

## Supplementary materials

**Table S1:** Radiographic outcome criteria for EMS described by Rud *et al* and Molven *et al*.

<p><b>Complete Healing*</b></p>	<ol style="list-style-type: none"> <li>1. Re-formation of periodontal space of normal width and lamina dura to be followed around the apex.</li> <li>2. Slight increase in width of apical periodontal space, but less than twice the width of non-involved parts of the root.</li> <li>3. Tiny defect in the lamina dura (maximum 1mm) adjacent to the root filling.</li> <li>4. Complete bone repair; bone bordering the apical area does not have the same density as surrounding non-involved bone.</li> <li>5. Complete bone repair; no apical periodontal space can be discerned.</li> </ol>
<p><b>Incomplete Healing*</b></p>	<p>The rarefaction has decreased in size or remained stationary, and is characterized by:</p> <ol style="list-style-type: none"> <li>1. Bone structures are recognized within the rarefaction; the periphery of the rarefaction is irregular and may be demarcated by a compact bone border; the rarefaction is located asymmetrically around the apex; the connection of the rarefaction with the periodontal space is angular;</li> <li>2. Isolated scar tissue in the bone.</li> </ol>
<p><b>Uncertain Healing**</b></p>	<p>The rarefaction has decreased in size, and with one or more of the following characteristics:</p> <ol style="list-style-type: none"> <li>1. The RL is larger than twice the width of periodontal space.</li> </ol>

	<ol style="list-style-type: none"> <li>2. The RL is bordered by lamina-dura like bone structures.</li> <li>3. The RL has a circular or semicircular periphery.</li> <li>4. The RL is located symmetrically around the apex as a funnel-shaped extension of the periodontal space.</li> </ol>
<b>Unsatisfactory Healing**</b>	The RL area appears enlarged or unchanged.

\*Complete and incomplete/scar categories were combined as success.

\*\* Uncertain and unsatisfactory healing were combined as failure.

<b>Exclusion criteria</b>	<b>Articles</b>
<b>2</b>	Song <i>et al.</i> , 2018; Al-Nuaimi <i>et al.</i> , 2018; Kruse <i>et al.</i> , 2017; Kim <i>et al.</i> , 2016; da Silva <i>et al.</i> , 2015; Shinbori <i>et al.</i> , 2015; Mente <i>et al.</i> , 2015; Kang <i>et al.</i> , 2015; Lui <i>et al.</i> , 2014; Song <i>et al.</i> , 2014; Bryce <i>et al.</i> , 2013; Angiero <i>et al.</i> , 2011; Taschieri <i>et al.</i> , 2011; Moshonov <i>et al.</i> , 2011; Song <i>et al.</i> , 2011; Taschieri <i>et al.</i> , 2010; Salehrabi <i>et al.</i> , 2010; Gilbert <i>et al.</i> , 2010; Tsesis <i>et al.</i> , 2009; Jonasson <i>et al.</i> , 2008; Iqbal <i>et al.</i> , 2007; Oberli <i>et al.</i> , 2007; Xu <i>et al.</i> , 2006; Tsesis <i>et al.</i> , 2006; von Arx <i>et al.</i> , 2005; Oginni <i>et al.</i> , 2002; Rahbaran <i>et al.</i> , 2001; Testori <i>et al.</i> , 1999; Danin <i>et al.</i> , 1999; Rud <i>et al.</i> , 1998; Mor <i>et al.</i> , 1995
<b>3</b>	Kruse <i>et al.</i> , 2017; Kacarska <i>et al.</i> , 2017; Wang <i>et al.</i> , 2017; Kruse <i>et al.</i> , 2016; Song <i>et al.</i> , 2013; Saunders <i>et al.</i> , 2008; Wang <i>et al.</i> , 2004
<b>4</b>	Kulakov <i>et al.</i> , 2018; Kruse <i>et al.</i> , 2017; Kacarska <i>et al.</i> , 2017; Barone <i>et al.</i> , 2010; Penarrocha <i>et al.</i> , 2007; Yazdi <i>et al.</i> , 2007; Leco Berrocal <i>et al.</i> , 2007; Gagliani <i>et al.</i> , 2005; Maddalone <i>et al.</i> , 2003; Rud <i>et al.</i> , 2001; Zuolo <i>et al.</i> , 2000; Kvist <i>et al.</i> , 1999; Rud <i>et al.</i> , 1996; Sumi <i>et al.</i> , 1996; Molven <i>et al.</i> , 1996; Rud <i>et al.</i> , 1996; Jesslen <i>et al.</i> , 1995
<b>5</b>	Safi <i>et al.</i> , 2019; Penarrocha <i>et al.</i> , 2019; Meschi <i>et al.</i> , 2018; Zhou <i>et al.</i> , 2017; Kacarska <i>et al.</i> , 2017; von Arx <i>et al.</i> , 2016; von Arx <i>et al.</i> , 2016; von Arx <i>et al.</i> , 2016; Jorge <i>et al.</i> , 2015; Kurt <i>et al.</i> , 2014; Song <i>et al.</i> , 2013; Kreisler <i>et al.</i> , 2013; Song <i>et al.</i> , 2012; Shen <i>et al.</i> , 2012; Patel <i>et al.</i> , 2012; Walivaara <i>et al.</i> , 2011; von Arx <i>et al.</i> , 2010; Walivaara <i>et al.</i> , 2009; Shearer <i>et al.</i> , 2009; Taschieri <i>et al.</i> , 2008; Carrillo <i>et al.</i> , 2008; Garcia <i>et al.</i> , 2008; Kim <i>et al.</i> , 2008; Penarrocha <i>et al.</i> , 2008; Taschieri <i>et al.</i> , 2007; de Lange <i>et al.</i> , 2007; Penarrocha <i>et al.</i> , 2007; Walivaara <i>et al.</i> , 2007; von Arx <i>et al.</i> , 2007; Taschieri <i>et al.</i> , 2007; Taschieri <i>et al.</i> , 2006; Marin-Botero <i>et al.</i> , 2006; Filippi <i>et al.</i> , 2006; Taschieri <i>et al.</i> , 2005; Marti-Bowen <i>et al.</i> , 2005; von Arx <i>et al.</i> , 2003; Dietrich <i>et al.</i> , 2003; Jensen <i>et al.</i> , 2002; Vallecillo Capilla <i>et al.</i> , 2002; von Arx <i>et al.</i> , 2001; von Arx <i>et al.</i> , 1999; Danin <i>et al.</i> , 1996; Van Doorne <i>et al.</i> , 1996; Pecora <i>et al.</i> , 1995
<b>6</b>	von Arx <i>et al.</i> , 2019; Kulakov <i>et al.</i> , 2018; Kacarska <i>et al.</i> , 2017

7	von Arx <i>et al.</i> , 2019; Penarrocha <i>et al.</i> , 2019; Riis <i>et al.</i> , 2018; Meschi <i>et al.</i> , 2018; Kulakov <i>et al.</i> , 2018; Kacarska <i>et al.</i> , 2017; Menendez-Nieto <i>et al.</i> , 2016; Caliskan <i>et al.</i> , 2016; Taschieri <i>et al.</i> , 2014; von Arx <i>et al.</i> , 2011; Wang <i>et al.</i> , 2004; Wang <i>et al.</i> , 2004
8	Zandi <i>et al.</i> , 2019; Castro <i>et al.</i> , 2018; Meschi <i>et al.</i> , 2018; Kulakov <i>et al.</i> , 2018; Prati <i>et al.</i> , 2018; Fariniuk <i>et al.</i> , 2017; Kruse <i>et al.</i> , 2017; Kacarska <i>et al.</i> , 2017; Menendez-Nieto <i>et al.</i> , 2016; Neskovic <i>et al.</i> , 2016; Patel <i>et al.</i> , 2012; Song <i>et al.</i> , 2011; de Chevigny <i>et al.</i> , 2008; Xu <i>et al.</i> , 2006; Farzaneh <i>et al.</i> , 2004; Sjogren <i>et al.</i> , 1997

**Table S2:** Reasons for articles exclusion according to the criteria previously established.

**Supplementary S1:** Pubmed electronic database search strategy.

The term: “(((((((periapical diseases[MeSH Terms]) OR periapical diseases) OR root-end filling) OR root canal therapy[MeSH Terms]) OR root canal therapy)) AND ((((((((((((((apicoectomy[MeSH Terms]) OR apicoectomy) OR surgical endodontic retreatment) OR apical surgery) OR retreatment[MeSH Terms]) OR apical surgery) OR periapical surgery) OR retrograde surgery) OR endodontic surgery) OR root-end surgery) OR root-end cavity preparation) OR periradicular surgery) OR microsurgery[MeSH Terms]) OR retreatment[MeSH Terms]) OR root-end resection) OR apicectomy)) AND (((((radiographic outcome) OR treatment outcome[MeSH Terms]) OR treatment outcome) OR success rate) OR radiographic success rate) NOT (review OR case report)” was used on Pubmed search. Limits used were studies on humans published from 1990/01/01.

**Supplementary S2:** The Cochrane Library electronic database search strategy.

The term: “[((Retrograde Obturation [MeSH descriptor]) OR (retrograde obturation) OR (root end filling)) AND ((Apicoectomy[MeSH descriptor]) OR (apicoectomy) OR (apical surgery) OR (periapical surgery) OR (Microsurgery[MeSH descriptor]) AND ((Treatment Outcome[MeSH descriptor]) OR (success rate) OR (radiographic success rate)))]” was used on The Cochrane Library search. Limits used were trials and studies published from 1990/01/01.