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The role of Dental Fear, Pain anticipation and Self-efficacy in Endodontic Therapy

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Background: Cognitive-behavioural interventions may be important for the prevention and treatment of oral diseases. One cognitive factor that has generated considerable interest as a possible mediator is self-efficacy. ***Methods***: One hundred patients diagnosed with pulpal or periapical pathology that required endodontic therapy were treated. Data were collected at baseline in the waiting room before therapy and then during treatment. ***Results***: Positive correlations were found between dental fear, pain anticipation and dental avoidance ($p<0.001$). The correlation between dental fear and pain anticipation showed the largest effect sizes. Healthy participants had higher scores in self-efficacy (Mean=32.55; SD=7.15) than those with systemic diseases (n=15; Mean=29.33; SD=4.76, p=0.04). Participants who not taking medication before treatment had lower scores for pain anticipation (Mean=3.63; SD=2.85) than those taking medication. The contribution of pain anticipation to dental avoidance varied at different values of self-efficacy. The indirect effect of dental fear on dental avoidance via dental anxiety was significant in individuals with higher self-efficacy. ***Conclusions***: Self-efficacy had an essential moderation role between pain anticipation and dental avoidance during endodontic treatment.

Keywords*: Self-efficacy, endodontic therapy, dental fear, dental avoidance*

Introduction

Dental fear is a worldwide phenomenon, not restricted to specific countries (Peretz, 1998). With a prevalence of between 5 and 20% in the adult population, it is one of the most common fears (Bernson *et al*., 2011; Oosterink *et al*., 2009). Previous literature has described a ´vicious circle dynamics´(Berggren and Meynert, 1984; Klepac *et al*., 1982) through which people with dental fear delay or avoid dental visiting, which results in a worsening oral health (Armfield and Heaton, 2013; Skaret *et al*., 2003). It is common for fearful people to seek dental care only when they are in pain or require emergency treatment (Armfield *et al*., 2008; Carter *et al*., 2015; Dou *et al*., 2018), leading to treatments which are more complex and longer lasting, that in turn reinforce their fear and continued avoidance of dental visits (Armfield and Heaton, 2013). Patients with this profile can't enjoy the benefits of preventive treatment at regular dental appointments (Armfield and Heaton, 2013), which jeopardises the individual´s wellbeing and is a public health concern (Crego *et al*., 2014; Diercke *et al*., 2013).

Individuals' perceptions of a stimulus or situation are more important in the constitution of fear than previous experiences (Armfield, 2006; Armfield *et al*., 2008). Armfield (2006) described the Cognitive Vulnerability Model of the etiological factors involved in fear acquisition. This model modified the Cognitive Psychological Theory introducing cognitive factors related to treatment. In particular, perceptions of the stimulus as uncontrollable, unpredictable, dangerous and disgusting are central to the aetiology of fear. This model has identified a cognitive schema that guides experiences, beliefs, emotions and behaviours. Specifically in the dental field, this model explains the reaction of a fearful person exposed to a dental situation. Cognitive elements have been identified as the best predictors of a person's level of dental fear (Crego *et al*., 2014).

Thus, it has been argued that cognitive-behavioural interventions are important for the prevention and treatment of oral diseases (Hashemi *et al*., 2021). One cognitive factor that has generated considerable interest as a possible mediator of health behaviour is self-efficacy (Hashemi *et al*., 2021). Self-efficacy has been defined as a judgment regarding one's ability to cope with specific situations (Bandura, 1977) and is an important predictor of a wide range of health behaviour changes, such as smoking cessation (Qin, 2022), weight control (Bretschneider *et al*., 2022) and physical activity (Neumann *et al*., 2022). In the dental field, several studies have investigated the relationship between self-efficacy and the maintenance of oral hygiene behaviour such as tooth brushing or flossing frequency (Buglar *et al*., 2010; Hashemi *et al*., 2021; Kakudate *et al*., 2010). Therefore, patients could benefit from therapies focused on reducing their sensation of lack of ability to confront dental situations by studying their levels of perceived self-efficacy. Thus, our study was carried out with patients that were about to undergo endodontic therapy, which is a dental procedure associated with high levels of fear and overestimation of pain (Carter *et al*., 2015; Diercke *et al*., 2013; Huh *et al*., 2015; Segura-Egea *et al*., 2009).

The aim of this study was to explore whether pain anticipation (mediator variable) mediates the effect of dental fear before endodontic treatment (independent variable) on

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dental avoidance during root canal treatment (dependent variable) as a function of self-efficacy (moderator variable). We hypothesised that dental fear operates on dental avoidance through pain anticipation and that, in turn, the relationship between pain anticipation and dental avoidance will vary depending on the levels of self-efficacy (i.e. the higher the self-efficacy, the lower the relationship between pain anticipation and dental avoidance). Figure 1 illustrates the hypothesized process. Thus the study had two objectives: (1) to exam whether the strength of the pain anticipation-dental avoidance association depends on the level of self-efficacy and how this effect influences the mediation (whether the mediation of dental fear-pain anticipation-dental avoidance is moderated by self-efficacy), and (2) to test whether this moderated mediation holds true after accounting for different sociodemographic and endodontic variables (only those with statistically significant relationships with the variables under study). To our knowledge, ours is the first study to test moderated mediation for this research question.

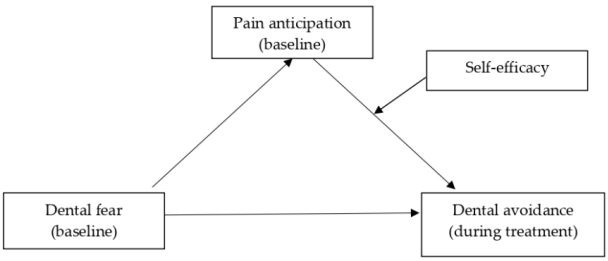

***Figure 1**. Conceptual Moderated Medication Model.*

Methods

This prospective observational study was conducted in two different clinics by the same team of researchers. The sample consisted of 100 patients, 59 participants were treated in an academic setting, University Dental Clinic, at the Health Sciences Faculty of Rey Juan Carlos University (Madrid, Spain) and 41 in a private dental practice (Ferrus and Bratos Dental Practice, Madrid, Spain). Participants ranged in age from 18 to 72 (mean, 42.91 years, SD 11.92) and 60% were women. The distribution regarding marital status is as follows: 31% single, 67% married or with a partner, and 2% divorced. Most of the sample considered their socioeconomic level to be medium (69%), assessing it as low and high by 15% and 16% of the sample, respectively. Patients from the private clinic were younger (p=0.02) and had a higher socioeconomic level (p<0.01) in comparison to the university dental clinic, therefore the clinic was considered as a possible covariate.

Of the total sample, 74% of the patients had undergone at least one previous root canal treatment. Forty-six percent of treated teeth were molars; 29% were premolars, 7% were canines, and 17% were incisors. Thirty two percent were diagnosed with needed retreatment and 68% were primary endodontic treatment.

Consecutive patients diagnosed with any pulp or periapical pathology that needed non-surgical endodontic therapy and who were >18 years old were invited to participate. A researcher invited patients to participate while they were in the waiting room before treatment. All invited patients agreed to participate. Participants signed informed consent separately for the treatment and the study. The treatments were carried out between February 2014 to March 2019, recruitment continued until 100 patients were included. The study was undertaken with the approval of the Committee for Ethics in Research of the Rey Juan Carlos University (Madrid, Spain).

Treatments were performed by a single experienced endodontist (MSc Endodontics and Operative dentistry) following the recommendations of the European Society of Endodontology (2006). Only the first root canal treatment conducted for a patient was included in the study. Under local analgesia, teeth were isolated using rubber dam. Access to the cavity was made with a diamond bur high speed size 014 (Komet®, Lemgo, Germany). The canals were cleaned and shaped with a combination of hand files (k-files, Denstply Maillefer®, Baillagues, Switzerland) and rotary files (ProTaper Universal files®, Denstply Maillefer, Baillagues, Switzerland). The working lengths of the canals were verified by apex locator (Root ZX®, J. Morita, Tokyo, Japan). Sodium hypochlorite 5.25% between each file was used and the chemomechanical protocol included a final rinse of 18% EDTA (Ultradent®, St Louis, USA). Finally, canals were dried using paper points and filling using a sealer (AH Plus®, Denstply Sirona, Baillagues, Switzerland) and guttapercha with a continuous wave down pack technique of obturation (System B, SybronEndo®, Glendora, USA).

Data were collected in the waiting room before starting endodontic therapy and then during endodontic therapy.

Baseline measurements included the following psychological variables:

1. *Pain Anticipation:* an ad hoc item was used, with the question: ´How painful do you feel the pain will be during treatment?´ The measure was scored on a 10-point Likert scale from ´0 = no pain´ to ´10 = maximum pain´.
2. *Self-Efficacy* using the Spanish version of the 'General Self-efficacy Scale' (Baessler and Schwarzer, 1996). This scale is brief and widely used to measure a person's belief in their ability to control their symptoms. It comprises 10-items such as ´I am confident that I could deal efficiently with unexpected events´ or ´I can solve most problems if I invest the necessary effort´ scored on 4-point Likert-type responses ranging from 1 (strongly disagree) to 4 (strongly agree), with total scores from 10 to 40 and higher scores denoting greater self-efficacy. Internal consistency for this scale was high in these data (Cronbach´s alpha = 0.83).
3. *Dental Fear* using core module of the Index of Dental Anxiety and Fear (IDAF-4C, Armfield, 2010). The Anxiety and Fear module focuses on central features of dental anxiety relating to four theoretical components: emotional, cognitive, behavioral and physiological. Each component includes two items. The response formats include a 5-point Likert scale, ranging from `1 = disagree´ to `5 = strongly agree´. Mean full scale scores were categorized to indicate little or no dental fear

(1–1.50), low dental fear (1.51–2.50), moderate dental fear (2.51–3.50), and high dental fear (> 3.50). The IDAF-4C has high internal consistency (Cronbach´s alpha = 0.91) and good test-retest reliability (r = 0.82) (Armfield, 2011; 2010). Internal consistency was also high in these data (Cronbach´s alpha = 0.87).

Sociodemographic and clinical covariates included: age, gender, marital status, socioeconomic level and clinic where the treatment was performed were recorded through the medical history and ad-hoc items.

Clinical variables:

1. *American Society of Anesthesiologist's Physical Status Classification System (ASA-PS)* (Saklad, 1941) is a single categorization of the patient´s overall health. The score consists of six classes (I to VI), with the addition of an "E" to any class that indicates emergency. We used only classes I (normal healthy patient), II (patient with mild systemic disease) and III (patient with severe systemic disease). Despite being routinely used, the rating has low inter-rater reliability with a strong reliance on work experience (De Cassani *et al*., 2019).
2. *Medication:* antibiotics and/or anti-inflammatory drugs used for patients' presenting dental condition.
3. *Endodontic variables:* Pulpal status was diagnosed using symptoms and clinical palpation, percussion and a cold sensibility test as irreversible pulpitis, necrosis, apical periodontitis or need for retreatment. A preoperative periapical radiograph of the tooth was used to register periapical status as showing a radiolucent apical lesion or not.
4. *The Endodontic Case Difficulty Assessment Form* (AAE, 2015) identifies three categories of considerations that may affect treatment complexity: (i) patient considerations including medical history according to ASA-PS Classification, patient disposition (cooperative, anxious or uncooperative), anaesthesia problems, patient´s ability to open mouth, gag reflex and treatment emergency condition; (b) diagnosis and treatment considerations including difficulty taking x-rays, position of the tooth, difficulty isolating the tooth, anomalies in the morphology of the crown/canal/root, radiographic appearance of canals and presence of resorption and (iii) trauma history, endodontic treatment history, and periodontal-endodontic condition. Levels of difficulty were assigned within each category according to the number of complicating factors with 'minimal difficulty' denoting no complicating factors, 'moderate difficulty' for cases with one or more complicating factors and high difficulty for those with multiple factors.

The following data were collected during treatment:

1. *Dental Avoidance during treatment* using an ad-hoc item. Patients were asked ´To what extent would you avoid this situation?´ half-way through treatment, at the time when x-rays were taken. Patients were asked to score on a 10-point Likert scale from ´0 = no avoidance´ to `10 = maximum avoidance´.
2. *Number of canals of treated teeth*

Data Analysis first described the distribution of variables and internal reliability of psychological scales. Bivariate associations between the study variables were investigated using Pearson correlations, Student's t-tests and one-way ANOVAs (with corresponding post-hoc analyses) to identify possible covariates. The second stage involved moderated mediation analysis combining both the mediation and moderation effects into a single model (Hayes, 2013). We tested the proposed moderated mediation model using PROCESS macro for SPSS. PROCESS is an observed variable ordinary least squares (OLS) and logistic regression path analysis modelling tool widely used in social, business, and health sciences for estimating direct and indirect effects in single and multiple mediator models (parallel and serial), two and three way interactions in moderation models along with simple slopes and regions of significance for probing interactions, and conditional indirect effects in moderated mediation models with a single or multiple mediators or moderators. PROCESS has more than 70 models each relating to a different combination of mediators and moderators. Consistent with our aim, we used model 14 (moderated mediation analysis) which tests a mediator variable (M) between X (predictor) and Y (outcome), and in turn, a moderator variable (Mo) in the relationship between M and Y. The model was populated whereby path X ("dental fear") to Y ("dental avoidance") was mediated by M ("pain anticipation"), and in turn, the path M ("pain anticipation") to Y ("dental avoidance") was moderated by Mo ("self-efficacy"). Analyses were based on 5,000 bootstrapped samples, using bias-corrected 95% confidence intervals. For the mediation analysis, when the confidence interval did not include 0, an indirect effect was considered significant (Preacher *et al*., 2007). The moderation, if significant, was analysed at three levels: 16th, 50th and 84th percentiles (default values).

Results

Table 1 describes the variables and bivariate correlations between them. Pain anticipation and dental avoidance presented symmetrical distributions (values close to zero), whereas self-efficacy and dental fear data were non-normally distributed. The medians and interquartile ranges of the two single item measures (pain anticipation and dental avoidance) were 4 (2 for 25th, 6 for 75th) and 5 (2 for 25th, 8 for 75th) respectively.

Positive correlations were found between dental fear, pain anticipation and dental avoidance (all $p<0.05$ in Table 1). The correlation between dental fear and pain anticipation was greatest. Self-efficacy was unrelated to any of the other variables.

Age, gender, marital status, socioeconomic level and treatment clinic were tested as possible covariates. Higher socioeconomic level correlated with less dental fear (r^2= -0.24, p= 0.02). The clinical variables (systemic disease, previous medication, radiolucent apical lesion, ASA classification, number of canals, pulpal diagnosis and case difficulty) were also investigated as possible covariates. Systemic disease correlated with self-efficacy (partial eta squared= 0.02, p=0.04) and previous medication correlated with pain anticipation (partial eta squared=

0.01, p= 0.01). Specifically, patients without previous systemic diseases scored higher for self-efficacy (n=84; Mean=32.55; SD=7.15) than those who did (n=15; Mean=29.33; SD=4.76), and patients who had not taken medication before treatment scored lower for pain anticipation (n=71; Mean=3.63; SD=2.85) than those who had (n= 29; Mean=5.28; SD=2.08). Given the correlations between these variables and others in the model, we included them as covariables.

The indirect effect of dental fear on dental avoidance, by way of pain anticipation, depending on the level of self-efficacy was tested in the four-step moderation mediation model (Figure 1 and Table 2). Socioeconomic level, dental clinic, systemic disease and previous medication were included as covariates. Step 1 shows the positive effect of dental fear on pain anticipation, with previous medication a significant covariate. Step 2 shows the model for dental avoidance, with the effect of dental fear, moderated by pain anticipation and self-efficacy and the interaction between them (all significant in the model). Step 3 shows the conditional effects of pain anticipation on dental avoidance depending on self-efficacy. I.e., the relationship between pain anticipation and dental avoidance depended in turn on self-efficacy. Only high levels of self-efficacy were associated with a significant relationship between pain anticipation and dental avoidance. Finally, step 4 considers the effects on dental avoidance, in relation to dental fear and pain anticipation, for the different levels of self-efficacy (low, medium and high) Again, there were significant effects in the case of high self-efficacy. The model explained 23% of the variance in dental avoidance.

Table 1. Descriptive statistics and correlation between outcome variables.

	Mean (SD)	*Asymmetry*	*Kurtosis*	*2*	*3*	*4*
1. Dental fear	1.70 (0.78)	1.25	0.82	0.48*	0.31*	-0.13
2. Pain anticipation	4.11 (2.40)	-0.07	-1.01		0.28*	-0.14
3. Dental avoidance	5.08 (3.42)	-0.04	-1.15			0.08
4. Self-efficacy	32.01 (6.86)	4.63	35.12			

* p<0.05

Table 2. Moderate mediation model.

Step 1. Regression of dental fear on pain anticipation			
	B (SE)	*p*	*LLCI-ULCI*
VD: Pain anticipation			
VI: Dental fear	1.38 (0.28)	<0.01	0.81-1.93
Previous medication	1.02 (0.49)	0.05	0.04-2.00
Step 2. Regression of dental fear on dental avoidance through pain anticipation (including interaction between pain anticipation and self-efficacy)			
VD: Dental avoidance			
VI: Dental fear	1.22 (0.05)	0.02	0.23-2.20
M: Pain anticipation	0.36 (0.17)	0.03	0.02-0.87
Mo: Self-efficacy	0.13 (0.07)	0.01	0.03-0.36
Interaction Me*Mo	0.07 (0.04)	0.02	0.01-0.29
Model summary	R^2: 0.23	p=0.01	
Step 3. Conditional effects of pain anticipation on dental avoidance in relation to self-efficacy			
28 (low self-efficacy)	0.01 (0.19)	0.98	-0.38/0.39
31 (medium self-efficacy)	0.23 (0.16)	0.16	-0.10/0.56
37 (high self-efficacy)	0.68 (0.26)	0.01	0.17/1.20
Step 4. Indirect effects on dental avoidance, in relation to dental fear and pain anticipation, in relation to self-efficacy			
28 (low self-efficacy)	0.02 (0.28)		-0.62/0.49
31 (medium self-efficacy)	0.32 (0.24)		-0.21/0.77
37 (high self-efficacy)	0.95 (0.37)		0.21/1.66
Index of moderated mediation	0.10 (0.05)		0.02/0.20

BootLLCI, bootstrapping lower limit confidence interval; BootULCI, bootstrapping upper limit confidence interval; VD, Dependent variable; VI, Independent variable; M, Mediator; Mo, Moderator.
Only significant covariates are shown.
Non-significant covariates in Step 1: socioeconomic level, dental clinic and systemic disease.
Non-significant covariates in Step 2: socioeconomic level, dental clinic, systemic disease and previous medication.

Discussion

These data among patients attending for endodontic treatment showed an indirect effect of dental fear on dental avoidance mediated via pain anticipation in individuals with higher self-efficacy. These findings are consistent with previous literature, where it is assumed that dental fear predicts subjective avoidance of dental treatment (Armfield *et al*., 2007).

Dental fear is problematic in itself but also has consequences on the health of the people experiencing it (Carter *et al*., 2014) as they often have poorer oral health because they are more likely to delay dental appointments (Armfield and Heaton, 2013; Skaret *et al*., 2003). Previous research has consistently shown a vicious cycle of dental fear, whereby avoidance of dental visits allows for the progression of disease that may require emergency treatment, which then reinforces the fear (Armfield *et al*., 2008).

In addition to the vicious cycle of dental fear and avoidance, pain plays a crucial role in the development of dental fear (Dou *et al*., 2018), as the fear of pain during treatment is a key reason for dental phobia (Van Wijk and Hoogstraten, 2005). Furthermore, the relationship between pain anticipation and avoidance has also been established (Lin, 2013; Van Wijk and Hoogstraten, 2006), although, on occasions, dental fear and pain anticipation have not been sufficiently well described as completely independent variables. To the best of our knowledge, this is the first study where pain anticipation has been studied independently from the fear of pain or dental fear. This allowed us to explore its role as a mediator in the interaction between fear and avoidance, which makes up a large part of the vicious circle.

A novel result of this study was that self-efficacy moderated the effect of pain anticipation on avoidance during endodontic treatment. The anticipation of pain seems to lead to treatment avoidance in patients with high self-efficacy. Because of this, the level of patient´s self-efficacy is suggested to have a significant role in terms of subjective avoidance in endodontic treatment. Put another way, the relationship between pain anticipation and avoidance was not universal, but depended on the patient´s self-efficacy. These results might seem contradictory because self-efficacy is an important predictor of a wide range of health behaviours (Holloway and Watson, 2002; Peters *et al*., 2019) and in oral health behaviours in particular (Woelber *et al*., 2015). A possible explanation could be given in line with the Cognitive Vulnerability Model and the aetiological factor of fear (Armfield, 2006). Within this model, dental patients may experience stimuli as uncontrollable, unpredictable, dangerous and disgusting and these perceptions may be antagonistic to self-efficacy. People with high levels of self-efficacy need to take the control of situations and find it difficult to delegate control to others, in this case, to the dentist. Further research in this field is necessary. The new Index of Dentist Trust Scale (Armfield *et al*., 2017) which assesses the extent to which patients trust their dentists, could be a valuable tool in such research.

Patients without a previous systemic disease showed greater self-efficacy than those with a disease. Other research has shown that patients with chronic diseases present lower levels of self-efficacy (Bakan and Inci, 2021; Doğan *et al*., 2016). Many psychological interventions aimed to improve quality of life among patients with chronic diseases include aspects to enhance self-efficacy (Martinez-Calderon *et al*., 2017). Finally, there is a close association between self-efficacy and healthy lifestyles, with implications as for health promotion (Bretschneider *et al*., 2022; Neumann *et al*., 2022; Qin, 2022). The role of self-efficacy in patients undergoing different dental treatments may warrant investigation.

Patients who were not taking medication before treatment anticipated less pain than those who had. This result is in accordance with the vicious circle of dental fear (Berggren and Meynert, 1984; Klepac *et al*., 1982; Van Wijk and Hoogstraten, 2005), as fearful people avoid dental treatment and only seek it when they are in pain or have developed a dental problem (Armfield *et al*., 2008; Carter *et al*., 2015; Dou *et al*., 2018).

A strength of this study is the accounting for numerous variables to highlight the mediating role of pain anticipation between dental fear and dental avoidance, having found that there is also an association between pain anticipation and avoidance, which is enhanced when self-efficacy levels are high. However, some limitations must be taken into account. The sample was small and differences between the two treatment clinics have been observed, so the findings should be generalized with care. Also, 74% of the patients had undergone previous endodontic treatment, and this sampling restriction may also limit generalisability. Nevertheless, root canal treatment is one of the most frequent treatments in odontology, and the data can be applied to this situation. Whilst single-items are widely used in pain assessment, they are less commonly used as attitudinal measures. Single-items are less reliable, which may have restricted power in some analyses. Finally, although the prospective design of this study is a strength, more time points would have allowed data collection to correspond to the three stages in the model to enhance causal inference. Future research could consider this type of design.

Despite these limitations these data reveal that pain anticipation mediates the relationship between dental fear and dental avoidance during endodontic treatments, especially in patients with high levels of self-efficacy. They demonstrate the importance of taking into account high self-efficacy as a factor that can contribute to avoidance in patients with high pain anticipation. In this regard, this study shows the importance of the use of the theory of self-efficacy in the field of endodontic therapy.

At a practical level, endodontists could assess patients´ self-efficacy before treatment using a very simple scale such as the one used here (General Self-Efficacy Scale with 10 items). Despite the difficulties and the scarce use of this instrument in the dental clinic, it could be administered at the same time as obtaining consent for treatment. The information could be valuable, as specialists could give patients advice about the benefits of using endodontic therapy to maintain a tooth, especially with patients with high self-efficacy. They might also give more detailed information about the procedure, its duration and the sensations to be expected. They could give special attention to questions the patient may have and establish ways to communicate between them during the procedure. These explanations may help patients who have greater need for control.

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Conflict of interest

The authors declare that they have no conflicts of interest.

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