# Applications of Piezoelectric Surgery in Endodontic Surgery: A Literature Review

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## Abstract

**Introduction:** Piezosurgery (piezoelectric bone surgery) devices were developed to cut bone atraumatically using ultrasonic vibrations and to provide an alternative to the mechanical and electrical instruments used in conventional oral surgery. Indications for piezosurgery are increasing in oral and maxillofacial surgery, as in other disciplines, such as endodontic surgery. Key features of piezosurgery instruments include their ability to selectively cut bone without damaging adjacent soft tissue, to provide a clear operative field, and to cut without generating heat. Although piezosurgery instruments can be used at most stages of endodontic surgery (osteotomy, root-end resection, and root-end preparation), no published data are available on the effect of piezosurgery on the outcomes of endodontic surgery. To our knowledge, no study has evaluated the effect of piezosurgery on root-end resection, and only 1 has investigated root-end morphology after retrograde cavity preparation using piezosurgery. **Methods:** We conducted a search of the PubMed and Cochrane databases using appropriate terms and keywords related to the use and applications of piezoelectric surgery in endodontic surgery. A hand search also was conducted of issues published in the preceding 2 years of several journals. Two independent reviewers obtained and analyzed the full texts of the selected articles. **Results:** A total of 121 articles published between January 2000 and December 2013 were identified. This review summarizes the operating principles of piezoelectric devices and outlines the applications of piezosurgery in endodontic surgery using clinical examples. **Conclusions:** Piezosurgery is a promising technical modality with applications in several aspects of endodontic surgery, but further studies are necessary to determine the influence of piezosurgery on root-end resection and root-end preparation. *(J Endod 2014;40:325–332)*

## Key Words

Apical surgery, cone-beam computed tomography imaging, endodontic surgery, piezoelectric device, piezosurgery

One goal of endodontic surgery is to treat apical periodontitis in cases in which healing has not occurred after nonsurgical retreatment or, in certain instances, after primary root canal therapy (1). Such cases include patients with persistent or refractory intracanal infection after iatrogenic changes to canal anatomy (2) or those with microorganisms in proximity to the constriction (3) and apical foramen (4). Other indications include extraradicular infections, such as the presence of bacterial plaque on the apical root surface (5) or bacteria within the lesion itself (6).

The outcome of endodontic surgery for periapical lesions depends on several factors. Modern surgical endodontic treatment involves the use of a magnification device, such as a dental operative microscope. This enables precision, with no or minimal bevel or root-end resection and retrograde canal preparation to a depth of 3–4 mm using an ultrasonic tip (7). Advantages of modern surgical endodontic treatment include easier identification of root apices; smaller osteotomies; and shallower resection angles, which preserve cortical bone and root length (8). The modern technique shows a much higher success rate than the traditional technique (9). Recently, Tsesis et al (10) reported that modern surgical endodontic treatment yields a successful outcome rate of 89%.

The introduction of cone-beam computed tomography (CBCT) scanning is particularly useful for both diagnosis and treatment planning (11) (Fig. 1*A–N*). Figure 1 shows the benefits of the use of CBCT imaging during endodontic surgery including elimination of the superimposition of anatomic structures, such as the zygomatic buttress, alveolar bone, maxillary sinus, and other roots (12), and early detection of the presence and dimensions of apical lesions and changes in apical bone density (13, 14). CBCT imaging also provides clinicians with a clear view of the anatomic relationship between root apices and neighboring structures, such as the mandibular canal (15), mental foramen, and maxillary sinus (16, 17). Furthermore, CBCT scanning establishes where access osteotomies can be performed, enabling minimally invasive surgery. Finally, in 70% of patients, CBCT scanning reveals clinically relevant information not identified by periapical radiography (13).

Although many published studies advocate the use of modern approaches, limited information is available on the applications of piezosurgery (piezoelectric bone surgery) in endodontic surgery. The introduction of piezoelectric instruments that vibrate within the ultrasonic frequency range represents a major advance in oral surgery (18). Piezosurgery is a meticulous and soft tissue–sparing system for bone cutting based on ultrasonic microvibrations. The first piezoelectric device is still being devel-

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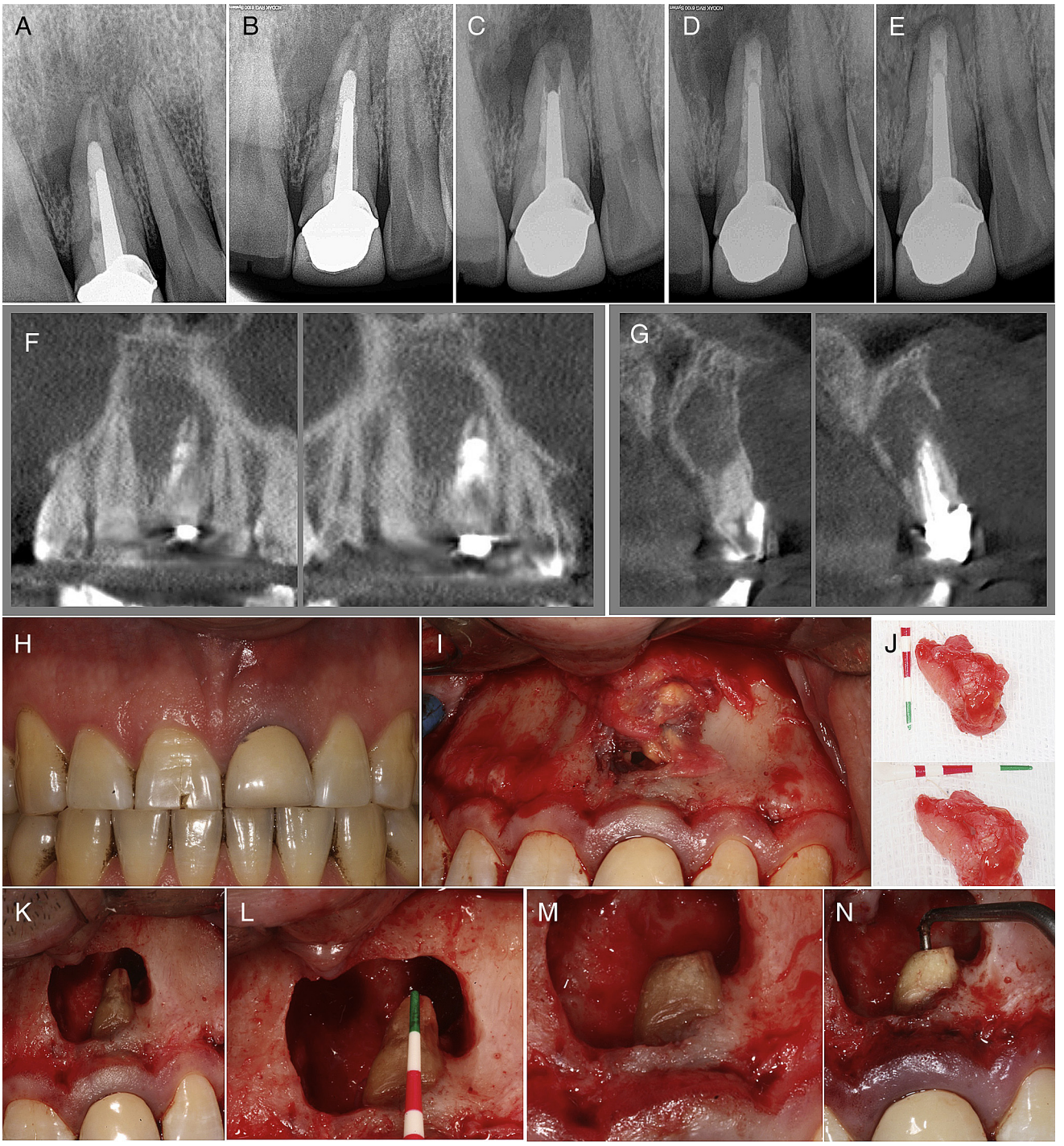


**Figure 1.** (*A* and *B*) Periapical radiographs showing an apical lesion associated with tooth #9. (*C*) Endodontic surgery was the treatment of choice. (*D*) White MTA (ProRoot MTA; Dentsply Maillefer, Ballaigues, Switzerland) root-end filling was used. (*E*) A follow-up radiograph at 1 year showed almost complete periapical healing. A CBCT scan (Sirona Galileos CBCT System; Sirona Dental Systems GmbH, Bensheim, Germany) was taken of the previously mentioned tooth as a complementary examination. (*F*) Coronal and (*G*) sagittal (G) reconstructed CBCT images revealed that the periapical radiolucency was larger than that seen radiographically. Note that the apical lesion affected the buccal cortical plate. (*H*) The clinical view of maxillary anterior teeth; note that tooth #9 had a metal-ceramic crown. (*I* and *J*) Enucleation of the apical lesion. (*K*–*N*) Images showing the root-end resection and root-end preparation of tooth #9. (*N*) Cavity preparation (3 mm deep) along the long axis of the root using an ultrasonic tip.

oped and widely debated in studies by Vercellotti et al (18, 19), who pioneered its application in periodontal surgery. Piezoelectric surgery devices operate with principles that are similar to the piezoelectric dental scaler devices, but the latter are not capable of cutting through hard tissues. Selective cutting is the most innovative feature of the piezoelectric surgery device. Although piezosurgery cuts mineralized tissues such as bone, it does not cut soft tissues such as blood vessels, nerves, and mucosa (19).