

ORIGINAL ARTICLE

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The impact of dental appearance and anxiety on self-esteem in adult orthodontic patients

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Date:

Accepted 28 February 2015

DOI: 10.1111/ocr.12091

© 2015 John Wiley & Sons A/S. Published by John Wiley & Sons Ltd Romero-Maroto M., Santos-Puerta N., González Olmo M. J., Peñacoba-Puente C. The impact of dental appearance and anxiety on self-esteem in adult orthodontic patients

Orthod Craniofac Res 2015; **18**: 143–155. © 2015 John Wiley & Sons A/S. Published by John Wiley & Sons Ltd

Structured Abstract

Objectives – To analyse the relationship between different dimensions of dental appearance impact and self-esteem in adult patients undergoing orthodontic treatment, with special attention to the possible mediating role of anxiety.
Setting and Sample Population – A quasi-experimental design was

used with a matched control group (without orthodontic treatment). In each group (experimental and control), there were 85 patients. *Material and Methods* – The impact of dental appearance was mea-

sured using the Psychosocial Impact of Dental Aesthetics Questionnaire (PIDAQ). State anxiety was assessed with the State Anxiety Inventory (STAI-S) and self-esteem with Rosenberg's self-esteem scale.

Results – In both groups (experimental and control), self-esteem correlates negatively, ranging between 0.26 and 0.43, with all dimensions of dental appearance impact (except for the positive dental self-confidence dimension, where all correlations were positive). Anxiety correlates positively, ranges between 0.35 and 0.44, with social impact, psychological impact and aesthetic concern, although it maintains no significant correlations with dental self-confidence. Nevertheless, in patients undergoing orthodontic treatment, anxiety plays a mediating role between dental impact dimensions and self-esteem, whilst for the control group anxiety only plays a mediator role between psychological impact and self-esteem. **Conclusion** – Anxiety plays a fundamental role in the effect of perceived dental impact on self-esteem in adult patients undergoing orthodontic treatment. These results have important practical implications for the design of bio-psycho-social intervention programs that contemplate cognitive-affective variables as an essential part of orthodontic treatment in adults.

Key words: adults; anxiety; dental impact; orthodontics; self-esteem

Introduction

The concept of dental aesthetics is clearly related to patients' concerns about the psychosocial impact of their dental appearance (1-3) and has a significant influence on the initiation and adherence to certain dental treatments, particularly in orthodontics (4). In spite of patients' differences regarding ethnic, economic, cultural and social aspects (3), it can be said that most of those who demand orthodontic treatment request it because of concerns about their physical appearance and other psychosocial factors related to this, such as self-confidence (3, 5, 6). This influence has been studied mostly in children and adolescents (7); less literature has focused on these aspects in adult samples (3, 8-11).

In this context, the impact of dental appearance on self-esteem has been analysed. As have pointed out, most studies centre on samples of children and adolescents. It appears that malocclusion and an unattractive dental appearance have a negative social impact on an individual (1, 12), particularly in girls (13), suggesting that the negative perception of the dentofacial region is more important for self-esteem than the severity of the malocclusion itself (14). De Baets et al. (15) found a significant relationship between orthodontic treatment need and oral health-related quality of life, and between selfesteem and oral health-related quality of life, but no evidence was found to suggest that selfesteem moderates the relationship between oral health-related quality of life and treatment need. Agou et al. (16), found that, compared to normative measures of malocclusion, self-esteem is a more salient determinant of oral health-related quality of life in children seeking orthodontic treatment.

However, despite this suggested relationship between dental aesthetics and self-esteem, the specific results of orthodontic treatment in improving self-esteem are not consistent across studies. Thus, while several studies show that orthodontic treatment influences the level of self-esteem, showing a marked improvement at

the end of treatment (13, 17) and impacting on improving social relationships (1), others have found no differences in self-esteem after completion of orthodontic treatment (18). The longitudinal study (baseline and one year after start of orthodontic treatment) carried out by Brosens et al. (19) shows that oral health-related quality of life deteriorates in children during orthodontic treatment and that self-esteem can be a protective factor in oral health-related quality of life during orthodontic treatment. It is important to highlight the negative psychosocial impact of orthodontic treatment, where different studies have analysed the relationship between orthodontic treatment and self-esteem in bullying (20). It has also been found that there are differences in the effects according to sex, pointing to larger effects on females (13).

The scarce literature on adult samples shows similar relations to those shown in studies on children and adolescents between dental appearance, self-esteem and oral health-related quality of life. Ozhavat (11), in patients with partial tooth loss, found that negative affectivity had the strongest and most clinically meaningful influence, but both negative affectivity (high) and self-esteem (low) were found to influence worse oral health-related quality of life. Frejman et al. (9) suggest, in a study conducted before orthodontic treatment, that patients with Class II and Class III dentofacial deformities had a more negative oral health-related quality of life and a lower self-esteem compared with controls with harmonious faces. Also, the studies focused on the development of self-esteem during the course of treatment have also shown contradictory results. Whilst some have found no differences in self-esteem after completion of orthodontic treatment (21), others found improved self-esteem and diminished depressive symptoms due to surgical intervention (10), although, this is the same result found in samples of children and adolescents, the results of improvements are especially significant among women (10), and these differences in relation to gender have also been observed when comparing patients with orthodontic treatment needs and a control group (3).

In this context, O'Regan et al. (22) have pointed out that improvement in dental and/or facial aesthetics does not necessarily lead to an increase in self-esteem. Possible explanations for this lack of consistency between different studies may lie in the fact, already discussed by Kenealy et al. (23), that when self-esteem at baseline was controlled for, orthodontics had little positive impact on psychological health and quality of life in adulthood. These authors, using a 20-year follow-up study in which they compared the dental and psychosocial status of individuals who received or did not receive orthodontic treatment as teenagers, showed that dental status alone was a weak predictor of self-esteem at outcome. Self-esteem in adulthood was more strongly predicted (65% of the variance) by psychological variables at outcome: perception of quality of life, life satisfaction, self-efficacy, depression, social anxiety, emotional health and by self-perception of attractiveness. Dental status in adulthood, whilst statistically significant, appeared to be of minor importance in a model that included other psychological variables. However, when self-esteem at baseline was controlled for, orthodontics had little positive impact on psychological health and quality of life in adulthood. When prior need for treatment was taken into account, there was little objective evidence to support the assumption that orthodontics improve longterm psychological health.

In particular, affective variables, specifically anxiety, might play a key role in explaining the effects of orthodontic treatment on self-esteem. Although the effects of these variables in other areas of health and illness have been widely studied, there are, to our knowledge, no studies analysing their effects in the direction pointed to by Kenealy et al. (23).

A review of the literature provides evidence that anxiety about dental treatment is a widespread problem that represents a barrier to the patients and must be overcome with the help of professionals (24). Most studies in the field of orthodontics focus on the role of anxiety on adherence to treatment (25, 26), tooth extractions (27, 28), painful experiences and how to reduce its levels through information, communication and informed consent (29). Specifically, the association between orthodontic treatment and anxiety has been clearly established, especially at the beginning of treatment (25, 30) and certain techniques (relaxation, information, telephone call) have been proven useful in reducing it (31-33), although not always with optimal results (29). It has also been established that anxiety levels decrease after patients become familiar with their orthodontist and they become accustomed to orthodontic treatment (30). Nevertheless, in spite of the above evidence about the association of anxiety and orthodontic treatment, there are scarce studies, to our knowledge, that examine the role of anxiety on the impact of dental appearance on self-esteem or other psychosocial outcomes in orthodontic treatment in the same direction as pointed out by Kenealy et al. (23). Topcuoglu et al. (34) assessed the changes in depression and anxiety levels of orthodontic patients before the extraoral appliance therapy, and at a 1-year follow-up, finding that the 1-year-treatment group scored significantly higher than the pre-treatment group on the depression scale and the trait anxiety scale.

This is why, due to the lack of studies analysing the possible mediating role of affective variables in the relationship between dental impact and self-esteem in adult patients with orthodontic treatment, this study has two main aims. One of the aims was to analyse the relationship between impact of dental appearance, selfesteem and anxiety in a sample of adult patients undergoing orthodontic treatment compared to a matched control group. The second aim was to investigate the possible mediator role of anxiety in the relation between dental impact and self-esteem in adult patients undergoing orthodontic treatment.

Material and methods Study design

To address the research purpose, we designed an observational, cross-sectional study with two groups: experimental (undergoing orthodontic treatment) and control (without orthodontic treatment).

Participants

A total of 170 Caucasian patients participated in this study, above 18 years old, all patients in the study attended the Rey Juan Carlos University Clinic. Of the 170 patients, 85 of them constitute the experimental group. These patients began orthodontic treatment at the Rey Juan Carlos University Clinic (Master of Orthodontics and Dentofacial Orthopedics) in Madrid, Spain, between May 2010 and November 2011. These patients were selected consecutively from the waiting list during this period. All patients were treated with fixed appliances (metal brackets) for around 18 months. Treatment procedures in all patients were very similar. The inclusion criteria were Class I, Class II and Class III malocclusion with upper and/or lower anterior malalignment with various degrees of overbite and overjet and no need for extractions as part of the orthodontic treatment, with dental crowding less than 6 mm. To be eligible, the participant had to be in good general health.

Comparison was made with a matched group of subjects without need of orthodontic treatment and of similar socio-demographic variables from patients of the dental service of Rey Juan Carlos University Clinic. The control group comprised 85 participants with age, gender, educational level and employment status matching the experimental group. The inclusion criteria were to have gone to the university clinic only requesting services such as dental filling, dental clinic ultrasonic and periodontal treatment.

The exclusion criteria for both groups were the presence of chronic diseases, diagnosis of a mental disorder, daily use of antidepressive medication or poor periodontal health status as indicated by a community periodontal index score of 3 or more, jaw discrepancies requiring orthognathic surgery, severe dentofacial anomalies such as cleft lip and palate, having received previous orthodontic treatment and to require headgear or auxiliary components such as a quadhelix. This was to prevent possible confounding effects of these conditions and to achieve a homogeneous sample. Exclusion criterion for the control group was the need for orthodontic treatment.

Our study was approved by the local Human Research Committee. All participants signed a declaration of informed consent prior to their inclusion in the study.

Measures

The Psychosocial Impact of Dental Aesthetics Questionnaire (PIDAQ) (35) is a psychometric instrument containing 23 items. Structurally, it is composed of four subscales, one positive and three negative, which represent four domains: aesthetic concern (AC; 3 items), psychological impact (PI; 6 items), social impact (SI; 8 items) and dental self-confidence (DSC; 6 items). Aesthetic concern is the positive subscale. A 5-point Likert scale is used, ranging from 0 [no impact of dental aesthetics on quality of life (QoL)] to 4 (maximal impact of dental aesthetics on OoL) for each item. The PIDAQ instrument has been widely tested and results show high internal consistency and factorial stability across samples (21, 36).

To assess self-esteem, we used *Rosenberg's self-esteem scale* (37). Rosenberg's scale is a 10-item instrument with a 4-point Likert scale. A high score reflects positive self-esteem. This scale has been used many times with proven reliability and validity for general population and orthodontic patients (13); it is simpler and more focused on self-esteem than other scales related to self-concept.

The State Anxiety Scale from *State-Trait Anxiety Inventory (STAI)* was used (38). The STAI is a self-report instrument, which is comprised of separate self-report scales measuring two distinct anxiety concepts: state anxiety (how one feels at a particular moment or situation; e.g. dental visit) and trait anxiety (how one usually feels). This scale has been widely used and validated in different populations, and it has also been frequently used amongst orthodontic patients (25, 26). The State Anxiety Scale consists of 20 items, using a four-point Likert scale rang-

ing from 0 to 3 (0 indicates rarely; 1 sometimes; 2 often; 3 almost always). In this study, we used state anxiety because our aim was to assess patient's anxiety about orthodontic treatment, as has been carried out in previous studies (39).

The Cronbach's alpha for each variable in our study is presented in Table 1.

Socio-demographic data

These were gathered by means of a questionnaire designed by the research team. The sociodemographic variables collected were age, gender, educational level and employment status at the time of the study.

Procedure

All participants from both groups were recruited at the Rey Juan Carlos University Clinic, Madrid, Spain, within the Odontology and Orthodontics services of The Rey Juan Carlos University, one of six public universities of Madrid. The Odontology and Orthodontics services of the University Clinic treats approximately 1700 adult patients a year for general odontology treatments and about 90 adult patients to initiate orthodontic treatment.

Participants of the experimental group were recruited by a trained research assistant in the waiting room before regularly scheduled appointments. Recruitment focused on patients at their initial orthodontic screening appointment and those scheduled for regular orthodontic treatment appointments. Patients at their initial orthodontic screening (T1) had no prior interaction with an orthodontist before this survey. The experimental group accounted for 84% of all patients seeking orthodontic treatment, who fulfilled inclusion criteria, in the period of data collection, 16% of the patients approached refused to participate in the study.

After 3–6 months of treatment, we proceeded to assess the target variables (dental impact, anxiety and self-esteem). We chose this time frame due to two reasons. A review by Jian et al. (40) shows that the dental alignment and levelling occurs in the first 10 weeks of treatment. Table 1. Means, standard deviations (SD) and Pearson's correlation coefficients for all variables (experimental and control group)

Ц	leor. range	group Mean (SD)	Control group Mean (SD)	$t\left(p ight)$	-	2	б	4	IJ	Q
1. Dental 0)-24	14.89 (6.50)	13.78 (5.39)	1.150	(0.93)	-0.30* (-0.05)	-0.30** (-0.50**)	-0.57** (-0.54**)	-0.06 (-0.21)	0.43** (0.30**)
self-confidence										
2. Social Impact 0)-32	15.34 (9.46)	9.72 (7.80)	3.871**		(0.70)	0.54** (0.45**)	0.44** (0.45**)	0.44** (0.30*)	-0.36** (-0.24)
3. Psychological 0)24	12.16 (8.63)	8.86 (4.93)	2.835**			(0.69)	0.44** (0.69**)	0.35** (0.38**)	-0.26* (-0.45**)
impact										
4. Aesthetic C)—12	6.30 (4.13)	4.12 (3.16)	3.611**				(0.92)	0.36** (0.29*)	-0.32** (-0.25*)
concern										
5. Anxiety (state) 0)-60	17.50 (9.97)	18.01 (10.67)	-0.267					(0.82)	-0.37** (-0.64**)
5. Self-esteem 10)-40	32.14 (4.72)	31.47 (4.79)	0.839						(0.86)

Also, patients, during the initial 3 months, will have already experienced the discomfort involved in wearing fixed appliances in various aspects of their lives, but are not yet tired of wearing the appliance, that usually occurs later. It is also known that anxiety levels decrease after patients become familiar with their orthodontist and they become accustomed to orthodontic treatment and this period is usually between 3 and 6 months (30).

The control group was included in the study consecutively as they sought dental services. The control group was matched for age, gender, educational level and employment status. If the criteria for matching were fulfilled they were asked to participate; none refused. Having collected the sample and the corresponding analysis performed, no significant differences in any of the socio-demographic variables with the group undergoing orthodontic treatment were found.

Statistical analysis

The relationships between socio-demographic variables and self-esteem, anxiety and PIDAQ dimensions were explored by conducting the appropriate test for each variable (Pearson' correlations, *t*-tests and one-way ANOVAS). Student's *t*-test was used to compare differences in target variables (self-esteem, anxiety and PIDAQ dimensions) between the experimental and control groups. The significance of the *post hoc* comparisons was calculated with the Scheffé test.

The relationships between self-esteem, anxiety and PIDAQ dimensions were analysed using Pearson's correlations.

To test for the presence of mediating effects, we conducted an ordinary least squares multiple regression analysis (41) and a Sobel test (42). Several preconditions must be met to assess whether a variable has a mediating effect, such as: 1) significant relationships between the predictor variables (dental impact dimensions) and the mediator (anxiety), 2) significant relationships between the predictor variables and the outcome variables (self-esteem) and 3) significant relationships between the mediator variable and the outcome variables. These preconditions were assessed with Pearson's correlations among the variables of interest. This analysis allowed us to identify the relevant variables to introduce in the subsequent regression analyses. In this way, we selected the dental impact dimensions that were significantly related to anxiety (first precondition) and to selfesteem (second precondition). When the preconditions have been fulfilled, the final step consists of showing that the strength of the association between dental impact and self-esteem is significantly reduced when the mediating variable (anxiety) is added to the regression model. Sociodemographic variables showing a significant relationship with the target variables were entered in Step 1 of the hierarchical regression analyses.

Partial mediation is demonstrated when the beta weight for the predictor variable is reduced (but not to non-significance) when the proposed mediator is added to the equation. Full mediation is demonstrated if the (beta) value for the predictor variable is reduced from significance to non-significance when the proposed mediator is added to the equation (41). Based on the observed correlations, we conducted hierarchical regression analyses. The relevant regression diagnostics were conducted, to verify the assumptions of the model (linearity, homoscedasticity) based on the residual plot, independence based on the Durbin-Watson statistic and normality of the distribution of residuals with the Kolmogorov-Smirnov test.

Because a reduced beta weight in itself does not seem to be indicative of significance, and this assumption of the Baron and Kenny method (41) has been criticized, we additionally performed the Sobel test to demonstrate partial mediation (42).

Differences were considered significant at a *p* level <0.05. Data were analyzed with the SPSS statistical package (v.17.0; SPSS Inc, Chicago, IL).

Results

Socio-demographics characteristics of the sample

The average age of the experimental group was of 29.80 ± 9.55 years, and 41.1% were male. With regard to participants' educational level,

employed at the time of the study. Due to the selection procedure of the control group mentioned above, no significant differences were found for any of the socio-demographic variables considered for both groups.

Differences between experimental and control group in the target variables (self-esteem, anxiety and PIDAQ dimensions)

When the relevant variables were considered for both groups, significant differences were found for three of the four PIDAQ dimensions. Specifically, the experimental group showed significantly higher scores for social impact ($\eta = 0.31$), psychological impact ($\eta = 0.23$) and aesthetic concern ($\eta = 0.27$) than the control group (Table 1).

Relation between socio-demographic and target variables

For the experimental group, mean anxiety scores were significantly different between the educational levels (F = 4.53; p = 0.019), showing significant differences post hoc between primary education (Mean = 9.40, SD = 6.65) and university studies (Mean = 22.57, SD = 9.50). Age showed a significant positive correlation with social impact $(r^2 = 0.31, p = 0.01)$. Women (Mean = 13.87, SD = 9.74) showed higher psychological impact than men (Mean = 9.90, SD = 6.66; t = 2.089, p = 04, $\eta = 0.23$). For the control group, the only significant associations between socio-demographic variables and target variables were between self-confidence and age ($r^2 = -0.248$, p = 043), and educational level (F = 5.204, p = 0.003), with participants with university studies presenting higher scores on self-confidence (Mean = 16.28, SD = 4.69) than participants with primary studies (Mean = 11.30, SD = 3.85) and secondary studies (Mean = 11.44, SD = 6.13).

Mediation by state anxiety

Preliminary analysis (correlations among variables)

As shown in Table 1, for the group undergoing orthodontic treatment, there are significant posi-

tive correlations between psychological, social and aesthetic dimensions of dental impact and negative correlations between these dimensions and dental confidence. Self-esteem maintains significant correlations with the dimensions of dental impact. State anxiety maintains significant correlations with all dimensions of dental impact, except for dental confidence. The control group maintains very similar associations, except for the absence of a correlation between social impact and dental self-confidence, and social impact and self-esteem, although in the latter, associations approach significance.

In addition to describing relationships among our target variables, correlation analyses allowed us to verify compliance with the preconditions in order to select the variables to be entered in a regression analysis for evaluating mediation. Our interest is focused on the mediating role of state anxiety. The correlations table (Table 1) indicates that, for both groups, the preconditions are met for mediation analysis using all dimensions of dental impact (except dental confidence that does not maintain a positive correlation with state anxiety) as predictors.

Consequently, to assess the role of anxiety as a possible mediator, a regression analysis was applied, using dental impact dimensions (except dental confidence) as predictors and self-esteem as outcome variable. Additionally, in the experimental group, gender in the case of psychological impact and age in the case of social impact were established as control variables, as they have shown significant relationships with the target variables.

For the experimental group, the analyses showed that anxiety mediated the relationship between the three dental impact dimensions (social impact, psychological impact and aesthetic concern) and self-esteem (Table 2), and in psychological impact and aesthetic concern cases the mediation effect was total, whereas for social impact the mediation effect is partial. Regarding the control variables, we found that neither age nor gender play a significant predictor role in explaining self-esteem, so it does not appear to be a relevant variable to consider.

	F	R ²	IncR ²	Beta	t
VD: Self-esteem					
Step 1: age	0.140	0.001		-0.014	0.100
Step 2: social impact	2.652	0.094	0.093	-0.307 (-0.303*) [†]	-2.301*
Step 3: anxiety	4.895**	0.227	0.133	-0.365	-2.931**
Step 1: gender	0.203	0.010		0.086	0.365
Step 2: psychological impact	2.428*	0.127	0.117	-0.369 (-0.269) [†]	-2.690**
Step 3: anxiety	3.009*	0.197	0.080	-0.282	-2.068*
Step 1: psychological impact	13.235**	0.197		<i>−0.444 (−0.234*)</i> [†]	-3.638**
Step 2: anxiety	22.224**	0.456	0.259	-0.551	-5.026**
Step 1: aesthetic concern	1.608	0.088		-0.303 (-0.181) [†]	-2.185*
Step 2: anxiety	2.406	0.164	0.076	-0.135	-2.114*

Only significant findings are presented. Standardized regression coefficients (betas) are derived from the step in which they are added to the equation.

Step 1: gender (1: men, 0: women).

Significant mediations for the control group are presented in italics.

*p < 0.05; **p < 0.01.

[†]Beta value after introduction of anxiety.

For the control group, we only observed the meditational role (partial) of anxiety between psychological impact and self-esteem.

Discussion

This study shows results that allow us to reflect on the relationship between impact of dental appearance, anxiety and self-esteem in a sample of adult patients undergoing metal multibracket fixed orthodontic treatment. Regarding PIDAO descriptive indicators, dental self-confidence scores are similar to the scores obtained in other studies both with non-clinical and adolescent samples (43) as well as in a sample of adults seeking orthodontic treatment (44). As for the other dimensions (social impact, psychological impact and aesthetic concern), scores observed in our study are higher than those found in previous studies, specifically in the study of Gazit-Rappaport et al. (44) in adult patients seeking orthodontic treatment. When we compared the results for the patients with orthodontic treatment with the control group, we observed significant differences for social impact, psychological impact and aesthetic concern, so that the patients with orthodontic treatment had a higher perception of dental impact than the healthy patients; this is in accordance with previous studies (3, 5, 6).

The level of self-esteem observed in the sample is similar to that found in other studies in non-clinical population whose scores ranged from 30.4 (45, 46) to 38.7 (47), and significantly higher than those found in clinical populations (25.7) (48), we also found them to be similar to those found in other studies that assess the effects of malocclusion and orthodontic treatment on self-esteem using of the same instrument (13). It should be noted that no significant differences were found in relation to self-esteem between the groups, as opposed to findings by Frejman et al. (9), in spite of the important differences found in perception of dental impact. These results are in accordance with what O'Regan et al. (22) point out about relative independence, in spite of the association, between dental impact and self-esteem.

Anxiety scores in our study are very similar, using the same instrument, to those found in samples of adolescents undergoing orthodontic treatment and their parents (25, 26), and considerably lower than those found by Sud and Sud (39) in patients with dental problems affecting oral hygiene residing in India.

Most dimensions of dental impact (social impact, psychological impact and aesthetic concern) maintain negative correlations with selfesteem, consistent with what has been presented throughout the literature (9, 49). It should be taken into account that this pattern of correlations is maintained for both groups, although the correlations are slightly stronger in the group undergoing orthodontic treatment. Although, as pointed out previously, literature on the association between dental impact and self-esteem is not always consistent (15) and has mainly been carried out on samples of children and adolescents, the results found in our study show a clear association between dental impact and self-esteem both in patients undergoing orthodontic treatment and those who are not, in the same way that others have found in previous studies carried out on adults (9, 11).

Similarly, the significant positive relationship found between dental self-confidence and selfesteem indicates that satisfaction with dental appearance has a positive effect on self-esteem, which in fact is an important aspect within the conceptualization of self-esteem (39) in regards to satisfaction with physical appearance. It seems that this dimension of physical appearance of self-esteem is not only relevant in adolescence (50), but in view of the results remains important during adulthood (as additional data in our study showed a significant positive correlation between age and social impact). This positive relation between age and social dental impact, as far as we know, has not been presented in previous literature, as other studies have not found a relation between age and dental impact or patient satisfaction (51, 52). Our results do show gender differences in relation to psychological dental impact, but only for the group undergoing orthodontic treatment, which is consistent with previous studies in adult (3), child and adolescent populations (13), which have shown a higher perception of dental impact in women.

We found significant positive correlations between negative dimensions of dental impact (social impact, psychological impact and aesthetic concern) and anxiety, implying that the perception and impact of dental image can have emotional repercussions associated with anxiety (4). Also, we found no significant correlations between dental self-confidence and anxiety in either groups (experimental and control) indicating that dental confidence is not associated with the reduction of negative emotional states such as anxiety, but with the increase of emotions and states of positive health through self-esteem as noted above. These results are consistent with the current conceptualization of affect as two independent dimensions (53): positive affect and negative affect. Positive affect includes a variety of moods and emotions with a pleasant subjective content (joy, love, enjoyment, interest in doing things or amazement at something positive). On the other hand, negative affect includes emotions and moods with an unpleasant subjective content (anger, sadness, anxiety, worry, guilt, shame, envy, jealousy...). In this context, dental self-confidence would contribute to increased positive affect but not to the reduction of negative affect, having a repercussion on wellbeing but not in the reduction of associated psychological distress. These results have important implications in the promotion of health and wellness.

As for the mediating role of anxiety between dental impact and self-esteem found in our study, it should be highlighted that these results are interesting due to how rare previous studies about this relation are. In the same critical direction as what Kenealy et al. (23) pointed out in relation to the scarce predictive power of dental status over self-esteem, and in the light of our findings, we can point to the role of anxiety as a possible explicative variable of this relationship. The mediation analysis highlights the role that anxiety plays between three dimensions of dental impact and self-esteem, so that the relationship between two of the dental impact dimensions and self-esteem can be explained entirely through anxiety. Further, the mediator role of anxiety between dental impact and selfesteem is highly relevant in patients undergoing orthodontic treatment (because in patients without orthodontic treatment this mediating role of anxiety between dental impact and self-esteem

is only observed for the psychological impact dimension). Also, the important role of anxiety in patients undergoing orthodontic treatment in the relationship between dental impact and selfesteem could explain, as pointed out by O'Regan et al. (22), that improvement in dental and/or facial aesthetics does not necessarily lead to an increase in self-esteem. In this sense, it could be argued that the inconsistent and even contradictory results found in relation to the possible increase in self-esteem during treatment, in samples of adults (10, 21) and adolescents (13, 16-19), could be due to the absence of controlling for variables such as anxiety that could be responsible for part of the variance, within the differences presented by Kenealy et al. (23).

Numerous studies in the field of orthodontics have aimed to reduce anxiety levels in patients undergoing treatment (31-33), due to its important impact on treatment adherence and patient satisfaction. In the light of the findings of our study, and due to the lack of other studies in the area, it could also be considered that decreasing anxiety could have a fundamental role in the fact that dental impact improvements through orthodontic treatment have an impact on patients' self-esteem, although this would need to be backed up by longitudinal studies. If we consider that the study by Topcuoglu et al. (34) shows that there is an increase in anxiety and depression in adult patients whilst undergoing orthodontic treatment, assessment and intervention on anxiety becomes a highly relevant need in orthodontic contexts.

This study has some limitations that may curtail the generalization of results. The convenient nature of the sample, composed of voluntary patients recruited through the University Clinic of Rey Juan Carlos University, Campus de Alcorcón (Madrid, Spain), may limit its representativeness, and thus prevent the generalization of these findings to the general population. We should also consider that another limitation is the small sample size, although, as we have pointed out, it is representative of the number of people seeking treatment at the Clinic where we conducted the study. Another limitation is that the findings are based on cross-sectional data, therefore, showing the well-known limitations of this type of study, mainly those associated to causality. As pointed out, the scarce longitudinal studies in adult orthodontic patients examining the relation between dental impact, self-esteem and oral health-related quality of life shows inconsistent results. This may be due to the absence of appropriate assessment of psychological variables that could be affecting this relationship, such as life satisfaction, self-efficacy, depression, social anxiety, emotional health and self-perception of attractiveness (23). Because of this, it is of great relevance to continue this type of study using longitudinal designs.

Despite these limitations, we believe that these results not only allow us to advance our understanding of the complex relationships between the impact of dental appearance, anxiety and self-esteem, but also have important practical implications for the design of bio-psycho-social intervention programs that address cognitiveemotional variables as an essential part of treatment. Specifically, implications for practice derived from this study have to do with two fundamental objectives: 1) on the one hand, to increase adherence to orthodontic treatment through anxiety reduction and 2) on the other hand, to increase self-esteem of patients and satisfaction with treatment, because anxiety can have a fundamental role in the relationship between dental impact and self-esteem, and therefore, and as suggested by O'Regan et al. (22), the improvement of dental status through orthodontic treatment does not guarantee an increase in patients' self-esteem or indirectly on the oral health-related quality of life if we do not also work on anxiety associated with treatment. The previous literature has shown that levels of anxiety experienced by patients are higher at the beginning of treatment, decreasing after the first 3 months, mainly because patients become familiar with their orthodontist and become accustomed to orthodontic treatment (25, 30). It is therefore particularly important to include the care and treatment of anxiety as an additional aim of orthodontic treatment. As indicated by different studies (33, 54), good dental health education, regular dental visits, good patientdentist relationships, and suitable communication with patients may all contribute to the control of the anxiety associated with orthodontic treatment.

Conclusions

There is a higher perception of dental impact in adult patients undergoing orthodontic treatment than amongst those who are not, although these differences do not remain significant in relation to self-esteem or anxiety. This perception of dental impact (psychological impact) is stronger in women.

Self-esteem associates to perception of dental impact both in patients undergoing orthodontic treatment and those who are not.

Anxiety has a mediating role (total on most occasions) in the relation between dental impact and self-esteem in patients undergoing orthodontic treatment.

Clinical relevance

In adult orthodontic patients, there is a clear association between their perception of dental impact and self-esteem. Nevertheless, state anxiety affects the relationship with dental treatment. Within the biopsychosocial model of health, these results are particularly relevant, given the need to consider the psychological and social aspects as part of a comprehensive treatment. In adults undergoing orthodontic treatment, anxiety plays a fundamental role in the effect of perceived dental impact on self-esteem. Therefore, if we want orthodontic treatment to have positive impact on the image and selfesteem of the patient, we would need to incorporate anxiety as a key variable in successful treatment.

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