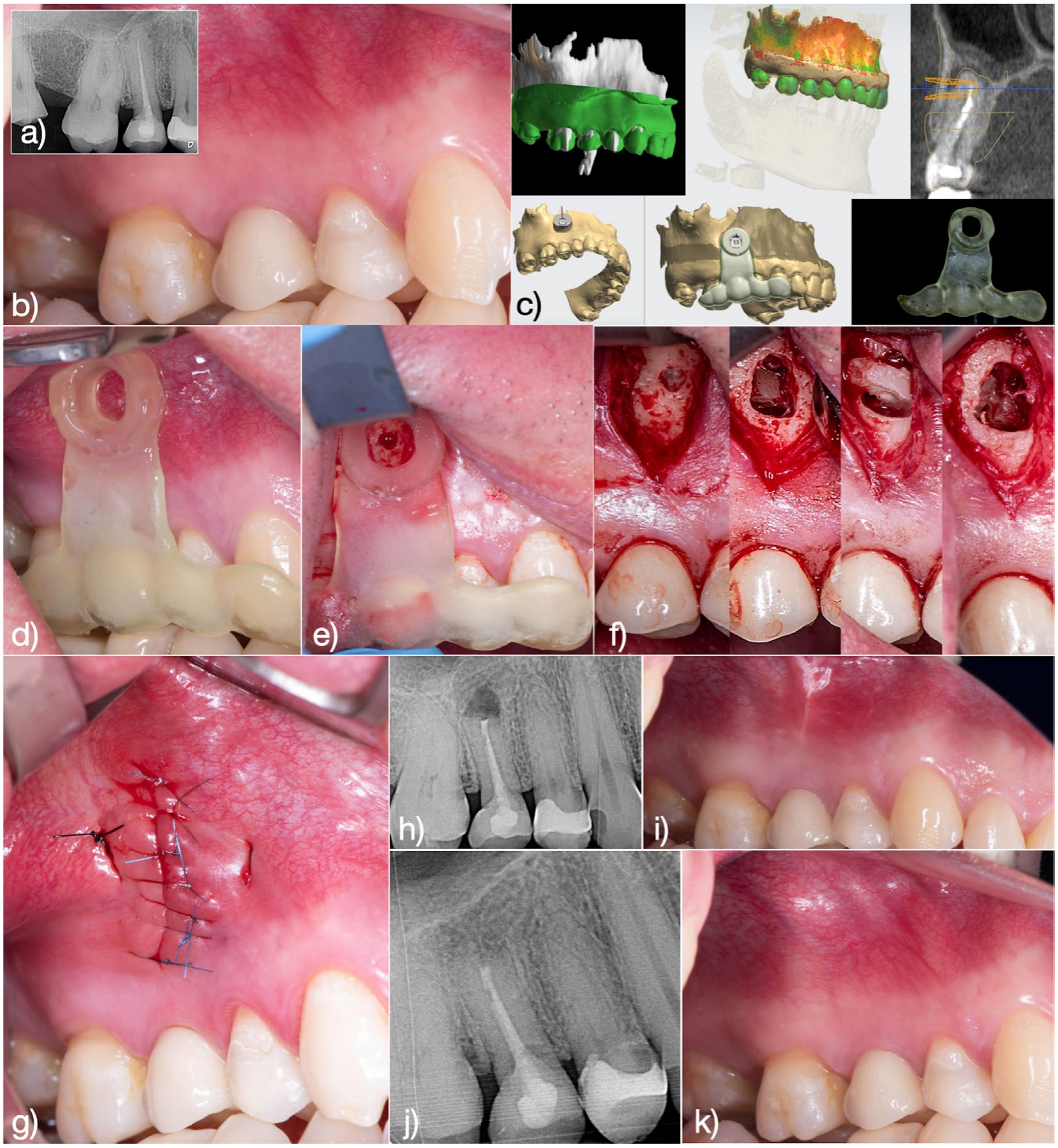

FIGURE 2 | (a) Initial preoperative periapical radiograph showing the root filled maxillary right second premolar (tooth 15), with an associated periapical lesion and fibre post, (b) Initial clinical view showing acceptable crown adaptation, (c) CAD-CAM process for manufacturing the surgical guide, (d) preoperative try-in of the static surgical guide to verify its stability and fit, (e) placement of the surgical guide after performing the MIVIST incision, (f) sequence of images showing the progress of the endodontic surgery under magnification. Note the minimal trauma to the adjacent soft tissues, (g) flap closure with simple interrupted sutures also depicting the closure of two auxiliary release incisions made adjacent to the main vertical incision, (h) periapical radiograph immediately after root-end filling, (i) appearance of the soft tissues at 2 months, (j, k) two years postoperatively, the surgical site has excellent periodontal health with no signs of scar formation or gingival recession. Radiographically, the periapical area appears to have healed completely.

root-end cavity (Figure 2f). The flap was repositioned and closed with a simple continuous suture technique using non-resorbable 6-0 polypropylene sutures (Figure 2g) (Prolene; Ethicon, Somerville, NJ, USA). A periapical radiograph was taken immediately after placing the root-end filling material (Figure 2h). Post-operative instructions were provided, and healing was uneventful. A course of Amoxycillin and analgesics was prescribed for 4 days, and the patient was recalled for review after 7 days. The suture was removed after 7 days, based on soft tissue healing observations and standard practice.

The patient was reviewed at 2 weeks post-operatively and then every 6 months for 2 years. Clinically, the patient was asymptomatic with no associated pain, swelling or periodontal problems, and the surgical site had excellent healing with no signs of scar formation or gingival recession. Radiographically, the periapical area revealed new bone formation with no associated radiolucency or marginal periodontal bone loss (Figure 2i–k).

4 | Discussion

The pooled success rate of modern endodontic surgery with the aid of magnification has been reported to range between 92% and 94% (Setzer et al. 2010). However, free-hand EMS is challenging in critical areas such as near the maxillary sinus and mental foramen as well as at sites with difficult access (Floratos and Kim 2017). The development of CBCT and CADCAM facilitates targeted EMS, allowing for the execution of very precise procedures even in difficult clinical scenarios (Benjamin et al. 2021). Guided EMS utilises either a static or dynamic guide for osteotomy and root-end resection procedures. Utilising a 3D static guide reduces surgery time, allows customised osteotomy sizes using trephine burs, which, along with control over the root resection (level and bevel), enhances the accuracy and efficiency of targeted EMS with minimal complications (Ha et al. 2025). Static guides assist during the osteotomy phase using piezoelectric devices, combining the benefits of guided navigation and ultrasonic bone cutting to minimise trauma to surrounding tissues (Kim et al. 2020; Lee et al. 2020). The deviation of bone drilling without surgical guides has been reported to be 2 mm 70% of the time in comparison to drilling using surgical guides (0.79 mm) (Pinsky et al. 2007).

In the current case, persistent apical periodontitis after root canal treatment was treated with EMS rather than an orthograde retreatment approach. The removal of a crown and fibre post presents technical challenges and potentially weakens the remaining tooth structure. In these clinical scenarios, microsurgery has been suggested as a dependable alternative treatment option to root canal retreatment. This approach has been reported to be associated with approximately 98% radiological healing after 5 years (Truschnegg et al. 2020).

In endodontic surgery, there is a positive correlation between the healing of the reflected soft tissue flap and periapical bone healing (Ng and Gulabivala 2023). Currently, full mucoperiosteal flaps are elevated for targeted EMS; thus, minimal tissue damage along with minimal and precise osteotomy using guides can enhance the healing of the surgical site. Sufficient access to the surgical site as well as adequate wound closure is essential for preventing infection and primary healing. This is influenced by gingival and soft tissue management during the surgical procedure. Gingival margin level, periodontal pocket depth (Velvart 2002), crestal bone loss and width of keratinised tissue are some of the parameters that are used to assess soft tissue healing postoperatively. A recent meta-analysis concluded that among the intrasulcular, sub-marginal and papilla-based incisions, the latter ranked first with minimal gingival recession (Castro-Calderón et al. 2021). However, papilla-based incisions, which result in less scarring, are technique sensitive and require careful planning (Kirkevang et al. 2018). The presence of a fibre post and full-coverage crown often complicates root canal retreatment due to the technical difficulty of post removal and the potential risk of compromising the remaining tooth structure (Ng and Gulabivala 2023). In such cases, a surgical approach may offer a more predictable and conservative alternative. While the MIVIST technique presents advantages in terms of soft tissue preservation and minimal invasiveness, the decision to proceed surgically was primarily influenced by the prosthetic and restorative constraints, rather than being dependent on the surgical technique itself. The use of MIVIST in this context aimed to optimise surgical access and healing outcomes, along with the impact of other factors such as the limited keratinised gingiva and the thick buccal cortical plate. In the proposed MIVIST technique, the minimally invasive incision promotes optimal soft tissue healing, ultimately improving the clinical outcome of the surgical procedure. The MIVIST technique is particularly beneficial in areas that are difficult to access and in cases with thick cortical plates, such as mandibular molars. The MIVIST approach is indicated in situations where periapical lesions are ≤ 5 mm in diameter, particularly when a 3D-printed guide is used. These conditions allow for precise and conservative access. Hence, the MIVIST technique is not recommended in the presence of large bony defects (> 5 mm) where full access is required. A systematic review reported that smaller periapical lesions (< 5 mm) measured on periapical radiographs are associated with better clinical outcomes in comparison to those of larger lesions (> 5 mm) (Sabeti et al. 2023). Thus, we propose that smaller periapical lesions and adequate bone height when combined with the minimal incision will enhance periapical healing following endodontic microsurgery.

In the current case report, two additional auxiliary incisions were placed strategically mesial and distal to the main vertical incision to allow sufficient periosteal release to facilitate effective saline irrigation throughout the surgical site. By creating additional entry points, these small incisions improve the distribution and outflow of irrigating solutions, helping to flush the surgical site, reduce intraoperative heat and maintain a clear visual field during osteotomy and root-end cavity preparation. It is worth noting that the bone window in the present case was small and confined, and the overlying soft tissue remained intact. Consequently, regenerative materials were not considered necessary. Nevertheless, the utilisation of membranes or grafts may prove advantageous in instances of larger defects.

The concept of using static guided minimal straight incision for micro endodontic surgery was initially proposed by Popowicz et al. (2019) in patients with previously root canal treated teeth with symptomatic apical periodontitis. A case series has demonstrated that this incision is associated with accurate bone removal and root-end resection as well as enhanced healing outcomes (Guan et al. 2025). However, the previous guided surgical approaches for minimal incision describe the 3D surgical guide (3DSG) being used to directly mark the incision line on the mucosa. The vertical incision line is marked using a dental probe and double-pinched with the surgical stent in place or the static guide was used to mark the labial mucosa at the apex (Popowicz et al. 2019; Guan et al. 2025). The uniqueness of the proposed MIVIST technique relies on pre-calculating the precise position from CBCT scans and making the incision based on digital planning prior to placement of the guide. Since the need for printed guides for placement of the main vertical or the additional release incisions is not essential during the MIVIST technique, the use of this minimal invasive technique can be effective in regular microendodontic surgery with smaller periapical lesions without the surgical templates.

The proposed MIVIST offers a variety of advantages, including the preservation of the papilla and marginal gingiva, reduced scar formation, improved aesthetic outcomes, tension-free flap closure and reduced risk of gingival recession. The limitations of the MIVIST procedure are that it is inappropriate for situations with larger bony lesions (> 5 mm) or apico-marginal defects (buccal marginal height > 3 mm). Performing apical surgery within a confined space requires careful planning and experience. Additionally, the quality of suturing is critical to ensure primary healing. Precise approximation of the flap margins is essential, as any gap or tension in the wound closure may result in healing by secondary intention. Long-term clinical studies and randomised trials are necessary to confirm whether the MIVIST technique offers distinct advantages over conventional surgical approaches.

5 | Conclusion

The MIVIST procedure along with the auxiliary release incisions is a promising minimally invasive technique for targeted endodontic surgery, as it results in minimal tissue damage and promotes soft tissue healing. Its use has the potential to improve patient outcomes and lead to a greater acceptance of minimally invasive endodontic approaches. However, to verify the effectiveness of the MIVIST technique, long-term clinical studies are necessary.

Author Contributions

Francesc Abella Sans: conceptualization, writing – original draft, writing – review and editing. **Jaime Barragán Montes:** conceptualization, writing – original draft, writing – review and editing. **Tomasz Zbozen:** conceptualization, writing – original draft, writing – review and editing. **Nandini Suresh:** conceptualization, writing – original draft, writing – review and editing. **Lalli Dharmarajan:** conceptualization, writing – original draft, writing – review and editing. **Paul M. H. Dummer:** conceptualization, writing – original draft, writing – review and editing. **Venkateshbabu Nagendrababu:** conceptualization, writing – original draft, writing – review and editing.

Ethics Statement

The authors have nothing to report.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section. **Figure S1:** iej70014-sup-0001-FigureS1.docx.