New Multipurpose Endodontic Device Developed in Germany for Use in Predoctoral and Continuing Dental Education and Science


Abstract: The purpose of this article is to describe a simple and versatile aid for the endodontic treatment of extracted teeth and its possible applications. The Med*-box is a new endodontic multipurpose device made of transparent acrylic that permits all elements of root canal treatment to be performed and evaluated either visually or radiologically. The Med*-box represents a valuable addition to the spectrum of educational and practical means in endodontic training. It is well suited for students, dentists, and endodontists for learning the handling of new materials, methods, and instruments in endodontics before they work clinically upon a patient. Also in the context of scientific endodontic issues, the Med*-box represents a simple, economical, and easily manageable aid.

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Successful endodontic treatment requires a high degree of anatomical and biological knowledge as well as manual skill. It is a prerequisite for every clinical root canal treatment that the dentist fully masters the materials used and their related methods. In predoctoral endodontic education, in continuing education courses, and in the context of scientific examinations, endodontic treatments are carried out on simulated root canals in resin blocks,1-8 on artificial teeth manufactured individually,9-12 and on extracted human teeth.13-16 For the fastening of extracted teeth, various do-it-yourself methods are being used.15-18 To simulate clinical conditions in the context of endodontic procedures, individually manufactured jaw models fitted with natural teeth,19 technically complicated equipment, and mannequin heads are used.17,20-25 The purpose of this article is to describe a simple, economical, and as universal as possible functional device for educational and practical purposes, as well as for scientific examinations, and to test its possible applications.

Materials and Methods

The Med*-box consists of a base body (enclosed basin) and a cover plate. The base body of the prototype of the Med*-box was joined together from single transparent 4 mm thick polyvinylchloride plates by means of silicone glue to a double walled watertight basin (Figure 1). The industrially manufactured basin of the Med*-box consists of 5 mm thick section acrylic glass (Figure 2). The removable top was produced from 4 mm thick polyvinylchloride plates with eleven holes drilled through it. Ten holes arranged in two rows (diameters 10 mm and 14 mm) serve to fix single-rooted and multi-rooted extracted teeth in place. A hole situated on the cover edge (diameter 2.2 mm) serves the purpose of fastening the lip clip for the electronic apex locator. An additional 70 mm x 1.5 mm long central groove is provided for the holding of x-ray films of teeth fixed in the Med*-box.

For the fixation of the teeth, we selected a drilling hole corresponding to the tooth size. The secure fixing of the tooth in the region of the cementoenamel junction is then secured with an autopolymerization resin (Pattern resin LS GC Europa, Leuven, Belgium) or Pattex Power Knete (Henkel AG, Düsseldorf, Germany). After a short setting time for the resin or Pattex, a cuff locks the tooth into the hole for the planned endodontic treatment. The materials for the endodontic and post-endodontic use in the Med*-box are as follows: equipment, instruments, and materials for all endodontic procedures, for the
Figure 1. Prototype of the transparent Med*-box for the execution of complete endodontic treatment with fixed teeth

Figure 2. Med*-box with electronic apex locator and radiograph film
removal of fractured root canal instruments, and for endodontic retreatments; extracted human teeth of all tooth groups after cleaning, removal of blood and tissue residues, and storage in formaldehyde solution (5-10 percent) plus washing and drying of the tooth surface; and artificial teeth. In the context of the application of a test of the Med*-box, all relevant working steps connected with the endodontic treatment were carried out and judged both under visual supervision and after covering the Med*-box with foil or dental dam (black box; Figure 3) as well as radiographically evaluated (Figure 2). After completion of the endodontic procedures, the removal of the cover plate and the fixed teeth was carried out. With the help of a blunt object, the teeth were pushed from the bottom up (root side) out of the cover plate.

Results

In our project, the Med*-box was developed and examined for its possible applications and its ability to handle endodontic measures. The following results were achieved. The Med*-box was found to be robust, resistant to common endodontological rinsing solutions, reusable, and ensuring an ergonomically favorable, simple, and sure handling. The Med*-box can be used with or without an electrically conductive medium (sodium solution 0.9 percent). The used extracted teeth fixed by means of customary autopolymerization dental resin or adhesive are relatively easy to remove from the cover plate of the construction again. Through the slot in the center of the cover plate in the area of the six central drill holes, the usual radiograph films can be slipped into the Med*-box (Figure 2).

We also found that all the measures of the root canal treatment, such as trephination, preparation of the access cavity, representation and expansion of the root canal orifices, manual and machine root canal preparation, disinfection, obturation, post-endodontic therapy, and removal of fractured root canal instruments and old root canal materials (retreatments), are feasible with the Med*-box, both with and without use of a dental microscope. During the procedure, the root canal treatment can be observed by the therapist or another person through the transparent construction of the Med*-box (Figure 2) to see whether rinsing solution overflows at the apical foramen or if the apical foramen becomes overinstrumented.
Furthermore, it is possible to determine whether, and at which time, the root canal filling sealer at the apical constriction overflows. By covering the Med*-box with non-transparent materials (adhesive foils, rubber dam), only a restricted view of the access cavity is possible (black box; Figure 3). An electrical length measurement by means of apex locators for the determination of the working length with respect to the determination of the endpoint of the root canal treatment can be carried out while using the Med*-box with an electrically conductive medium (sodium solution 0.9 percent; Figure 2).

Discussion

The aim of our project was to develop a simple, economical, and as versatile as possible construction for endodontic treatment for teaching, further education, and science as well as the verification of its possible applications. The transparent Med*-box was invented and designed by the second author (G.B.) as a prototype (Figure 1) and later optimized for industrial production (Figure 2), so that all endodontic procedures can be performed and controlled. A direct comparison with the literature is only conditionally possible since the Med*-box was recently developed and reports were not found in the literature about endodontic aids with comparable multifunctional equipment.

For endodontic education, postgraduate education, and scientific examinations, suitable practical and examination tools for the execution of endodontic measures are needed. For this reason, several practice models have been designed. Simulated root canals in transparent epoxy resin blocks,18,26-30 in artificial dentin material,31 or in artificial teeth produced individually10,32 that allow students or endodontists to simulate shaping, cleaning, and filling of root canals have been described. Despite all advantages and possibilities of the use of acryl blocks with root canal equivalents or artificial teeth, the hardness and abrasive characteristics of resin material and dentin are not comparable. This is why natural extracted teeth are preferred by some.33,34 Therefore, due to lack of comparability, it is not yet possible to imagine one without the other in teaching and research. In addition, the use of extracted human teeth is the only known way to teach students the wide biological variation in human root canal anatomy.17 As such, natural teeth are embedded in plaster,35 gelatin,36 alginate,15,57-60 or material combinations and in models manufactured individually19,41 for endodontic education and exercise purposes.

In the context of scientific examinations of extracted teeth, whereby apex locators were tested, constructions of one’s own have been used for the fixation of the teeth.15 By the individual embedding of extracted teeth in duplicated jaw models, the oral conditions should be simulated by use of different materials. The in vitro model introduced by Nikhil and Nikhil41 permits the use of electrically conductive material and an apex locator, while the model of Balto19 can be used also in the phantom head. Another invention (CQ Lee, inventor, Kansas City/USA patent US 6,520,775 B2, 2003; CQ Lee et al., inventors, USA patent US 6,988,894 B2, 2006) provides an improved device and method for the training of the use of an apical position locator using a real or replicated tooth with root canals having an apex at the root tip. The tooth is set in a medium that mimics the electrical impedance of human tissue found around the natural live root apex, even in a manikin that simulates a working human jaw. These constructions and their further development are technically very complex and elaborate.

A simple, versatile, and, as far as possible, economical construction should therefore be produced for the execution of endodontic measures of extracted teeth to close a gap between the different models with most versatile possible applications. The advantages of the Med*-box are many. All working steps relevant to endodontic treatments could be carried out without problems and ergonomically on teeth fixed in the Med*-box. This results from the optimal size and the stability of the box on the worktop, allowing secure support of the hands during endodontic procedures. Particularly practical is the use of the Med*-box when endodontic treatment is planned on natural teeth that do not require any fixation of the teeth in jaw models or phantom heads. This is frequently the case in predoctoral education and in postgraduate education. The same is the case in the context of scientific examinations under standardized conditions. As such, the Med*-box has already been used successfully in comparative examinations of root canal filling materials.42

In addition, comparisons carried out on apex locators (for example, by Venturi and Breschi16) on extracted teeth can be performed quickly and simply in this Med*-box filled with sodium solution. In connection with the length determination in the Med*-box, comparable roentgenological or manual apex or working length determinations can be carried out.
Radiographs can be taken through the additional slit in the cover plate at any time during the endodontic treatment directly in the Med*-box.

Another advantage is the transparency of the Med*-box. If required, all steps can be checked visually. In particular, procedures in the apical area such as overinstrumentations during the root canal preparation and overrun with rinsing solutions or sealers during a root canal filling are well controllable and documentable. However, if endodontic steps should be carried out under practically relevant conditions as a blind test (black box), it is very easily possible to cover the Med*-box with rubber dam or a non-transparent foil, so that an insight is only possible by the access cavity (Figure 3).

The relatively easy use of a dental microscope in the process is another field of application of the Med*-box in the context of endodontic measures of extracted teeth. This is helpful, particularly for learning techniques such as the removal of fractured root canal instruments and in retreatments. Concomitantly due to the safe fixture of teeth in the stable Med*-box during the procedure, work with the dental microscope can be learned and/or practiced.

It is the disadvantage of many applied simple models that they are often provisional solutions, and only one tooth can be treated in each or is not reusable. A small limitation of the Med*-box lies in the fixation and removal of extracted teeth. This handling requires practice. Sometimes, the fixated teeth can only be removed by milling. However, even after multiple individualizations of the hole size by means of acrylic resin mills for very large teeth or signs of wear after years of application, the cover plate of the Med*-box can be economically exchanged.

Many models introduced with several possible applications are expensive specialist models because they have to be produced with a lot of difficulty and thus are available to only a few in dental education. The Med*-box is more economical through possible industrial production and therefore could be used by a variety of interested persons. The adoption of this Med*-box in dental school, continuing dental education, and research could therefore be a useful step forward and might improve teaching-learning and working conditions.

Conclusions

The Med*-box is a simple and economical model for the fixation and execution of endodontic treatments on extracted or artificial teeth. It permits a contemporary, good control of the individual therapy steps and is very versatile. The Med*-box is well suited for student education, for endodontic continuing education courses, and for scientific research. It would be a useful aid because of its simple handling, reasonable price, and durability.

REFERENCES


