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Are pre-treatment psychological characteristics influenced by pre-surgical orthodontics?

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SUMMARY A number of investigations have looked at psychological changes occurring in association with orthognathic treatment. However, most of these studies have used a pre-surgery questionnaire as the baseline measurement. There is little data relating to the true baseline, i.e. that prior to any active treatment. Until this aspect is investigated, it is not possible to assume that pre-surgery is an acceptable baseline. This questionnaire based study aimed to assess changes in six psychological outcome measures between T1 (prior to any active treatment) and T2 (following pre-surgical orthodontics/prior to surgery). The outcome variables were: state anxiety, trait anxiety, depression, self-esteem, body image, and facial body image. Sixty-two patients (39 females and 23 males) completed both questionnaires.

The results showed that intervention, in the form of orthodontic treatment, had a minimal effect on the chosen psychometric outcome variables. There was a significant reduction in satisfaction with body image amongst patients who initially reported mild to moderate dental/facial problems, whilst a moderate increase in satisfaction occurred in those patients reporting severe conditions initially. Also of note were significant increases in state anxiety amongst older patients whilst trait anxiety showed greater increases in females than males.

Introduction

Many studies have looked at changes in psychological well-being and personality characteristics following orthognathic treatment. Early investigations tended to be retrospective (Hutton, 1967; Crowell *et al*., 1970; Jacobson, 1984). More recent studies have been prospective, but the baseline, which has been used for pre/post-treatment comparisons, is typically in the pre-surgery phase, when orthodontic treatment had already commenced (Kiyak *et al*., 1982, 1986; Flanary *et al*., 1990; Barbosa *et al*., 1993; Finlay *et al*., 1995). There is very little information regarding any potential psychological effects of pre-surgical orthodontics.

Studies that have looked at pre- and post-surgery changes include the longitudinal investigation undertaken by Kiyak *et al*. (1982, 1986), who found good psychological adaptation following orthognathic treatment. Flanary *et al*. (1990) also investigated psychological adjustment and self-concept in orthognathic patients, and found them to be relatively healthy and well adjusted both pre- and post-operatively. Significant improvements were noted in the following areas: psychoses, neuroses and personality disorders, integration, and all sub-scales of self-concept.

However, it is difficult to make definite conclusions regarding such studies because there was no baseline measurement before any active treatment commenced and no previous research to indicate whether the patients' psychological characteristics were the same at the start of treatment as at the end of pre-surgical orthodontics. The aim of this research was therefore to determine whether any psychological changes occurred during the pre-surgical phase and whether there is justification for using T2

(following pre-surgical orthodontics) as a baseline for future research.

Materials and methods

Questionnaire design

The questionnaire included six standard instruments that assessed the patient's psychological well-being. All measures had been evaluated previously for reliability and validity, but not with this specific group of patients; therefore, test-retest reliability was established by asking 25 respondents to complete identical questionnaires six weeks apart. Intra-class correlation coefficients (ICC) were acceptable for all outcome measures. The following measures were used:

State and trait anxiety. Anxiety is generally viewed as taking two forms: the state form (transitory feelings of fear/worry) and the trait form (the stable tendency to respond anxiously to stressful situations). Anxiety was measured using the State-Trait Anxiety Inventory, which is one of the most widely used measures in psychological and clinical research (Spielberger *et al*., 1983).

Depression. The Beck Depression Inventory (BDI) was used to assess depression (Beck *et al*., 1988). The BDI covers a wide range of items from sadness and sense of failure to self-dislike, social withdrawal, and indecisiveness.

Self-esteem. This study utilized the Rosenberg Self-Esteem (RSE) Scale, developed by Rosenberg (1965). It is a 10-item scale with a four-point scale of agreement, with half the items being expressions of positive self-esteem and half negative.

Body image and facial body image. Body image is considered as a complex psychological concept related to the mental representation of self and it is therefore reasonable to assume that a change in body image may occur due to intervention (surgical or orthodontic). A revised version of Secord and Jourard's Body Cathexis Scale with a specific section asking about facial features was selected for use in the study (Secord and Jourard, 1953). This scale had previously been used in investigations involving orthognathic patients (Kiyak *et al*., 1982, 1986; Finlay *et al*., 1995).

In addition to the six measures detailed above, a 100-mm visual analogue scale (VAS) was also included in the T1 questionnaire to allow the patient to rate the severity of their malocclusion at initial presentation. This was anchored with the statements 'no problem at all' at the 0-cm mark and 'the worst problem imaginable' at the 10-cm mark. The data from the VAS were used to categorize patients into one of three groups: mild (0–3.3 cm), moderate (3.4–6.6 cm), and severe problems (6.7–10 cm).

Subjects

This study was part of a longitudinal investigation to determine the psychological well being of orthognathic patients during treatment. Ethical approval was received from the Joint Research and Ethics Committees of the centres involved. All participants signed a consent form and it was stressed that responses were confidential and would not affect treatment in any way.

Subjects from three different centres were enrolled over a six month period in 1997 (June to December). Sixty-seven consecutive patients who had decided to proceed with treatment were asked to participate and 65 agreed. All patients were approached on the clinic by the same author (SJC), but were asked to complete the questionnaires at home and were provided with a stamped addressed envelope. Respondents who did not reply within two weeks were contacted by telephone. The questionnaires at T1 and T2 were identical, with the exception of a VAS included at T1. The first questionnaire (T1) was distributed after the initial joint orthodontic/surgical planning clinic appointment, but prior to any active treatment being undertaken. All T1 questionnaires were returned (100 per cent response rate). The second questionnaire (T2) was distributed following the pre-surgical orthodontic phase and prior to the patient

returning to the joint orthodontic/surgical clinic in order to confirm the definitive surgical treatment plan. Sixty-two T2 questionnaires were returned (response rate 95 per cent). One patient stopped treatment at this stage, one questionnaire was not sent in sufficient time, and one was not returned. The range of time between the two questionnaires was 10–29 months with a mean of 17 months.

Statistical analysis

The changes between T2 and T1 were calculated for each respondent for the six outcome measures. Multivariate multiple regression analysis was undertaken where demographic characteristics were considered for their impact on the six outcome measures (Cunningham *et al*., 2000; Gilthorpe and Cunningham, 2000). These characteristics were: age, gender, ethnic group, duration of pre-surgical orthodontics, the unit/hospital the respondent was treated in, antero-posterior skeletal base discrepancy (as assessed from both clinical and radiographic examination), and the patient-perceived severity of their malocclusion at T1 (as measured by the 100-mm VAS).

This method allowed any underlying demographic differences to be accounted for whilst evaluating the impact of orthodontic intervention on all six outcomes simultaneously. The data were analysed using the MLwiN statistical software (Rasbash *et al*., 2000).

Assessment of psychometric measures is difficult, particularly when the scales have different ranges and means. This makes comparison of differences in each scale difficult to interpret, and in order to provide a similar range of values across all outcome measures, each variable was scaled by standardization (Rice, 1988). This involved dividing the differences between T2 and T1 scores by their standard deviation. Changes in one outcome can then be directly compared in magnitude with changes in other outcomes. Transformation, to reduce asymmetry, may be required when using this technique. However, since all differences in scores were sufficiently normally distributed, transformation was not necessary.

Age and duration of treatment were centred, a process where all values have their mean (or a rounded figure close to the mean) deducted. This process is advisable prior to regression analysis since the inclusion of explanatory variables, whose ranges do not contain zero, increases uncertainty in the modelled coefficients, inflating their associated confidence intervals (Gardner and Altman, 1993). This process therefore provided a meaningful interpretation of the regression coefficient when the adjusted age variable adopts the value of zero.

Gender was allocated values of 1 or 0 for male or female respectively. Variables were also created to represent each racial group, the unit/hospital where the patient was treated, antero-posterior skeletal base discrepancy, and the patient-perceived severity of their malocclusion at the start of treatment as derived from the 100-mm VAS. In each case the contrast group, i.e. the category for which each variable adopted the value zero, was the largest group. If a categorical variable attained significance, variables representing each category remained in the model, even though some may not have been significant in isolation.

Six simultaneous regression models were produced, one for each outcome variable. For every explanatory variable, coefficients and standard errors were estimated. For each coefficient to be significant, it should be approximately twice its standard error, although exact levels of significance were ascertained using MLwiN's 'Intervals and Tests' procedure. Model subset selection is recognized as being difficult and can result in potential bias for both parameter estimates and their standard errors (Miller, 1990). However, with orthogonal variables and where the number of covariates is small, selecting only significant covariates does not generally yield problems of bias. All variables were considered and those that were not significant were removed. The final reduced model was then compared with the initial model to ensure agreement. In addition, the intercept for each equation was of particular importance as this represented the mean change in each outcome due to pre-surgical orthodontics, having accounted for all other significant explanatory variables.

Results

The results are shown in Tables 1–4 and Figures 1 and 2. Table 1 shows the data for the test-retest study and confirms that all ICC were comparable to previously recommended values. Demographic data are presented in Table 2. Of the 62 patients who completed both questionnaires, 38 were female and 23 male, with a mean age of 21.8 years. The majority were Caucasian (44 of 62) with a greater proportion of Class III than Class II malocclusions.

Table 3 illustrates the differences between the values at T2 and T1 for each outcome variable. It is worth noting the small mean differences between the scores and also the large standard deviations for the mean changes between T2 and T1. This supports the hypothesis that the impact of pre-surgical orthodontics is, on the whole, negligible in contrast to the degree of individual variation.

Table 4 illustrates the final model with the significant parameters for each outcome variable. Of the explanatory variables, age was significant for state anxiety ($P < 0.001$); gender and unit/hospital of treatment were significant for trait anxiety ($P = 0.040$ and 0.009, respectively), and patient-perceived severity of the malocclusion was significant for body image. Only one intercept was significant, that for body image ($P = 0.050$), and this indicated significant change due to orthodontic intervention, having accounted for differences in patient-perceived severity of malocclusion.

Figure 1 illustrates the relationship between patient-perceived severity of dental/facial problems and the body image index. The findings were different to those anticipated, in that it was body image, rather than facial body image, that was affected. As a result of this, a *post-hoc* analysis of the individual scores for each of the body image items was undertaken (Figure 2).

Discussion

Six outcome variables were studied longitudinally: state anxiety, trait anxiety, depression, self-esteem, body image, and facial body image. Multivariate regression was undertaken in order to optimize the modelling for each psychometric scale through consideration of all six models simultaneously. The model intercepts were of particular importance because they represented the mean change in outcome due to the intervention (i.e. orthodontic treatment) occurring between T2 and T1 for patients with baseline properties. Overall, the findings were that intervention, in the form of pre-surgical orthodontics, had a minimal effect on the chosen psychometric outcome variables. Therefore, previous authors were probably justified in using T2 as a baseline measure.

The only outcome measure that appeared to be influenced by pre-surgical orthodontics was that of body image (intercept P value = 0.05). However, this only became apparent after controlling for differences in patient-perceived severity of malocclusion. The respondents' perceived severity of their dental/facial problems significantly influenced changes in body image scores between T2 and T1. Those individuals who initially perceived their problem to be mild had, on average, a greater reduction in their satisfaction with body image (i.e. increased scores) as a result of the intervention (Figure 1).

Table 1 Test-retest results.

Index (possible range)	Intra-class correlation coefficient	Suggested acceptable correlations
State anxiety (20–80)	0.78	0.16–0.62 (Spielberger *et al*., 1983)
Trait anxiety (20–80)	0.87	0.65–0.86 (Spielberger *et al*., 1983)
Depression (0–63)	0.92	>0.90 (Beck *et al*., 1961)
Self-esteem (10–40)	0.93	0.85–0.92 (Rosenberg, 1965)
Body image (27–135)	0.89	Not quoted
Facial body image (10–50)	0.81	Not quoted

Table 2 Demographic details.

Gender		Age (years)	Ethnic group		Duration of pre-surgical orthodontics (months)	Unit/hospital			A-P malocclusion		Patient-perceived severity		
Male	Female[R]	Mean (SD)	Caucasian[R]	Non-Caucasian	Mean (SD)	1[R]	2	3	2	3[R]	Mild 0–3.3 cm	Mod 3.4–6.6 cm	Severe[R] 6.7–10.0 cm
23	39	21.8 (6.2)	44	17 (Asian 6; Black 4; Other 7)	17 (5)	36	9	16	24	36	9	23	29

NB: One respondent excluded from A-P malocclusion as they had an anterior open bite only and a Class I base.
R = reference category.

Those who reported their problem to be moderate also experienced reduced body image satisfaction, although to a lesser extent. Interestingly, those who initially reported a severe problem, showed a slight increase in their satisfaction with body image (i.e. reduced scores). This may have been in anticipation of the surgical change in the near future. Therefore, it may be that those individuals who rate their problem as mild at the start of treatment should be given additional warnings that there could be a deterioration in how they perceive their problems as treatment proceeds.

It is interesting that it was body image, rather than facial body image, which was most affected. Therefore, individual item responses were also looked at for this scale. It was noted that those items in the facial body image index, when studied individually, showed a significantly different mean change as compared with items not in the facial body image component ($P = 0.04$). In addition, Figure 2 illustrates that the facial body image items tended to score at the upper end of the scale in the T1 questionnaire and this may create a 'ceiling'-type effect where facial body image items have a reduced opportunity to increase as compared with the remaining items. Respondents may then express their dissatisfaction as a general dissatisfaction affecting other body parts as well as the facial area.

There were a number of interesting findings related to the other explanatory variables. One particularly important finding was that duration of pre-surgical orthodontic treatment did not significantly affect any of the outcome variables.

Age was significantly associated with changes in state anxiety. Increasing age resulted in a moderate increase in state anxiety levels and this could have importance when treating older patients as they may require additional support from the clinicians involved in their care during the treatment period.

Although trait anxiety is the in-built response to anxious situations and fluctuations were not expected in the same way as for state anxiety, significant changes were found. Changes in trait anxiety varied significantly by gender, with females showing a greater increase in anxiety than males. The distinction between state and

Table 3 Instrument scores at T1 and T2.

Index (possible range)	T1		T2		Change between T2 and T1 Mean (SD)
	Range	Mean (SD)	Range	Mean (SD)	
State anxiety (20–80)	22–77	42.0 (10.9)	27–78	44.5 (12.8)	2.46 (11.2)
Trait anxiety (20–80)	25–78	44.6 (12.4)	24–79	45.6 (13.5)	0.93 (8.9)
Depression (0–63)	0–38	9.8 (9.2)	0–44	10.8 (10.3)	1.10 (6.4)
Self-esteem (10–40)	11–37	21.5 (5.7)	12–38	21.5 (6.0)	0.02 (3.9)
Body image (27–135)	34–117	83.4 (16.8)	51–123	83.9 (15.7)	0.46 (11.8)
Facial body image (10–50)	16–46	33.3 (6.1)	22–46	33.9 (5.9)	0.76 (4.3)

Scoring system: State and trait anxiety—higher scores = greater anxiety; Depression—higher scores = greater depression; Self-esteem—higher scores = lower self-esteem; Body image/facial body image—higher scores = lower body image.

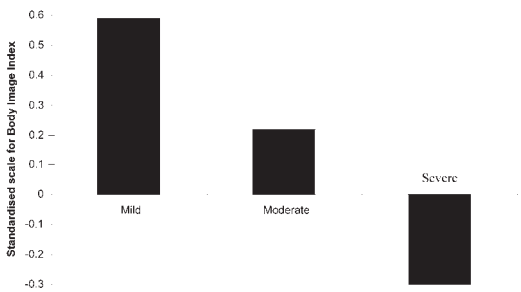

Figure 1 Graph showing the relationship between patient-perceived severity and the Body Image Index.

trait anxiety has always been controversial and a number of researchers have proposed that the distinction between state and trait anxiety is not clear cut (Reiss, 1997). The findings in this study tend to confirm this. Alternatively, it may be that this was a spurious finding and must be treated with caution, especially in view of the fact that the *P*-value was borderline at 0.04. In addition, the unit in which the patient was treated also significantly affected changes in trait anxiety. Changes in trait anxiety amongst subjects from unit 3 significantly differed with respect to unit 1. Changes at unit 2 did not significantly differ from changes at unit 1. However, it should be noted that when initial trait anxiety was examined for each of the units independently, patients from unit 3 showed a tendency for higher pre-treatment values than those individuals in units 1 ($P = 0.107$)

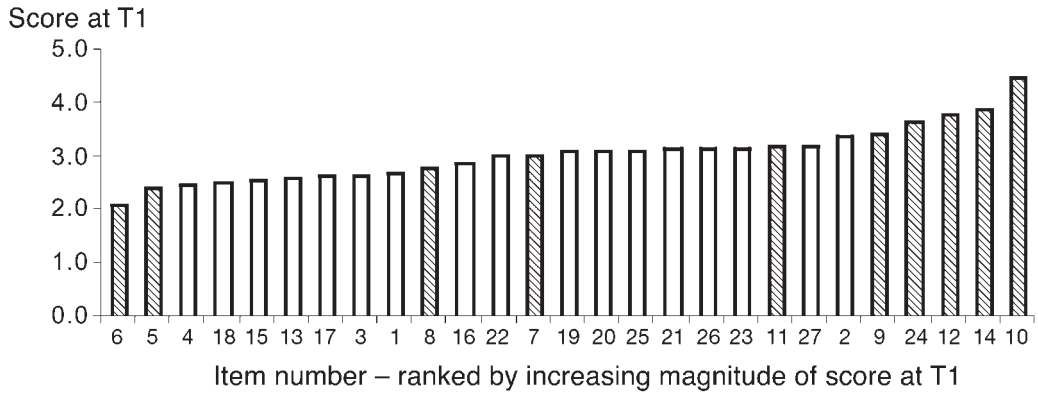

Figure 2 Distribution of scores at T1 for the Body Image Index. Items 5–12, 14, and 24 constitute the Facial Body Image Index (shaded bars).

Table 4 Significant parameters for each outcome variable (values presented are regression coefficients with standard errors in parentheses and *P*-values in italics).

	Intercept	Gender	Age	Unit/ hospital	Patient-perceived severity
State anxiety	0.22 (0.12)	–	0.06 (0.02) *P < 0.001*	– –	–
Trait anxiety	0.17 (0.15)	–0.36 (0.17) *P = 0.040*	–	–0.40 (0.25) unit 2 *NS*; 0.41 (0.19) unit 3 *P = 0.031*; unit 2 vs unit 3 *P = 0.009*	–
Depression	0.14 (0.13)	–	–	–	–
Self-esteem	–0.04 (0.13)	–	–	–	–
Body image	–0.30 (0.15) *P = 0.050*	–	–	–	0.89 (0.27) sev 1 *P < 0.001*; 0.52 (0.18) sev 2 *P = 0.004*; sev 1 vs sev 2 *P < 0.001*
Facial body image	0.14 (0.13)	–	–	– –	–

and 2 (P = 0.221). Although this was not significant, the sample size for unit 3 was small with only 16 subjects, so this may have been a sample size effect. There may have been some underlying differences in the patient group selected at unit 3 and this result may be an artefact of differences in self-selection of groups.

When the multivariate results were compared with the separate regression models for each outcome variable, some differences were noted. For trait anxiety, gender was significant, as in the multivariate analysis. However, the unit was not significant in the separate regression analysis. The same applied for body image, in which perceived severity was not significant in the separate regression model, but was in the multivariate analysis. These are probably examples of Type II statistical errors, where explanatory variables are wrongly assessed as having no significance due to insufficient sample size and, in this instance, multivariate analysis improved the statistical power of the study by considering all outcomes simultaneously.

Conclusions

The findings of importance in this investigation into changes in psychometric outcomes during the pre-surgical orthodontic phase are:

1. Intervention, in the form of orthodontic treatment, has a minimal effect on the chosen psychometric outcome variables. It therefore seems reasonable to use the pre-surgery measurement (T2) as a baseline.
2. Significant changes associated with orthodontic intervention were observed for the body image index, but this was largely amongst those respondents whose perceived severity was mild/moderate.
3. The facial body image index may be 'saturated' at T1, which prevents further increases in score at T2.
4. The duration of pre-surgical orthodontics did not significantly affect any of the six outcome variables.
5. Older patients requesting orthognathic treatment may need additional support prior to surgery due to the tendency for state

anxiety levels to increase during pre-surgical orthodontics.

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References

Barbosa A L B, Marcantonio E, Barbosa C E de M, Gabrielli M F R, Gabrielli M A C 1993 Psychological evaluation of patients scheduled for orthognathic surgery. Journal of Nihon University School of Dentistry 35: 1–9

Beck A T, Ward C H, Mendelson M, Mock J, Erbaugh J 1961 An inventory for measuring depression. Archives of General Psychiatry 4: 561–571

Beck A T, Steer R A, Garbin M G 1988 Psychometric properties of the Beck Depression Inventory: twenty-five years of evaluation. Clinical Psychology Review 8: 77–100

Crowell N T, Sazima H J, Elder S T 1970 Survey of patients' attitudes after surgical correction of prognathism: study of 33 patients. Journal of Oral Surgery 28: 818–822

Cunningham S J, Gilthorpe M S, Hunt N P 2000 Are orthognathic patients different? European Journal of Orthodontics 22: 195–202

Finlay P M, Atkinson J M, Moos K F 1995 Orthognathic surgery: patient expectations; psychological profile and satisfaction with outcome. British Journal of Oral and Maxillofacial Surgery 33: 9–14

Flanary C M, Barnwell G M, Van Sickels J E, Littlefield J H, Rugh A L 1990 Impact of orthognathic surgery on normal and abnormal personality dimensions: a 2 year follow-up study of 61 patients. American Journal of Orthodontics and Dentofacial Orthopedics 98: 313–322

Gardner M J, Altman D G 1993 Statistics with confidence. British Medical Journal Publications, London

Gilthorpe M S, Cunningham S J 2000 The application of multilevel modelling to multivariate dental research data. Community Dental Health 17: 236–242

Hutton C E 1967 Patients' evaluation of surgical correction of prognathism: survey of 32 cases. Journal of Oral Surgery 25: 225–228

Jacobson A 1984 Psychological aspects of dentofacial esthetics and orthognathic surgery. Angle Orthodontist 54: 18–35

Kiyak H A, West R A, Hohl T, McNeill R W 1982 The psychological impact of orthognathic surgery: a 9 month follow-up. American Journal of Orthodontics 81: 404–412

Kiyak H A, McNeill R W, West R A, Hohl T, Heaton P J 1986 Personality characteristics as predictors and sequelae of surgical and conventional orthodontics. American Journal of Orthodontics 89: 383–392

Miller A J 1990 Subset selection in regression. Chapman and Hall, London

Rasbash J, Browne W, Cameron B, Charlton C 2000 MLwiN version 1.10.0006, Multilevel Models Project. Institute of Education, London

Reiss S 1997 Trait anxiety: it's not what you think it is. Journal of Anxiety Disorders 11: 201–214

Rice J A 1988 Mathematical statistics and data analysis. Wadsworth and Brooks, Pacific Grove

Rosenberg M 1965 Society and the adolescent self image. Princeton University Press, Princeton

Secord P F, Jourard S M 1953 The appraisal of body cathexis: body cathexis and the self. Journal of Consulting Psychology 17: 343–347

Spielberger C D, Gorsuch R L, Luchene R E 1983 Manual for the State-Trait Anxiety Inventory. Consulting Psychologists Press, Palo Alto