Removal of broken endodontic instruments with ERS – Endo Removal System® designed by Dr. K. Gończowski

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Removing a broken piece of an endodontic instrument is one of the most demanding procedures performed by dental surgeons. Ultrasonic method is most commonly used for removing broken pieces of endodontic instruments. It involves dislodging and activation of the broken instrument piece using a vibrating ultrasonic tip without water cooling under visual control of a dental microscope. The key disadvantage of this method is that the broken instrument piece cannot be directly grabbed. This method is also associated with a high risk of further fragmentation of the removed piece. All too often, once the old root filling material in the root canal or the root dentin are broken down, it is not technically feasible to remove the broken piece as it is, for example, stuck firmly or too deeply located inside a narrow and angled root canal. If this is the case, one solution is to use dedicated clamping microinstruments together with an endodontic microprobe and an endodontic microlever to remove the broken piece of an instrument in a quick and reproducible manner, without any risk of complications, such as canal wall perforations or further fragmentation of the damaged instrument by ultrasounds. ERS® was designed and made of top-quality surgical steel for ergonomic and comfortable use under control of a dental microscope. The first version of the system was designed and released in 2010. The system was modified in 2015 by adding a new unique structure consisting of a patent-protected movable wedge and microwindows. The original ERS® was designed to be used mainly for removing broken pieces of manual or machine-operated endodontic instruments with the maximum angle of convergence of 2-4 degrees. In 2019, a brand new version of the system was introduced featuring optimized retaining force of the removed instrument piece, simplicity of operation, sterilization effectiveness, and the ability to remove rotating and reciprocating instruments with higher taper. The unique features of the new ERS® *beta* version of 2019 are as follows:

- Extremely firm and stable grasp of a broken piece of an endodontic instrument (as little as 0.8 mm of accessible length of the broken piece!!!) If broken endodontic instruments with a long, thin active surface passing through a microwindow are removed (e.g. Lentulo spiral or C-File, D-File, S-File or K-File types of files), the retention force of the instrument is only one of its kind on the market and allows for smooth, quick and safe removal of the broken instrument, even if it is stuck in the bone of alveolar process extending **BEYOND** a root canal! In this clinical case the ultrasonic dislodging of the instrument would be associated with a risk of its further fragmentation.
- No additional costs of worn single-use parts (all ERS® components can be reused and re-sterilized)
- No complicated procedure of instrument preparation – you only need to insert the selected microtip onto a universal handle; it is not necessary to assemble the ligature each time the system is used!
- Very high resistance to mechanical damage. Extremely stable and simple structure resistant to misuse.
- Precisely operating system of automatic wedge or ligature return to the starting position – Blow-back System. If you fail to grasp the broken piece, release the trigger switch on ERS® handle and the wedge or the loop (depending on the selected microtip) will return to the starting position. You do not have to remove the locking element by hand!
- Effective sterilization – detachable universal handle and all microtips are fitted with a **PERMANENTLY** attached universal Luer-lock connector. No adaptors are necessary to effectively disinfect and clean the **INSIDE** of the tip with a water jet.

- The angle of convergence of the movable wedge is designed to effectively lock inside the tube both tiniest instruments having a low angle of convergence as well as state-of-art rotating and reciprocal files having a high taper (up to 8 degree).

Stages of procedure using ERS – Endo Removal System® designed by Dr. K. Gończowski

1. **Preliminary identification of location and type of broken instrument with RVG and/or CBCT**:
    a. Identification of the appropriate root canal where the instrument fragment is located, as well as the depth and position of the broken piece
    b. Determination of the presumed type and size of the damaged instrument – the type of the selected microtip depends on the type and size of the removed piece
2. **Getting wide access to the broken instrument with the aid of a dental microscope while maintaining maximum tissue protection:**
    a. Any suitable rotating or reciprocal endodontic instruments, including Gates-Glidden, Largo-Peeso or Beutelrock drills, can be used to widen access to the lumen of the root canal. Munce Discovery drills are highly recommended, or even indispensable. Various types of ultrasound tips can also be used (without water cooling) either with a diamond abrasive or silicon carbide brushes (slower wear and tear, better cutting performance).
    b. Trepan-like sleeve burs can be used during the final stage of the root canal extension over the broken instruments to reduce operating time, but also involve high loss of the tooth tissues. Therefore it is recommended to use an angular (typically 120^{o}) ultrasonic tip with force reduction as well as smooth, rounded and sharp pointed files made of metal alloys that can be **PERMANENTLY** bent to the shape of the root canal to remove dentine and the old root filling material.
    c. No less than 0.8 mm of the removed piece should be exposed to obtain an effective gripping force of the broken instrument piece. The larger the piece of a broken instrument inserted inside the microtip, the higher its gripping force. The maximum holding force can be obtained by inserting the broken piece into the microtip and by evaluating it to the side through one of 2 microwindows located ca. 0.6 mm from the entrance.
    d. Heavy rinsing of the root canal is recommended while operating inside the root canal above the broken instrument piece, either with sodium hypochlorite (NaOCl) and disodium edetate (EDTA), in both cases with an addition of surfactants. The detergents reduce the surface tension of NaOCl and EDTA, which more readily permeate to narrow spaces between the wall of a root canal and the broken instrument piece. The sonic activation of NaOCl is a necessary element of the root canal rinsing procedure. The most recommended sonic activation method is to use an air scaler with a single-use **NON-CUTTING** plastic tip as it produces no iatrogenic complications (no risk of perforation or notch excision e.g. EDDY – VDW®), offers high effectiveness of root system decontamination, and it is easily accessible and inexpensive.
    e. It is recommended to use special-purpose solvents to remove old filling material in the root canal over the broken instrument. Methylene chloride is also recommended

because of very high effectiveness in dissolving Gutta-percha pins and Endomethasone pastes as well as ultra-low surface tension. Alternatively, chloroform, orange oil and eucalyptol can be used.

3. **Dislodging and activation of the piece of broken instrument using an ultrasonic system:**
    a. It is recommended to use an angular (typically 120^{o}) ultrasonic tip with force reduction as well as smooth, rounded and sharp pointed files made of metal alloys that can be **PERMANENTLY** bent to the shape of the root canal. The procedure is performed under visual control of a dental microscope, without water cooling, in a pulse mode (avoid overheating – take breaks every 10-15 s while working with ultrasounds). Counter-clockwise circular movements are performed around the broken piece. The exception are broken reciprocating instruments with a left sided thread, such as Reciproc VDW or WaveOne Dentsply Maillefer, in which case clockwise rotation is recommended.
    b. If the broken instrument piece is made of a Ni-Ti alloy and it is located in a curved root canal (partially behind the curvature), it is recommended to cut the root dentin with the use of an ultrasonic tip **ON THE INNER SIDE OF THE CURVATURE.** This is determined by the properties of the alloy that the broken piece is made of. This type of alloy has a tendency to return to its original straight alignment. Therefore if the incision is performed on the outer wall of the curvature, the broken piece will remain in a bent position in the place where its end rests on the canal wall and will lodge more firmly within the root canal.
    c. As soon as the first signs of the fragment loosening are observed under the microscope, the cavitation phenomenon can be taken advantage of, caused by the vibrations of the thin ultrasonic tip within a space bound by hard walls of the root canal. The phenomenon of acoustic microflow of fluid in the vicinity of the broken element facilitates the transfer of kinetic energy from the vibrating ultrasonic tip to the fragment being removed – the liquid being denser than air more effectively transfers these vibrations.
    d. If the broken fragments are long and are firmly wedged inside the root canal, or they are partially beyond the canal inside the bone of alveolar process, the force generated by the ERS® instrument may be sufficient to dislodge it while avoiding the risk accompanying ultrasonic dislodging of the instrument. In this case ultrasonic dislodging of the instrument involves a risk of further fragmentation of the proximal section of the broken instrument at an even deeper level of the canal, typically at the boundaries of the removed filler material or at the most distal extent of the root dentin preparation. This type of complication is typical for broken long fragments of Lentulo spirals, manual negotiating files, or silver points.
4. **Gripping and removal of a broken instrument piece using ERS®:**
    a. The type of ERS® microtip is selected depending on the location, size, and angle of convergence of the broken fragment being removed. **NOTE!!!** Not all microtips are available in all countries! As of March 2019 (microtips with a movable wedge and a tightening loop made from a piece of a wire):
        - **1.2 mm** and **1.0 mm** in diameter – removal of rotating and reciprocating instruments with a high taper (> 6 degrees)

- **0.8 mm** and **0.7 mm** in diameter – removal of rotating and reciprocating instruments with a low taper (< 6 degrees), manual instruments and Lentulo spirals
- **0.55 mm** in diameter – removal of very thin pieces of tips of rotating and reciprocating instruments with a low taper (< 6°), and small fragments of manual instruments and Lentulo spirals – **NOTE!!!** A microtip **WITHOUT** microwindows behind initial serration!
- **0.7 mm** in diameter with a loop – removal of large and thick foreign bodies from root canals – recommended mainly for removal of silver pins and foreign bodies which do not fit into the internal diameter of the microtips with a movable wedge
- **0.7-0.5 mm** (cone) endodontic microlever – a universal auxiliary tool with a very simple structure to facilitate careful dislodging and gripping of the broken instrument piece

b. The entry path of ERS® microtips with a movable wedge does not have to an extension of the long axis of a broken piece (180 degrees). This is very important from a clinical point of view as typically it is not technically feasible to gain rectilinear access, otherwise the tooth structure would have to be significantly affected. All diameters of microtips with a movable wedge, except for the smallest one (0.55 mm) are designed to grasp the instrument at a 45 degree angle. Two microwindows placed opposite each other, the size of 0.4/1mm at a distance of around 0.6 mm from entrance to the tube are designed for visual control of the entry path under a dental microscope whenever there is a sharp access angle to the broken piece; the microwindows also create an additional point of reference during removal of the instrument.

c. Operating a microtip with a movable wedge:
   - Introduce the instrument into the lumen of the properly widened root canal all the way down to the level of the broken instrument piece.
   - Insert the sleeve on the exposed piece of a broken instrument to the minimum depth of 0.8 mm – the longer instrument piece is placed inside the tube, the higher the retention force. The maximum retention force can be produced when the broken instrument passes through a lateral microwindow.
   - Smoothly press the trigger switch on ERS® handle as far as it will go.
   - Remove the broken instrument piece from the root canal by pulling the microtip out without releasing the grasp.
   - If the broken instrument slips out of the microtip, release the trigger switch and the blow-back system will automatically withdraw the movable wedge to the inside of the tube. This mechanism allows to immediately repeat the attempt to grip the broken tool **WITHOUT** having to remove ERS® from the root canal to prepare it for another grasping attempt.
   - After several unsuccessful attempts to grasp and remove the broken instrument you should expose a longer section of the instrument to increase retention force inside the tube and/or improve mobility of the instrument piece by more effectively dislodging it using an ultrasonic tip NOTE!!! The longer the exposed piece of the broken instrument, the higher the risk it will be fragmented during an attempt to dislodge it with ultrasounds!!!

d. Operating a microtip with a ligature loop:
   - Introduce the instrument into the lumen of the properly widened root canal all the way down to the level of a silver pin or another foreign body.
   - Slide the loop onto the exposed section of the foreign body to the minimum depth of 0.8 mm – the ligature can be tightened both to the front (the tube end is sealed) and to the side (the wire passes through two openings directed diagonally to the front and laterally).
   - Smoothly press the trigger switch on ERS® handle as far as it will go.
   - Remove the foreign body from the root canal by pulling the microtip out without releasing the grasp.
   - If the foreign body slips out, just release the trigger switch and the blow-back system will automatically withdraw the loop to the inside of the tube. This mechanism allows to immediately repeat the attempt to grasp the foreign body **WITHOUT** having to remove ERS® from the root canal to prepare it for another grasping attempt.

e. Endodontic microlever + endodontic microprobe – two-handed technique with direct visual control under a microscope and in light reflected from a mirror held by an assistant. These are very simple auxiliary instruments to facilitate careful dislodging and grasping of a broken instrument piece. They can be used separately, but their usefulness in removing broken instruments is very limited owing to their low retention force.
   - Introduce the microlever into the lumen of the properly widened root canal all the way down to the level of the broken instrument piece.
   - Place the semi-open sleeve over no less than 1-1.5 mm of the exposed instrument piece (0.8 mm is enough with automatic microtips with the blow-back system and movable wedge). The broken piece should pass through the cone in the proximal part of the sleeve. A 5 mm window is placed behind the cone, and it is not mandatory to maintain a linear alignment of access to the broken instrument. The long axis of the microlever does not have to be an extension of the long axis of the removed instrument piece. This instrument also operates at an angle of 45 degrees.
   - Place the microprobe end in the microlever window and press it to the inside of the groove and move down as far as it will go while using the wedge to block the broken instrument inside the cone in the proximal part of the sleeve.
   - Remove the broken instrument from the root canal by pulling the microlever and the microprobe out without releasing the grasp – **NOTE!!!** This requires considerable manual dexterity and the help of a properly trained assistant (both physician's hands are busy – microtips with a movable wedge can be operated with one hand only!)