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Minimally Invasive Single-Step Computer-Guided Endodontic Microsurgery: A Case Report

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Abstract

A major challenge in daily endodontic practice is when conventional treatment fails, and the endodontist has to shifts for surgery. Endodontic surgery entails precisely locating the root-end, this is challenging in cases with closed lesions, and high risk with cases having proximity to vital structures such as maxillary sinus or mental foramen, Cases with deeply seated palatal roots that require access from labial surface also represent a major challenge. Additionally, minimizing the osteotomy size has been correlated with a favorable postoperative course. Hence, a technique that involves osteotomy and root resection in a single step using a trephine bur through a three-dimensionally printed surgical guide is of great promise to minimize vital tissue injury, shorten the procedural time, minimizing bone removal and providing rapid as well as better healing. Here, that technique was successfully used on a patient reporting severe pain on percussion after failed conventional root canal treatment of an upper premolar, where radiographic examination showed transportation and apical perforation in the palatal root. The case was failed to be managed conventionally to negotiate the apical part of the canal. Endodontic surgery was planned where only the palatal root-end was resected through a buccal approach to avoid compromising the tooth support by resecting both roots. Postoperative cone beam computed tomography confirmed the successful surgery and the appropriate planning. The surgical guide was able to accurately transfer the virtual plan to the operation theatre. It is therefore shown that endosurgery in critical areas can be accurately accomplished using targeted endodontics.

Keywords: Image guided surgery, minimally invasive surgical procedures, endodontics, and microsurgery.

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1. Introduction

Modern technology including magnification, illumination, micro instruments, and Cone beam computed tomography (CBCT) has increased the precision of planning and performing endodontic surgery introducing the shift from traditional endosurgery to endodontic microsurgery (EMS) [1-3]. Cone-beam computed tomographic (CBCT) imaging provides increased visualization of tooth morphology, root and bone re sorption and visualization of the surrounding anatomic structures [4]. However, endodontic microsurgery carries a great risk of injury to surrounding vital structures, irrational excessive bone removal, and it requires a highly experienced operator [5]. Therefore, the computer guided approach is a more conservative approach that should overcome and minimize the risks encountered in traditional endodontic surgeries [6]. CBCT-derived Digital Imaging and Communications in Medicine (DICOM) files converted into stereo lithography files have long been used in the production of 3-dimensional–printed surgical guides (3DSGs) for implant placement [7]. Previous literature documents the applications of 3-dimensional (3D) printing in endodontics such as endodontic access guides, surgical soft tissue retraction, and localization of the osteotomy perforation site [8-10]. However, the precision, accuracy and usefulness in preoperatively designed guides has yet to be fully developed and implemented in endodontic surgeries [11]. Trephine burs have been used for the removal of failed implants and autogenously bone graft harvesting but have been lately introduced to EMS [10]. Targeted EMS can therefore be used to perform a single-step osteotomy; root-end resection; and biopsy with a defined perforation site, angulation, depth, and diameter. Previous reports have used 3DSGs to locate an

ideal bone perforation site [8]. In this case, a trephine bur was used through a 3DSG to specifically target the palatal root tip from a buccal approach, sparing unnecessary trauma to the buccal root, and the maxillary sinus.

2. Case report

Obtained, a CBCT was performed and showed an S-shaped curvature of the palatal root with an apical radiolucency related to the same root. Also showed a perforation as a result of the first attempt of treatment at a level of 3.5 mm from the apex (Figure 1). The original path of the canal wasn't possible to negotiate conventionally under magnification because of the large perforation. Therefore, apical surgery was the treatment of choice. Due to the tooth angulation, normal root resection through a buccal approach at the level of perforation of the palatal root would have been destructive to the buccal root and would compromise the crown root ratio, which consequently would affect the prognosis and the survival of such a case.

Therefore, a virtual plan to target only the palatal root and spare the buccal root was performed using Mimics Medical 19.0 software (Materialise NV, Technologielaan 15, and 3001 Leuven, Belgium) (Figure 2). Following 3D printing of the surgical guide, its seating and stability were checked at first both on the cast and intraoral. Local anesthesia was administrated, and a modified flap design ware performed that included only a single vertical incision. The guide was seated, and a trephine bur with 4 mm outer diameter was used for single step osteotomy and root resection through the guide, with the guide controlling the site, angulation and depth of the osteotomy. The retro cavity

A 40 years old female medically free patient was referred after a failed trial by a general practitioner to perform conventional root canal treatment in upper first premolar three weeks prior. Clinical examination showed sever pain on the percussion and the tooth was tender to touch. After an informed valid consent for the further investigations was
was then prepared using ultrasonic tip and filled with well-root PT under high power magnification. The cavity was then flushed with saline, and the flap was sutured (Figure 3). For evaluation, a postoperative CBCT was taken for the patient on the second postoperative day. This was used to visualize the results of the operation and confirm proper resection of the palatal root tip was performed (Figure 4).

3. Discussion

Various research has proved the higher success rates of microsurgical procedures over traditional ones. However, limited data in the literature concentrated on the use of modern technology in root localization and resection [3-12]. Few available studies agreed on the efficiency of guided endodontic microsurgery [8-10-11-13]. In this case the root was resected successfully with no injury to the buccal root, or the adjacent teeth and no other complications were recorded, the time of the surgical procedure was minimized. In addition, the modified flap design offered a recession free surgical procedure that can be of benefit mainly in esthetic zone. This technique illustrated the clinical simplicity and merit of targeted endodontic microsurgery that can be used in the treatment of anatomically complex scenarios involving the maxillary sinus, greater palatine artery, posterior dental arch location, mental nerve, and fused roots [14-17].

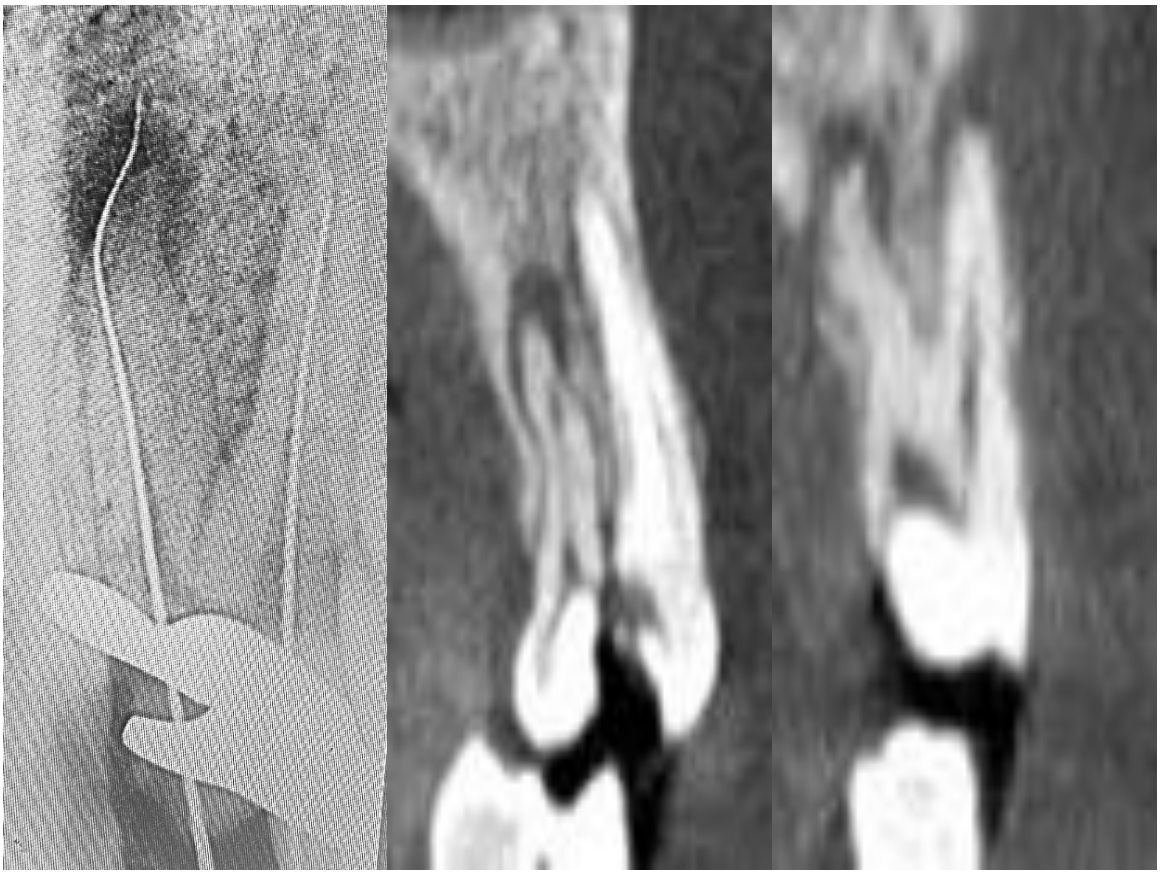


Figure 1: Pre-treatment, A) perforation of palatal root. B&C) CBCT showing root curvature and periapical lesion.

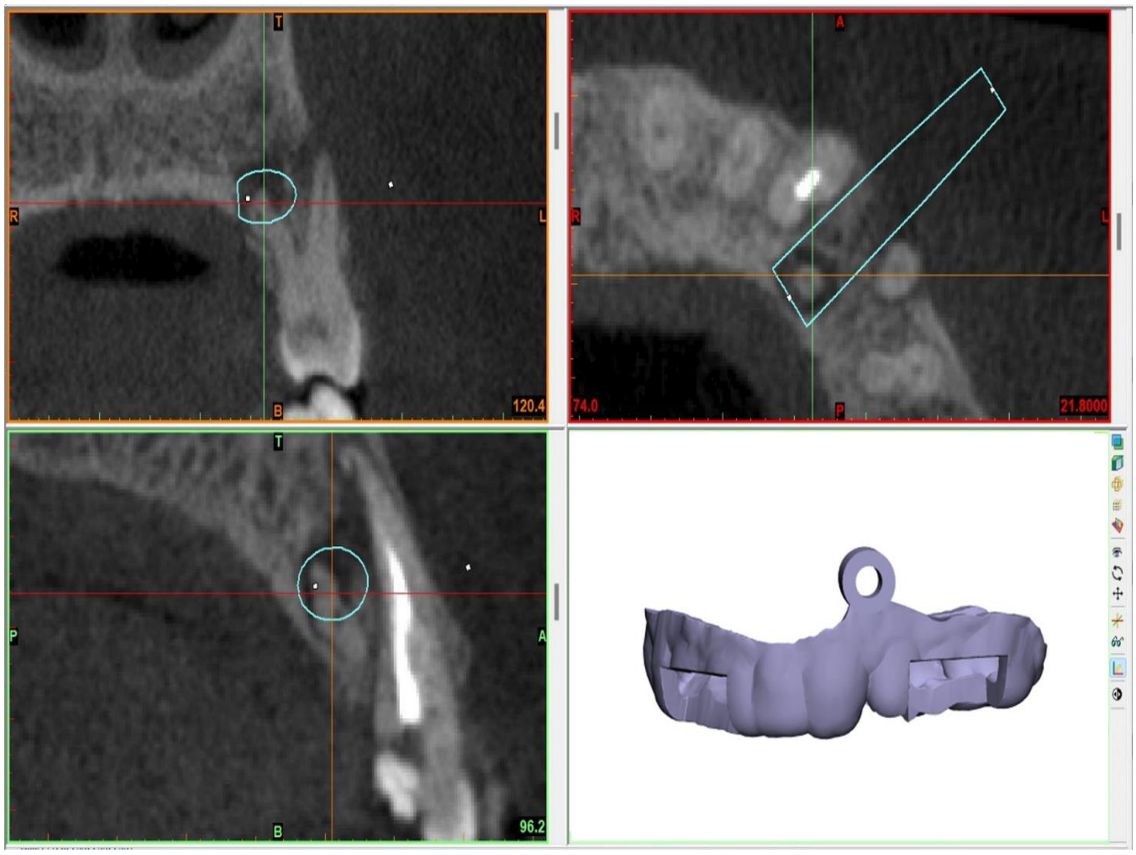
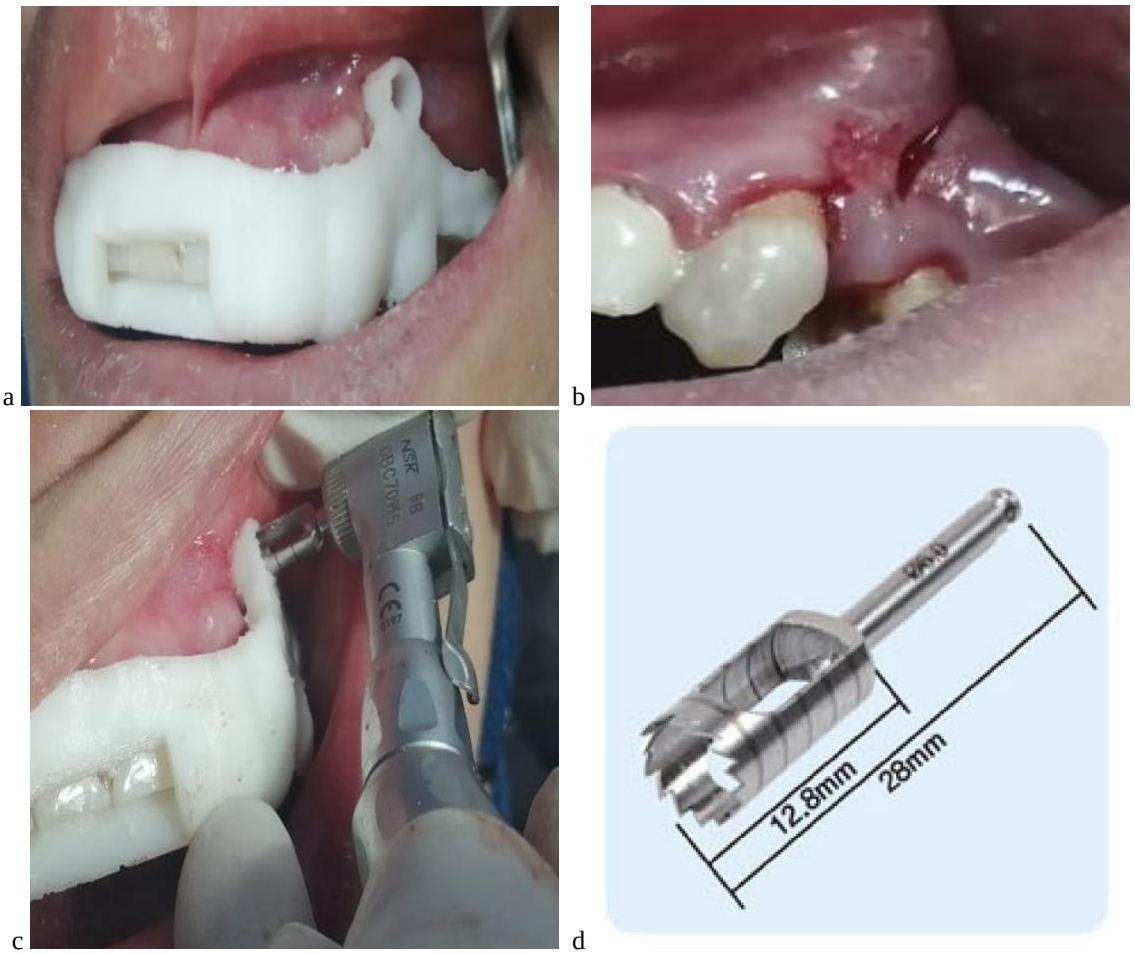


Figure 2: Design of Surgical guide with trephine bur's path targeting palatal root tip while sparing buccal root tip



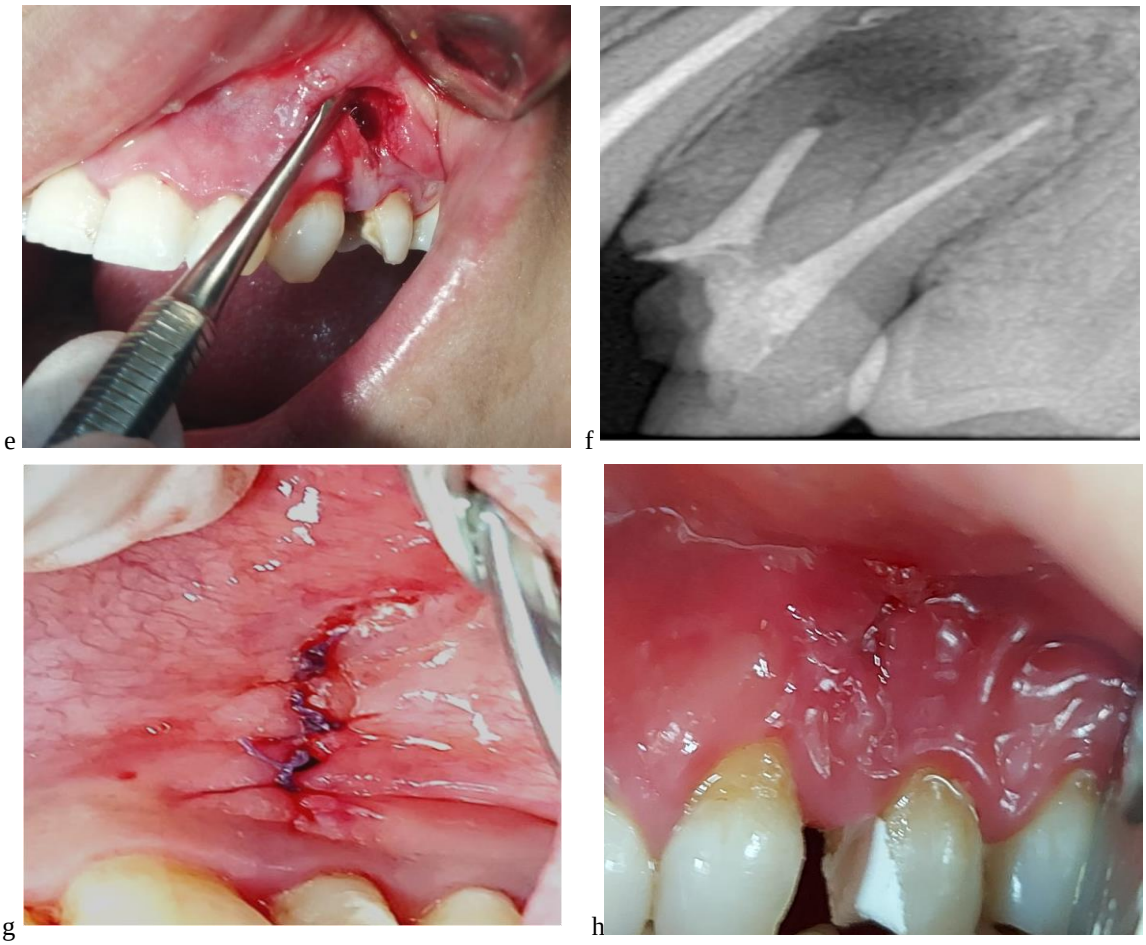


Figure 3: Intra-treatment Surgical procedure, a) check guide stability intraoral and mark site of incision, b) vertical incision, c) Single step osteotomy and root resection, d)trephine bur, e) Retro cavity through the osteotomy, f) radiograph to check the retro cavity preparation, g) suturing, h) after suture removal.

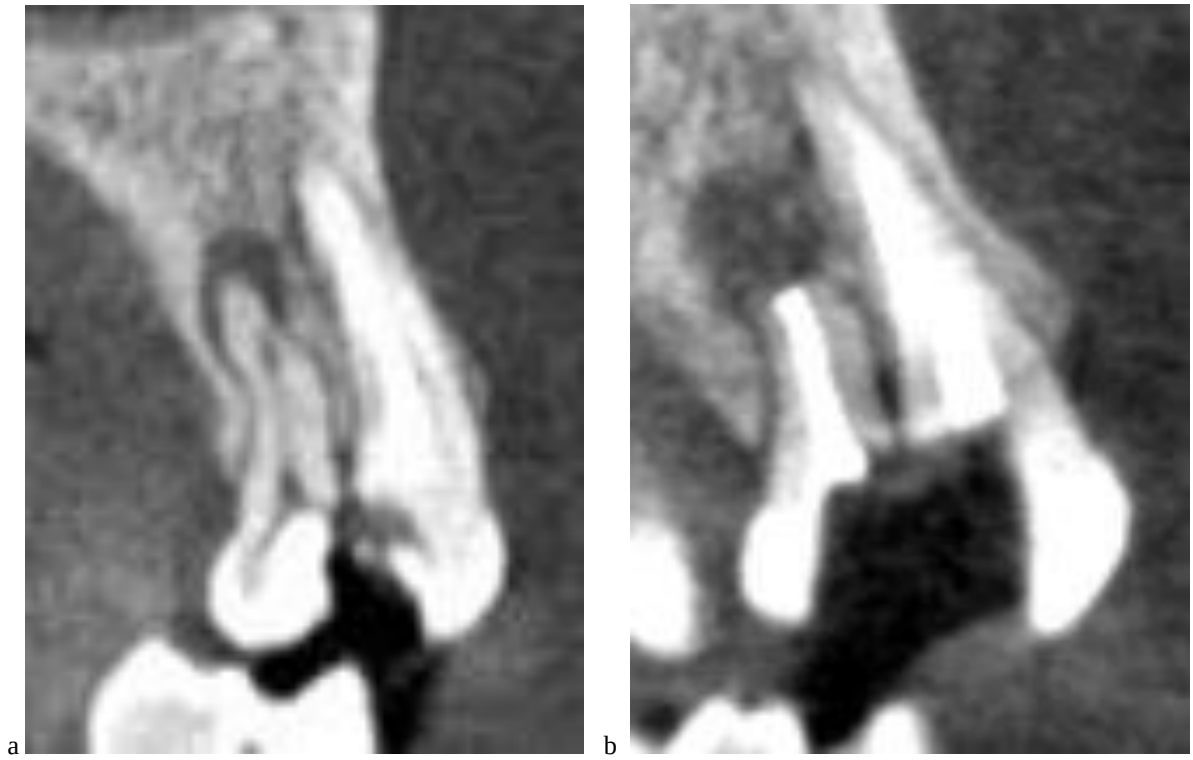


Figure 4: a) preoperative CBCT b) Post-operative CBCT

4. Conclusions

It can be concluded that targeted endodontic microsurgery is a promising, accurate and efficient way for treatment of difficult cases.

Disclosure

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