



## Influence of preoperative factors on the outcome of root canal treatment

### (Part 1): A retrospective clinical study

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#### ABSTRACT

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#### Keywords:

Factor-affecting outcome, Success rate, root canal treatment, European Society of Endodontology.

**Aim:** The aim of this study was to evaluate the effect of preoperative prognostic variables (Gender, Age, General medical health, Tooth type, Tooth location, Pulpal and periapical status) on the outcome of the initial endodontic therapy. **Material and methods:** Ninety-one patients out of 109 were included and had complete medical and dental record. A total of 146 teeth received an endodontic treatment and overall 408 Canals obturated. All treatments were performed through 2018 and 2019, in a private Dental Clinic in Sirte, Libya. Two independent endodontists, who have analyzed all preoperative and postoperative radiographs. Treatment effectiveness was evaluated using the European Society of Endodontology's standards. The periapical index was used to grade the periapical state. Setting the level of significance at  $p < 5\%$  by applying chi-square Pearson test. **Results:** The initial root canal procedure had an overall success rate of 89.7%. The health status showed their power effect on success rate with 83.6% ( $p$ -value = 0.0001). Periapical status had a strong effect on the outcome. Apical periodontitis (AP) was existing in 49 of all teeth, with a PAI  $>3$  in 17 teeth. The success rate (SR) was 61.6%, 11.6%, 6.8% & 9.7% with teeth has PAI 1, PAI 2, PAI 3 and PAI  $>3$ , respectively ( $p$ -value = 0.004). However, pulpal status shows that the success rate for vital teeth was 57.5% and for non-vital teeth was 32.2%. **Conclusion:** Within the parameters of the investigation, medical health and periapical condition have demonstrated to be powerful significant outcome predictors.

### 1.0 Introduction

The preservation and restoration of the health of periradicular tissues are considered as primary objectives of endodontic treatment. This is could be achieved through proper chemical and mechanical instrumentation and three dimensional obturation of root canal system (European Society of Endodontology., 2006). The endodontic treatment is employed in the management of two distinct diseases entities, the pulpal inflammation and the pulpal infection (Abbott, 2012). The objective of treatment of pulpal inflammation is to preserve the health of periradicular tissues while the main aim of treatment of pulpal infection is reestablish the periapical tissues back to health (Hargreaves K., 2011). Preoperative condition of the tooth considered as a strong prognostic factor influence the outcome of root canal treatment. For example, vital teeth had a much higher success than non-vital teeth (Grahne'n

H, 1961, Hoskinson SE, 2002, Storms JL, 1969, Smith CS., 1993). Two meta-analysis studies conclude that preoperative pulpal status is a significant influencing factor in successful endodontic treatment. In addition, they reported that the vital teeth had higher success rates (5-9%) (Ng YL, 2008, Kojima K, 2004). Several studies has also focused on the presence of a preoperative radiolucency and the extent of the periapical lesion. It appears likely that periapical radiolucency influences treatment outcomes as it consistently indicates that a root canal infection is present (Sundqvist G., 1976). Success rates drop between 9–13% when a radiograph displays signs of a periapical lesion (Ng YL, 2008). According to the evidence, any infected case will likely fail more frequently than an uninfected case. Tooth type may affect the prognosis of root canal treatment, although previous studies are contradictory (Cheung GS, 2003, Ricucci D, 2011, Lee AH, 2012, Hoskinson SE, 2002, Ng YL, 2008). Periapical healing of

different tooth type appears to be more likely after in anterior and premolars teeth than in molars (Lee AH, 2012, Ricucci D, 2011) and in single-rooted than in multi-rooted teeth (Hoskinson SE, 2002, de Chevigny C, 2008). Another preoperative factor is general patient factor (Age, gender, general medical health), many studies have investigated these variables and their effects on the outcome of root canal treatment. Swartz et al. (Swartz DB, 1983) and Smith et al. (Smith CS., 1993) both found a significantly higher success rate in men compared with women, although a systematic review carried out by Ng et al. (Ng YL, 2008) found no difference in the healing powers between gender. It looks likely from current literature that the gender does not affect the outcome of treatment. The effect of patient age on treatment outcomes has no statistically significant difference in success rates (Strindberg LZ, 1956, Seltzer S, 1963, Ingle JL, 1965, Harty FJ, 1970, Barbakow FH, 1980a, Barbakow FH, 1980b, Barbakow FH, 1981, Nelson, 1982, Oliet S, 1983, Ørstavik D, 1993, Sjögren U, 1990, Friedman S, 1995, Benenati FW, 2002, Cheung GS, 2002, Hoskinson SE, 2002). However, pooled success rates by age bands were recorded and found a trend that showed that success rates appeared to decrease with increasing age (Ng YL, 2008). The impaired immune response associated with systemic diseases can affect the frequency of root canal treatment and the prevalence of apical periodontitis (J J Segura-Egea, 2015, Y-L Ng, 2011). Systemic condition in which a stronger systemic inflammatory reaction is induced, with activation of NF- $\kappa$ B in macrophages and increased cellular oxidant stress, can alter bone turnover and periapical wound healing (John J Taylor, 2013). Some systemic condition such as cardiovascular disease, diabetes mellitus, hypertension, and osteoporosis can impair the non-specific immune system and alter the periapical healing process of teeth following root canal treatment (J J Segura-Egea, 2015). Uncontrolled or inadequately controlled diabetes was first mentioned by Bender et al. (I B BENDER, 1963) in 1963 as a potential risk factor for the emergence of significant and damaging periapical functions. The literature shows delayed periapical healing in diabetic individuals, lower level of repair associated with root treated teeth (I B BENDER, 1963, Suman Arya, 2017 Oct, E. Laukkanen, Oct 2019), slower reduction in the size of periapical lesions in inadequate controlled diabetic patients (E Cheraskin, 1968 Jul), and higher proportion of persistent apical periodontitis in diabetics, compared to control individuals (H Falk, 1989 Jun, Fouad AF, 2003, Leandro R Britto, Oct 2003, J J Segura-Egea, 2005 Aug, José López-López 1, 2011 May, Patrícia S Marotta 1, 2012 Mar, Manuel Marques Ferreira, 2014 Jan) Some epidemiological researches have reported the strength of the relation between the diabetes and endodontic treatment by calculating the odds ratio values. The odds ratio values calculated for the outcome of root canal treatment in diabetics and control individuals, ranged from 1.3 to 5.3, point toward that the outcome of root canal treatment could be considered moderately related with the diabetic condition. These studies have been investigated by systematic reviews and meta-analysis, conducted that the individuals with diabetes have considerably higher prevalence of root filled teeth with periapical lesions (Juan

J Segura-Egea, 2016 Jul) and considerably higher prevalence of extracted root filled teeth than non-diabetic individuals (D Cabanillas-Balsera 2019 Mar, V. Nagendrababu, 2019 Nov). Cardiovascular disease is another systemic disease has an effect on periapical healing as demonstrated in several cross sectional studies (M., 2019, Virtanen E., 2017, An, 2016, Costa T.H.R, 2014, Pasqualini D., 2012, Liliestrand J.M., 2016). Additionally, a correlation between apical periodontitis and cardiovascular disorders has been discovered in three longitudinal investigations (D.J, 2006, Jansson L., 2001, Gomes M.S., 2015). However, one comprehensive systematic review reported that although the majority of published studies found a positive relationship between cardiovascular disease and apical periodontitis, the quality of the available data was moderate-low and causal association could not be demonstrated (Berlin-Broner Y., 2017). The primary goal of this study is to assess how preoperative prognostic variables (Gender, Age, General medical health, Tooth type, and Pulpal & periapical status) affect the outcome of the initial root canal therapy.

## 2.0 Materials and Methods

### 2.1 Patients Sample:

Ninety-one patients with full record of medical and dental data were included out of 109 treated patients. Patient with no follow-up recall (n=18) were excluded from the study. All treatments were performed through 2018 and 2019, in private Dental Clinic in Sirte, Libya. One endodontist carried out all initial consultations, examination, and treatment. Preoperative pulpal and periradicular diagnoses were made at the initial consultation. After informing all patients of the outcomes of their treatment, verbal and written consent was obtained for ethical reasons. Preoperative data included age, gender, tooth type, health status, pulp status (vital, non-vital) and periradicular status (presence or absence of apical periodontitis). All patients were over 15 years of age when treatment commenced and all teeth examined clinically and radiographically. The European Society of Endodontology's standards used to evaluate the treatment outcome.

### 2.2 Patients' Recall.

Either patients were called or had appointments set up in advance for clinical and radiological control. Recall period, existence or absence of clinical sign or symptoms, presence or absence of periapical disease, and restoration type were all noted postoperatively.

**Criteria of Evaluation** To assess the success rate of root canal therapy, the following criteria adapted from the European Society of Endodontology (2006) (European Society of Endodontology., 2006)

Table1. In cases where a tooth had multiple roots, the evaluation was based on the root that presented the worst.

**Table 1: Root canal treatment assessment categories**

Outcome	Clinical findings	Radiographic findings		Recall period
		Initial	Recall	
Favorable	- Absence of pain, swelling, sinus tract, loss of function, other symptoms	- Normal periodontal space around the root	- Periodontal space unchanged - Healing of the lesion with normal periodontal space around the root	At least one year
		- Radiolucent area	- Radiolucent area	At least after 4 years
Uncertain		- Radiolucent area	- No changes in the size of the initial lesion	
Unfavorable	- Presence of pain, swelling, sinus tract, loss of function, and other symptoms	- Periodontal space remained normal after endodontic treatment	- Radiolucent area	Further treatments are required
	- Presence of signs of root resorption	- Radiolucent area	- Radiolucent area	

**2.3 Radiographic Method and Evaluation**

Periapical radiographs were either digital or scanned conventional radiographs. Two independent endodontists, who have analyzed all preoperative and postoperative radiographs. The periapical area was viewed using Photoshop software (Adobe Photoshop.CS, Version 8.0, USA) at a magnification of about three. All considered teeth were scored based on the PAI system (Orstavik D., 1986). For healthy or diseased teeth with AP, a score of 1 or  $\leq 2$  was given, respectively.

**2.4 Statistical analysis**

In the context of this study, the results were analyzed using factor description and association analysis. The factor description was performed via success rate, whereas factor association was discovered through two-way cross tabulation of each of the preoperative factors against the success rate, a chi-square Pearson test was applied at the  $< 5\%$  significance level. Furthermore, the percentage success rate is also considered for different categories as well as overall. Graphical representation of the effect of different factors on success rate were also used for more visual details.

**3.0 Results**

Numerical results were supported by graphical representation. Table 2 shows that among the eight preoperative factors, two factor, namely, the Health status (Chi-square= 28.019, p-value = 0.0001) and Periapical status (Chi-square =19.024, p-value =0.004) were established to have a significant impact on the success rate at  $\alpha =0.05$  level of significance. No significant effect is observed for the rest factors. Table 3 shows the success rate percentage for different assessment categories and as an overall rate. The registered overall success rate was 89.7%. Figures (Fig 1 through Fig 8) show detailed graphical representation of different preoperative factors on success rate.

**Table 2: Prognostic factors related to success rate**

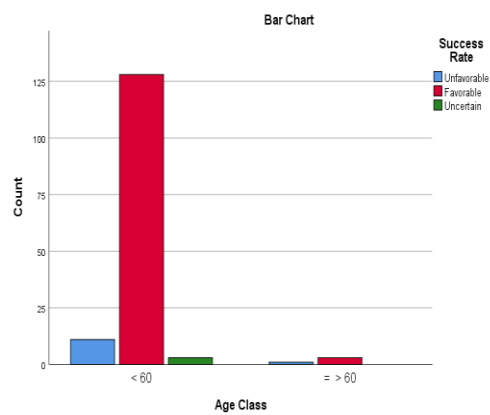
Prognostic factor	Category	Number of teeth	Success rate		p-value
			Categorical %	Overall %	
<b>Patient's gender</b>	Female	92	92.4%	58.2%	0.332
	Male	54	85.2%	31.5%	
<b>Health status</b>	Fit	132	92.4%	83.6%	0.0001
	Diabetic	8	50.0%	2.7%	
	Pregnant	5	80.0%	2.7%	
	Diabetic & Hypertensive	1	100%	0.7%	
<b>Tooth location</b>	Maxillary	98	92.9%	62.3%	0.146
	Mandibular	48	83.3%	27.4%	
<b>Tooth type</b>	Anterior	22	100.0%	15.0%	0.174
	Premolar	58	91.4%	36.3%	
	Molar	66	84.8%	38.4%	
<b>Number of teeth</b>	1	58	89.7%	35.6%	0.859
	2	36	83.3%	20.5%	
	3	24	87.5%	14.4%	
	4	12	100%	8.2%	
	5	10	100%	6.8%	
	6	6	100%	4.2%	
<b>Pulpal status</b>	Non-vital	56	83.9%	32.2%	0.184
	Vital	90	93.3%	57.5%	
<b>Age Class</b>	< 60	128	90.1%	87.7%	0.415
	= > 60	3	75.0%	2.1%	
<b>Periapical status</b>	1	97	92.8%	61.6%	0.004
	2	17	100%	11.6%	
	3	16	62.5%	6.8%	
	> 3	16	87.5%	9.7%	

**Table 3: Success rate percentage according to assessment categories.**

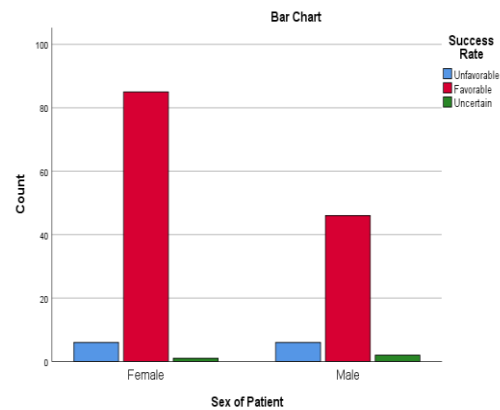
Category	Number of teeth	Percentage %	Overall success rate
Unfavorable	12	8.2%	89.7%
Favorable	131	89.7%	
Uncertain	3	2.1%	

**Graphical Representation**

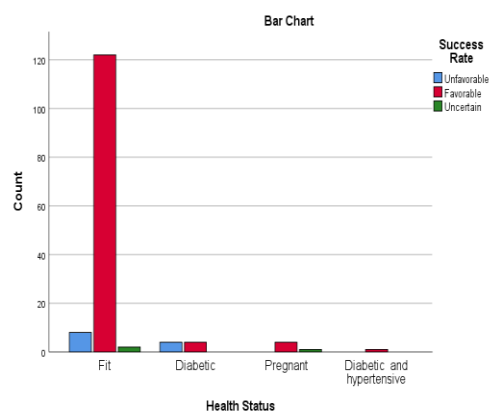
Below a graphical representation of the effect of preoperative factors on the success rate.



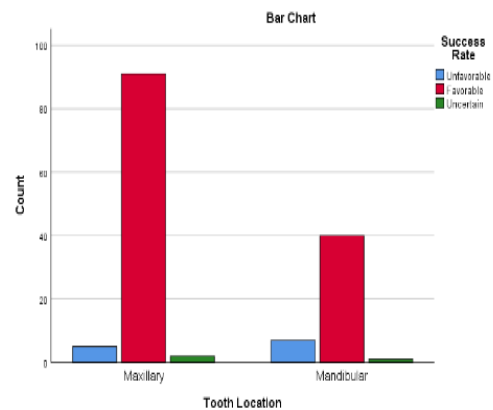
**Fig 1. Effect of age class on success rate**



**Fig 2. Effect of gender on success rate**



**Fig 3. Effect of health status on success rate**



**Fig 4. Effect of tooth location on success rate**

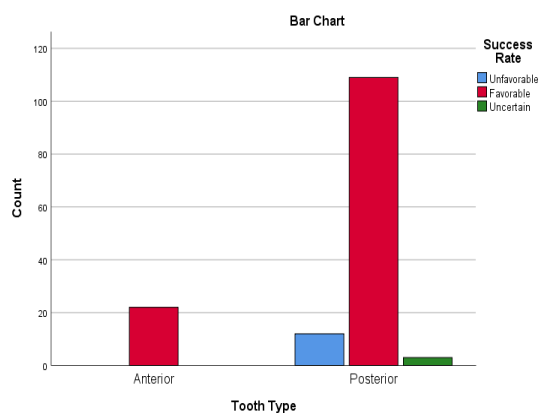


Fig 5. Effect of tooth type on success rate

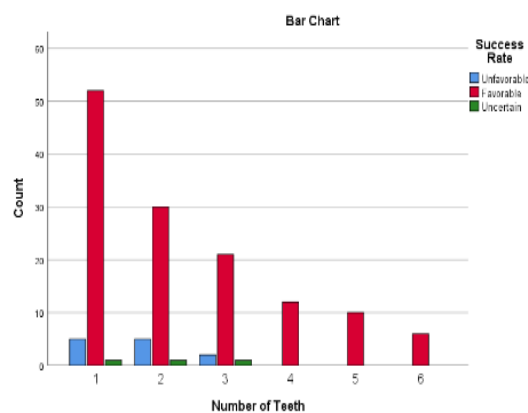


Fig 6. Effect of teeth number on success rate

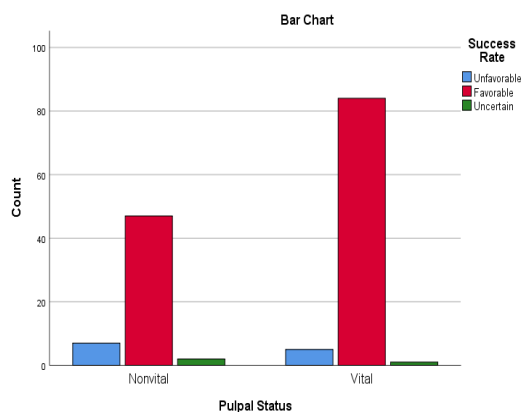


Fig 7. Effect of pulpal status on success rate

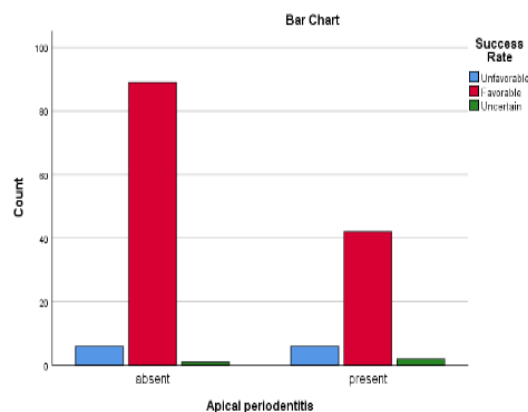


Fig 8. Effect of apical periodontitis on success rate

**4.0 Discussion**

In the present retrospective study, the Endodontic European Society recommendations served as the foundation for the evaluation of the clinical and radiographic results of initial endodontic treatments. The findings showed that medical health status and Periapical status are significant prognostic factors influencing the outcome. Other factors such gender, age, tooth type, tooth location, are not likely to have an impact on the treatment outcome. The study findings showed that there was no obvious difference in the success rate between male and female patients for the general patient characteristics (gender, age, and general medical health). Although there was no proof of a substantial variation in success rates by age bands, earlier research had found a pattern of success rates declining with age (Ng YL, 2008). This finding supports the idea that aging (Mogford JE, 2004),

malnutrition (Chernoff R., 2004) or systemic diseases such diabetes which are more prevalent in the older age group, impair the ability of older patients to heal (Cabanillas-Balsera Fig 6. Effect of teeth number on success rate D, 2006, Forouhi NG, 2006). A recent systematic review of longitudinal root canal treatment outcomes revealed that increased patient age does not decrease the success rate (Shakiba B, 2017), in agreement with findings of current study. According to the World Health Organization, older adults are those who are 65 years of age or older in developed countries, but only 60 years of age or older in developing countries (Hebling E, 2007). In this study, based on statistical analysis the medical health has a significant effect on treatment outcome. In addition, two further investigations(Fouad AF, 2003, Marending M, 2005) that corroborated the same conclusions found that the success rate of root canal therapy on teeth with periapical

lesions was significantly impacted by either diabetes (noninsulin dependent/insulin dependent) or a compromised nonspecific immune response. However, meta-analysis done by NG et al. (Ng YL, 2008) demonstrated that the medical health has a weak effect on root canal treatment outcome. The type of tooth does not significantly affect the success percentage of endodontic treatment. This statement confirmed in the majority of studies and corroborated by the pooled success rate calculated

using the meta-analysis approach (Ng YL, 2008). However, the reverse was demonstrated in a recent research by Erika et al. (Laukkanen E, 2019b), which suggested that the complicated canal structure of molar teeth can compromise the effectiveness of root canal therapy. Possibly more significant is the matter of apical anatomy and its infection (Wada M, 1998, Nair PN, 2005). The inconsistency between these results may be explained by the point that the majority of studies did not divide the outcome data according to pulpal and periapical condition for each tooth type. Preoperative status of the teeth (pulpal and periapical condition, and size of periapical lesion) may all potentially have an impact on treatment outcome (Restrepo-Restrepo FA, 2019, Paredes-Vieyra J, 2012). These studies demonstrated improved prognosis with endodontic treatment for small lesions, in agreement with the findings of the present study. The assessment of the outcome was based on the periapical index (PAI) which developed by Orstavik et al. (Orstavik D., 1986) who classified periapical lesions into five severity levels according to reference radiographs of teeth with a confirmed histologic diagnosis. The PAI was based on two-dimensional radiographic evaluation of three-dimensional structures. This limitation has been raised in several studies about the failure of conventional or digital radiograph in detection of some periapical lesion (Bender IB, 1961, Bender IB., 1982, Huuonen S, 2002, Stavropoulos A, 2007). In a region with a thin cortex, a certain size periapical lesion can be detected; in a region with a thicker cortex, the same size lesion will not be seen (Bender IB., 1982). Lesion location in various types of bone influences its radiographic visualization (Huuonen S, 2002). To be detectable radiographically, a periapical radiolucency must achieve almost 30%–50% of bone mineral loss (Bender IB, 1961). Regardless of the lesion size, the presence of pre-operative periapical radiolucency decreased the outcome or success of root canal treatment by 49% (Ng YL, 2008, Ng LY, 2011b).

### 5.0 Conclusion

Within the limitations of this study, medical condition and periapical status were found to significantly affect the success rate of root canal treatment. The other factors do not reveal a substantial impact on the success rate. Therefore, these elements need to be carefully

evaluated for root canal treatment. Because of the limitations of this study, the following may be help in conducting more controlled study in the future: 1-Launch prospective randomized controlled trials 2 Large sample size 3-Use limited field of view CBCT to assess periapical status instead of periapical radiographs

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