

## Evaluation of healing criteria for success after periapical surgery

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### Summary

**Introduction:** In periapical surgery, the absence of standardization between different studies makes it difficult to compare the outcomes.

**Objective:** To compare the healing classification of different authors and evaluate the prognostic criteria of periapical surgery at 12 months.

**Material and methods:** 278 patients (101 men and 177 women) with a mean age of 38.1 years (range 11 to 77) treated with periapical surgery using the ultrasound technique and a 2.6x magnifying glass, and silver amalgam as root-end filling material were included in the study. Evolution was analyzed using the clinical criteria of Mikkonen et al., 1983; radiographic criteria of Rud et al., 1972; the overall combined clinical and radiographic criteria of von Arx and Kurt, 1999; and the Friedman (2005) concept of functional tooth at 12 months of surgery.

**Results:** After 12 months, 87.2% clinical success was obtained according to the Mikkonen et al., 1983 criteria; 73.9% complete radiographic healing using Rud et al. criteria; 62.1% overall success, following the clinical and radiographic parameters of von Arx and Kurt, and 91.9% of teeth were functional. The von Arx and Kurt criteria was found to be the most reliable.

**Conclusion:** Overall evolution according to von Arx and Kurt agreed most closely with the other scales.

**Key words:** *Periapical surgery, prognosis, endodontic surgery.*

### Introduction

The success rate in periapical surgery (PS) varies between 37% (1) and 91% (2). These differences may be due to the criteria used when selecting the patients for surgery, to the variation in the surgical techniques, the magnification and lighting systems, the root-end filling materials, and/or the healing criteria used to evaluate the outcome of the studies (3).

Published studies use different criteria to determine the prognosis of PS (4), with no general agreement between them. There are clinical healing criteria based on patient

signs and symptoms (5); while others, such as Rud et al. (6), use only radiographic studies. The von Arx and Kurt scale (7) uses a combination of clinical and radiographic parameters, and in 2005, Friedman (3) established only whether the tooth was functional or not (it remained in the mouth). The healing classification most used in the literature is that of Rud et al. (6).

The aim of this study was to compare the success rates given by each of the different criteria used to assess healing in PS after 12 months of follow-up.

## Material and Method

### *Patient selection*

A clinical follow-up study was carried out between May 1999 and June 2004. Three hundred sixteen patients with chronic periapical lesions were treated with PS using the ultrasound technique and a 2.6x magnifying glass to prepare the root-end cavity, and filling with silver amalgam.

The inclusion criteria for patients in the study were: 1) apicoectomies on teeth with canals treated by ultrasound techniques to create the root-end cavity, filling with silver amalgam; and 2) at least 12 months follow-up after treatment (8). All patients provided informed consent; 38 patients were excluded for lack of follow-up.

Data were collected using a protocol for each patient and stored in an automated database. The data were coded for later statistical processing.

### *- Surgical Technique*

All operations were carried out by the same surgeon (MPD). Infiltrative loco-regional anesthesia was accomplished with 4% articaine and 1:100.000 adrenaline (Inibsa, Lliça de Vall, Barcelona, Spain). Complete or partial Newman flaps were raised; ostectomy was carried out using round 0.27mm tungsten-carbide drills (Jota, Switzerland) mounted in a handpiece, and abundant irrigation with sterile physiological serum. The minimum apical resection necessary to access the apex was made, with subsequent apical curettage. The cavity for root-end filling was prepared with ultrasound, Piezon Master® (EMS, Electro Medical Systems S.A, Switzerland). Magnifying glasses of 2.6 magnification Orascope® (Acuity™ System, Kerr Corporation, Middleton, USA) were used to facilitate the procedure, and root-end filling with non gamma 2 silver amalgam (Tytin®, Kerr, USA). Sutures were placed using 4/0 silk thread (Lorca Marin®, TB15, 3/8, Murcia, Spain).

### *- Radiographic study*

Panoramic radiographs were taken using a digital orthopantomograph OP100® (Instrumentarium Imaging, Tuusula, Finland). The resulting image was placed in an image analyzer, previously calibrated with the Cliniview® Version 5.1 program (Instrumentarium Imaging, Tuusula, Finland).

### *- Prognostic assessment healing classification*

The following criteria were used to evaluate the success of the PS.

The clinical criteria of Mikkonen et al. (5), considering: 1) success: when there is no pain, swelling or fistula, 2) uncertain healing: radiographic evidence of bone destruction and presence or not of symptomatology; and 3) failure: when there is bone destruction, root resorption and symptomatology.

The radiographic criteria of Rud et al. (6): 1) complete healing: complete bone regeneration, normal or slight increase in width of periodontal periapical space, but less than double the width of the unaffected radicular areas;

2) Incomplete healing: reduced radiolucency, characterized by signs of bone healing around the periphery of the rarefaction; 3) Doubtful healing: reduced radiolucency with one or more of the following characteristics: the radiolucency was greater than twice the width of the periodontal space, it was bordered by a structure such as hard lamina, it had a circular or semi-circular periphery, or was located symmetrically 'cone-like' around the apex as an extension of the periodontal space; 4) Radiographic failure: there were no changes, or there was an increase in radiolucency.

The clinic and radiographic criteria of von Arx and Kurt (9) to determine overall evolution: 1) success: when bone regeneration was  $\geq 90\%$  and the pain and clinical scales were 0 (on a scale of 0 to 3); 2) improvement: when bone regeneration was between 50% and 90% and the pain and clinical scales were 0; and 3) failure: when bone regeneration was less than 50% or there were clinical symptoms. Finally, it was evaluated if the tooth was functional (remained in place) or not (3).

### *- Statistical analysis*

The data were coded for later statistical processing using the SPSS version 12 for Windows. Pearson's correlation coefficients and spread graphs were used to establish the relationship between the different scales.

## Results

In total 278 patients were studied (177 female and 101 male) with a mean age of 36.9 years (range 11 to 77 years). The success rate of PS with ultrasound and silver amalgam was 82.7% at 12 months according to the clinical evolution of Mikkonen et al. (5); and 73.9% when using the radiographic healing classification of Rud et al. (6). According to the overall evolution of von Arx and Kurt (9) the success rate was 62.1%; and 91.9% of teeth were functional (Table 1).

The dispersion coefficients table (Table 2) verifies the relationship between the different prognostic criteria. The higher the values of rho for a healing classification, the better the correlation with the remainder at 12 months. The von Arx and Kurt (7) overall evolution agreed most closely with the other criteria used.

## Discussion

From the results obtained in this study, we find the success rate in PS with ultrasound and silver amalgam root-end filling was about 62.1% at 12 months according to the von Arx and Kurt (9) healing criteria. Using the same technique and criteria, Martí et al. (10) found 84.2% success. With respect to Rud et al. (6) and carrying out PS with ultrasound and Super-EBA root-end filling material, Taschieri et al. (11) obtained 91.3% complete healing while for Testori et al. (12) the success rate was of 85%. Peñarrocha et al. (13) carried out PS with ultrasound and silver amalgam as a root-end filling material in 31 man-

**Table 1.** Healing percentages according to the different criteria.

		12 MONTHS
CLINICAL EVOLUTION (Mikkonen et al.)	SUCCESS	87.2%
	IMPROVEMENT	7.7%
	FAILURE	5%
RADIOGRAPHIC EVOLUTION (Rud et al.)	COMPLETE HEALING	73.9%
	INCOMPLETE HEALING	20.6%
	DOUBTFUL	2.7%
	FAILURE	2.9%
PAIN SCALE (von Arx and Kurt)	NO PAIN	90.1%
	OCCASIONAL MODERATE	6.9%
	PERMANENT MODERATE	2.2%
	INTENSE PAIN	0.5%
CLINICAL SCALE (von Arx and Kurt)	NO EVIDENCE	87.3%
	APICAL AREA PAIN ON PALPATION	5%
	APICAL INFLAMMATION OR PAIN ON PERCUSSION	3.5%
	FÍSTULA OR ABSCESS	4.2%
RADIOGRAPHIC HEALING (von Arx and Kurt)	GREATER THAN 90%	72.7%
	BETWEEN 50-90%	21.9%
	LESS THAN 50%	4.9%
OVERALL EVOLUTION (von Arx and Kurt)	SUCCESS	62.1%
	IMPROVEMENT	22.9%
	FAILURE	14.3%
FUNCTIONAL TOOTH (Friedman 2005)	NOT FUNCTIONAL	8.1%
	FUNCTIONAL	91.9%

**Table 2.** Correlation between the different scales at 12 months.

	CLINICAL EVALUATION 12 MONTHS	RUD RADIOGRAPHIC EVALUATION 12 MONTHS	PAIN AT 12 MONTHS	CLINICAL SCALE AT 12 MONTHS	VON ARX RADIOGRAPHIC EVALUATION 12 MONTHS	OVERALL EVOLUTION 12 MONTHS
CLINICAL EVALUATION 12 MONTHS	1	0.704	0.710	0.879	0.593	0.752
RUD RADIOGRAPHIC EVALUATION 12 MONTHS	0.704	1	0.497	0.675	0.914	0.835
PAIN AT 12 MONTHS	0.710	0.497	1	0.727	0.504	0.608
CLINICAL SCALE AT 12 MONTHS	0.879	0.675	0.727	1	0.624	0.727
VON ARX RADIOGRAPHIC EVALUATION 12 MONTHS	0.593	0.914	0.504	0.624	1	0.862
OVERALL EVOLUTION 12 MONTHS	0.752	0.835	0.608	0.727	0.862	1

dibular molars and obtained 54.8% total healing, 32.3% of incomplete or partial healing and 12.9% failure after one year of follow-up.

Rud et al. (6) has been the healing classification most used since its creation, nevertheless the incomplete and doubtful healing criteria are difficult to differentiate and it is common to integrate the two criteria as the concept of a tooth in process of healing.

The lowest success rate was found using the overall criteria of von Arx and Kurt (7), since this covers both clinical and radiographic criteria, that is to say, when considering only the clinical manifestations, the success rate was higher than if the radiographic data was also included. When combining the clinical failures of the Mikkonen et al. (5) criteria, and the radiographic failures of Rut et al. (6), the figures were similar to the overall failures of von Arx and Kurt (7); which is logical, since this healing classification covers both parameters. Similarly, Vallecillo et al. (14) assessed the clinical and radiographic outcomes in PS with different techniques; after 12 months of follow-up, they obtained a success rate of 70% with ultrasound and saw that complete radiographic healing did not occur in any case until 6 months after surgery. Leco et al. (15) evaluated the efficiency of the Erbium:YAG laser in 45 patients with granulomatous periapical lesions, with a clinical and radiographic control; they obtained 95.5 % clinical success and 77.7 % radiographic healing after 24 months of follow-up.

On the other hand, the success rate for clinical evolution was similar to the functional tooth concept, since in this case it was only assessed if the tooth remained in the mouth, which is a similar situation to that of a tooth that does not cause pain. The overall evolution of von Ax and Kurt (7) was the healing classification most in agreement with all the others.

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