Pain and Anxiety Following the Placement of Dental Implants

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Purpose: *This study investigated pain experience and anxiety following dental implant placement using questionnaires and salivary cortisol measurements.* ***Materials and Methods:*** *Patients about to undergo implant placement were instructed to keep recovery diaries to assess pain experience (limitation of activities, postoperative symptoms) and to record average pain, worst pain, and interference with daily activities on a visual analog scale (VAS). To assess anxiety, patients completed the Spielberger self-evaluation questionnaire and collected salivary samples to measure cortisol levels. Saliva was collected 1 week before surgery, the day of surgery, and 3 and 6 days postoperatively. A repeated-measure analysis of variance was used to analyze pain and anxiety data.* ***Results:*** *Eighteen patients (12 women and 6 men) who received 30 implants were recruited for the study. Following implant placement, most patients reported mild to moderate interference with daily activities and postoperative symptoms. No patient reported high levels of any symptom. Average pain experience decreased significantly with time ($F = 6.17$; $P < .001$), from a VAS score of 24/100 on day 1 to 12 on day 3 and 9 on day 6. Worst pain ($F = 7.84$; $P < .001$) and limitation of daily activities ($F = 6.26$; $P < .001$) were also highest on the first postoperative day; they also decreased to about half the maximum level by the second or third day. State anxiety, as evaluated by the Spielberger self-evaluation scale, was highest on the day of surgery. The salivary cortisol level did not validate this, as it did not differ with the time of collection ($F = 2.22$; $P = .075$).* ***Conclusions:*** *Patient self-assessment indicates that implant placement is a mild to moderately painful and anxiety-provoking procedure. Some limitation of daily activities and symptoms are expected to occur, particularly during the first 3 postoperative days.* (Case Series) Int J Oral Maxillofac Implants 2006;21:943–950

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Despite the importance of pain for both the patient and the dental practitioner, there have been few studies on the factors which influence patients' perception of pain during dental treatment.[1–3] Experimental research has demonstrated that anxiety, previous experience, patients' expectations, anticipation of stress, and control of the environment can influence pain perception.[4,5] Generally, when anxiety exists, one is more perceptive of the painfulness of noxious events.[6–8]

Oral surgery is a common procedure that is rarely life-threatening and has a relatively short recovery period. However, its physical and psychological effects make it a stressful experience and a major barrier to seeking dental care.[9] Although there have been many investigations of pain, swelling, and trismus following surgical removal of teeth,[10,11] there appear to be very few reports on pain experience in patients following the placement of dental implants.

A patient who presents to the dental office for dental implants has a number of concerns, including the cost of treatment and the probability of success. A major concern is the fear of pain, which can increase when the patient becomes aware of the surgical procedures involved in the placement of dental implants. When patients ask about the pain involved in implant placement, the answers that clinicians provide to the patient are speculative[12] and lack scientific support. However, it is important to obtain data on the pain and anxiety related to implant placement.

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Adrenocorticotrophic hormones produced in the anterior pituitary gland regulate the production of cortisol. Stress and diurnal rhythm are modulating factors that can upregulate the production of cortisol, whereas decreased output of cortisol results from negative feedback and primary or secondary adrenal insufficiency.[13] Cortisol levels may be measured in saliva, which can be easily and safely collected in a stress-free and noninvasive manner. Furthermore the costs of storage and shipping tend to be lower for saliva than for serum or urine.[14] Salivary cortisol concentration has been shown to be independent of the saliva flow and a valid indicator of the unbound (free) cortisol concentration in plasma.[15–18]

The purpose of this study was first, to assess pain related to the placement of dental implants using questionnaires, recovery diaries, and visual analog scales (VAS). The second was to correlate pain to anxiety levels, which were estimated using salivary cortisol levels and the Spielberger self-evaluation questionnaire.

MATERIALS AND METHODS

Patient Sample

Patients scheduled to receive dental implants as part of their periodontal and restorative treatment were recruited to participate in the study. A letter explaining the purpose of the study and the procedures involved was sent to each patient by mail.

The dental implants were placed using local anesthesia only, with no premedication or sedation. In order to minimize the differences in preparation of patients for surgery, all were given standardized information regarding dental implants and the surgical procedure.

Exclusion Criteria

Patients who regularly used medications which could interfere with cortisol levels, or patients who had received any bone graft, soft tissue graft, sinus floor elevation, or nerve transposition procedures were excluded from the study. Informed consent to participate in the study was obtained from all patients, and ethical approval was obtained from the Research Ethics Committee in Trinity College, Dublin, Ireland.

Assessment of Pain and Function

A condition-specific Health-Related Quality Of Life (HRQOL) instrument for evaluating the short-term outcomes of third molar surgery was used in this study. Shugars and associates[19] developed the questionnaire in 1996, based on the work of Torrance[20] and others, to describe different aspects or "dimensions" of overall well being. The questionnaire was also based on the work of Bader and Shugars,[21] which suggested certain of these aspects are particularly important for patients' perception of dental procedures. Four quality-of-life categories were selected within which to collect data; these included oral function, general function, pain, and other symptoms.

This self-administered questionnaire consisted of 14 items representing the 4 dimensions of dental outcomes. Five-point Likert-type scales were used as the response format. It also contained VASs to evaluate average pain, worst pain, and interference with daily activities. Each patient was given a recovery diary that included 6 copies of the data-collecting instrument. Patients were instructed to read the items and seek clarification from the study coordinator when needed. Patients were also instructed to complete 1 instrument each evening for 6 days postoperatively.

The VAS consisted of a 100-mm line with clearly defined endpoints. One end of the line was labeled "no pain" and the other was labeled "most intense pain imaginable." This VAS was used to record patients' average pain and worst pain. A similar VAS was used to record interference with daily activities. Patients were also asked whether they were using analgesics (yes/no) and the number and frequency of any medications taken. In addition, patients were given the telephone number of the study coordinator and instructed to call if they had any questions. Each patient was called at least twice during the 6-day period as a reminder to complete the questionnaires and to inquire about any problems or difficulties with the diary.

Assessment of Anxiety

To assess anxiety, patients were asked to fill in a Spielberger self-evaluation questionnaire[22] 1 week before surgery and 3 and 6 days after surgery.

This questionnaire comprises 2 scales. The first scale measures state anxiety, which is a transitory emotional state or condition that is characterized by subjective, consciously perceived feelings of tension and apprehension and heightened autonomic nervous system activity. It may fluctuate over time and can vary in intensity. The second scale measures trait anxiety, which denotes relatively stable individual differences in anxiety proneness and refers to a general tendency to respond with anxiety to perceived threats in the environment.[22]

The state anxiety scale consists of 20 statements that evaluate how respondents feel "right now, at this very moment." The trait anxiety scale consists of 20 statements that assess how people "generally feel." Feelings of apprehension, tension, nervousness, and worry are evaluated on both scales.

Saliva Collection and Cortisol Assay

An information sheet, explaining the purpose of the research, was given to patients asking them to collect samples of saliva between 8:00 and 10:00 AM for 4 days. This sampling regimen consisted of specimens collected 1 week before surgery, the day of surgery, and 3 and 6 days after surgery.

Subjects collecting saliva were instructed to brush their teeth, rinse their mouth with water, and wait 15 minutes before salivating directly into the collection tubes. Patients were requested to collect 2 mL of whole saliva and store it in a freezer until their next appointment. The effect of freezing and thawing has been shown to cause no deterioration in the assaying technique.[23]

Before analysis, samples were thawed and solids were removed from specimens by centrifugation at 2500 rpm at 4°C for 10 minutes. Cortisol was measured in the clear supernatant fraction by a radioimmunoassay. The assay was performed in the Department of Clinical Biochemistry, Royal Infirmary, Glasgow. The technique used for estimating salivary cortisol employs a cortical antiserum (R9B4) (gift of J. Dyas, Tenovus Institute, Cardiff) microencapsulated in polyamide, I^{125}-labeled cortisol radioligand (GE Healthcare/Amersham Biosciences, Fairfield, CT), appropriate cortisol standards (Sigma Chemical, St Louis, MO), and controls. Radioactivity was measured using an NE1600 gamma counter (Nuclear Enterprises, Edinburgh, UK).[24]

Statistical Analysis

Continuous data were subjected to repeated measures analyses of variance (ANOVAs), which included the individual subject response as an independent variable. The dependent variables were average pain, worst pain, interference with daily activities, state anxiety, and salivary cortisol levels. Trait anxiety was compared at 2 time points using a paired *t* test. A Pearson correlation analysis was used to explore the relationship between state anxiety and worst pain scores.

RESULTS

Thirty consecutive patients were contacted; of these, 23 patients (76%) agreed to participate in the study. Two patients dropped out of the study, and 3 patients failed either to fill in the questionnaires or to collect all the salivary samples required.

Eighteen patients returned all of the questionnaires and salivary samples. Twelve of the patients were women and 6 were men; their age ranged from 27 to 63 years, with a mean age of 43.4 years. A total of 30 implants were placed; 7 in the mandible and 23 in the maxilla (Table 1). The same surgeon placed all of the implants.

Analysis of Recovery Diaries

Limitation of Activities. Table 2 shows the extent to which the outcomes of surgery interfered with patients' ability to chew, sleep, conduct daily routines, talk, and go to work or school. For the first 3 days some patients experienced "lots" or "quite a bit" of interference with chewing (range, 27% in the first day to 11% by the sixth postoperative day). Talking was affected minimally by the surgery. Sleeping was affected only minimally during the first 2 days after surgery. A few patients noted significant limitation of work and school-related activities. Opening the mouth wide, daily routine, social life, and favorite activities were affected minimally during the first 3 postoperative days; reports of limitation dropped to almost none by the sixth postoperative day.

Postoperative Symptoms

The frequency with which patients reported a range of symptoms is displayed in Table 3. No patient reported "lots" of any symptom. Swelling (quite a bit, some, and little) was the most frequent symptom reported by patients during the first 3 days postoperatively. The percentage of patients reporting swelling dropped from 72% on the first day to 39% by the sixth postoperative day.

Some or little bruising was also a notable finding during the first 3 postoperative days, as it was reported by 53% of patients. It dropped to 33% on the sixth postoperative day. Bleeding was reported by most patients to increase with brushing and ranged from 67% on the first postoperative day to 33% by the sixth postoperative day. Bad taste/bad breath (quite a bit, some, and little) were reported by 67% of patients during the first 3 days postoperatively; this was reduced to 17% by the sixth day. Food collecting in the implant site after implant placement was also a notable finding that seemed to persist over the 6-day period and decreased from 51% on the first day to 44% on the sixth day.

Nausea was reported by 16% of patients in the first 3 postoperative days, but by the sixth postoperative day, no patients reported nausea.

VAS Scores

The mean levels of average pain and worst pain and the extent pain interfered with daily activities throughout the 6-day period were recorded on the VAS and converted to scores out of 100 (Figs 1 to 3).

Average Pain. Repeated measures ANOVA was conducted for average pain and revealed significant differences among both subjects ($F = 12.56$; $P < .001$) and time points ($F = 6.17$; $P < .001$). This means that patients behaved substantially differently from each other, but that the overall pain experience for

Table 1 Details Regarding Implants Placed for Each Patient

Patient	Sex	Age	No. of implants	Type of implant and size (width × length)	Implant site	Time (min)*
1	Female	43	1	Osseotite 3.7 × 13.0 mm	Mandible, anterior area	30
2	Male	42	1	Osseotite 3.75 × 13.0 mm	Mandible, anterior area	70
3	Female	36	1	Straumann 4.8 × 10.0 mm	Maxilla, left posterior	60
4	Female	43	1	Osseotite 3.75 × 13.0 mm	Maxilla, anterior area	35
5	Female	60	2	Osseotite 3.75 × 11.5 mm	Mandible, anterior area	60
6	Female	35	2	Osseotite 3.25 × 11.5 mm	Mandible, anterior area	60
7	Male	46	1	Brånemark MKIII TiUnite 3.75 × 13.0 mm	Maxilla, left posterior	30
8	Female	52	3 1	Brånemark MKIII TiUnite 3.75 × 13.0 mm Brånemark MKIII TiUnite 3.3 × 13.0 mm	Maxilla, right and left posterior	45
9	Female	45	1	Osseotite 3.75 × 13.0 mm	Maxilla, anterior area	60
10	Male	27	2	Straumann 4.8 × 10.0 mm	Maxilla, right and left posterior	75
11	Male	31	1	Straumann 4.8 × 10.0 mm	Mandible, left posterior	45
12	Female	52	1	Osseotite 3.75 × 13.0 mm	Maxilla, left posterior	60
13	Female	39	1	Straumann 4.1 × 8.0 mm	Maxilla, right posterior	60
14	Male	34	2	Osseotite NT 4.0 × 15 mm Osseotite NT 3.25 × 13.0 mm	Maxilla, anterior area	40
15	Female	36	1	Osseotite 3.75 × 13.0 mm	Maxilla, anterior area	35
16	Female	50	2 1	Straumann 4.1 × 10.0 mm Straumann 3.3 × 10.0 mm	Maxilla, anterior area	45
17	Female	27	1	Osseotite NT 3.5 × 13.0 mm	Maxilla, left posterior	60
18	Male	57	2 2	Straumann 4.1 × 8.0 mm Straumann 4.1 × 10.0 mm	Maxilla, anterior area	45

*Total operative time for implant placement.

patients decreased over time. As shown in Fig 1, the VAS score for the average pain on the first postoperative day (24/100) was halved by the third postoperative day and then decreased further from the fourth day (10/100) to the sixth day (9/100).

Worst Pain. The worst pain experienced by subjects was not very severe, even on the first postoperative day, when a mean score of 31/100 was recorded on the VAS. The worst pain score then decreased by almost half on the third postoperative day (Fig 2). Thereafter, the worst pain continued to decrease until the sixth postoperative day (11/100). Repeated measures analysis for the worst pain confirmed that both subjects ($F = 4.59$; $P < .001$) and time ($F = 6.26$; $P < .001$) were significant.

Interference with Daily Activities. Most patients reported some limitation of daily activities on the first postoperative day, when a score of 25/100 was recorded on the VAS. This was halved by the second day and continued to improve in the following days (Fig 3). The improvement in daily activities was significant ($F = 6.26$; $P < .001$), as was the variability among subjects ($F = 4.59$; $P < .001$). By the sixth day postoperatively, the interference with daily activities registered a score of 6/100.

Spielberger Self-Evaluation Scores

State Anxiety. The state and trait anxiety scores of the 18 patients were analyzed at 3 time points for state anxiety (T1 was 1 week before surgery; T2, the day of surgery; and T3, 6 days after surgery), and at 2 time points for the trait anxiety (T1, T3), as shown in Table 4. The state anxiety scores were subjected to repeated measures ANOVA, which demonstrated significant differences among both subjects ($F = 5.405$; $P < .001$) and time points ($F = 6.26$; $P < .05$). This indicates that patients' state anxiety was significantly greater on the day of surgery as compared to the other 2 time points. A Pearson correlation analysis revealed that the relationship between state anxiety and worst pain scores was weak ($r = 0.175$).

Trait Anxiety. A paired *t* test was carried out to compare scores for trait anxiety. No statistically significant differences were found in this limited sample between the 2 trait anxiety measures, indicating that trait anxiety did not change during the course of the study ($P = .076$).

Salivary Cortisol Levels

For the 18 subjects in this study, the means and SDs of salivary cortisol levels were calculated at 4 time points, analyzed using ANOVA, and plotted in Fig 4. Overall, there was no significant change in salivary cortisol at different time points ($F = 2.22$; $P = .075$), but subjects were significantly different ($F = 3.32$; $P < .001$).

Table 2 No. of Patients Reporting Limitation of Various Activities

Activity/ amount of limitation	Postoperative day 1	2	3	4	5	6
Chewing						
Lots	2					
Quite a bit	3	3	1		2	2
Some	5	3	5	6	3	3
Little/none	8	12	12	12	13	13
Opening mouth wide						
Lots	1	1	1	1	1	1
Quite a bit						
Some	2	3		1	2	1
Little/none	15	14	17	16	15	16
Talking						
Lots		1	1	1	1	1
Quite a bit	2					
Some		1				
Little/none	16	16	17	17	17	17
Sleeping						
Lots		1	1	1	1	1
Quite a bit	1					
Some	4	2				
Little/none	13	15	17	17	17	17
Work/school						
Lots		1	1	1	1	1
Quite a bit	2					
Some	1	2	1	1	1	
Little/none	15	15	16	16	16	17
Daily routine						
Lots	1	1	1	1	1	1
Quite a bit	1					
Some	3	3				
Little/none	13	14	17	17	17	17
Social life						
Lots	1	2		1	1	1
Quite a bit	1		2	1		
Some	2	1		1	2	1
Little/none	14	15	16	15	15	16
Favorite activity						
Lots	1	2		1	1	1
Quite a bit			2			
Some	1	1		1	2	1
Little/none	16	15	16	16	15	16

Table 3 No. of Patients Reporting Postoperative Symptoms

Symptom/ amount of limitation	Postoperative day 1	2	3	4	5	6
Swelling						
Lots						
Quite a bit	2	2	1		2	
Some	3	4	2	4	1	4
Little	8	5	7	4	5	3
None	5	7	8	10	10	11
Bruising						
Lots						
Quite a bit		1	1			
Some	2	4	2	1	2	2
Little	9	5	7	7	3	4
None	7	8	8	10	13	12
Bleeding						
Lots						
Quite a bit						
Some		2	1			1
Little	12	2	4	3	5	5
None	6	14	13	15	13	12
Nausea						
Lots						
Quite a bit	1					
Some					1	
Little	3	3	2		1	
None	14	15	16	18	16	18
Bad taste/Bad breath						
Lots						
Quite a bit	1					
Some	4	3	2			1
Little	7	5	5	5	4	2
None	6	10	11	13	14	15
Food collecting in the implant site after placement						
Lots						
Quite a bit	1	1				
Some	1	1	2	1	3	
Little	7	6	6	6	4	8
None	9	10	10	11	11	10

Table 4 State and Trait Anxiety Scores at Different Time Points

Time points	State anxiety Mean	SD	Trait anxiety Mean	SD
T1 (1 week before surgery)	34.22	10.19	39.5	7.92
T2 (day of surgery)	40.61	10.97	—	—
T3 (6 days after surgery)	32.39	11.12	37.5	10.15

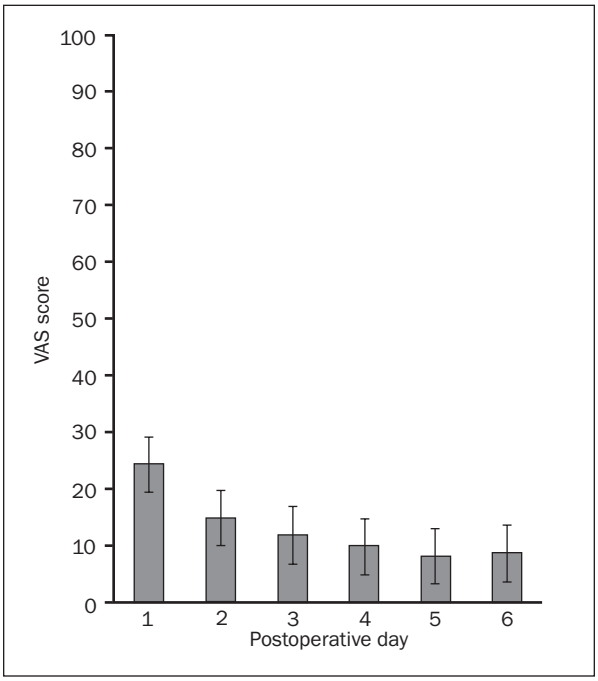

Fig 1 Means and standard deviations (SDs) of the VAS scores for average pain.

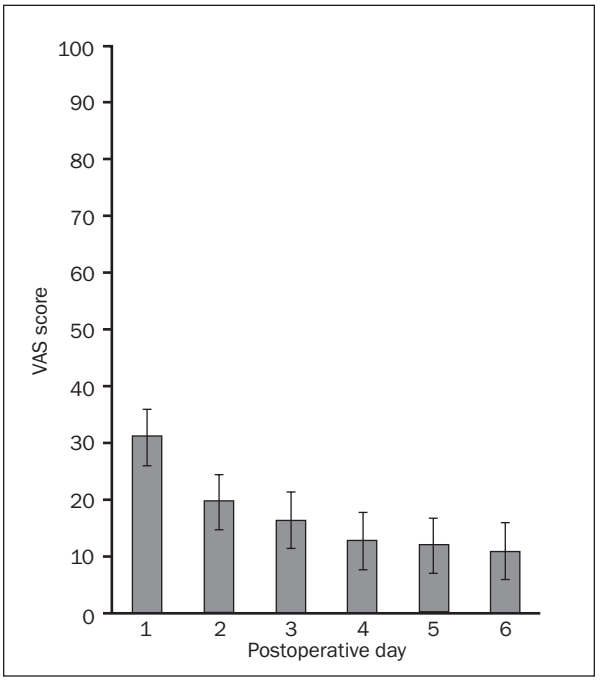

Fig 2 Means and SDs of the VAS scores for worst pain.

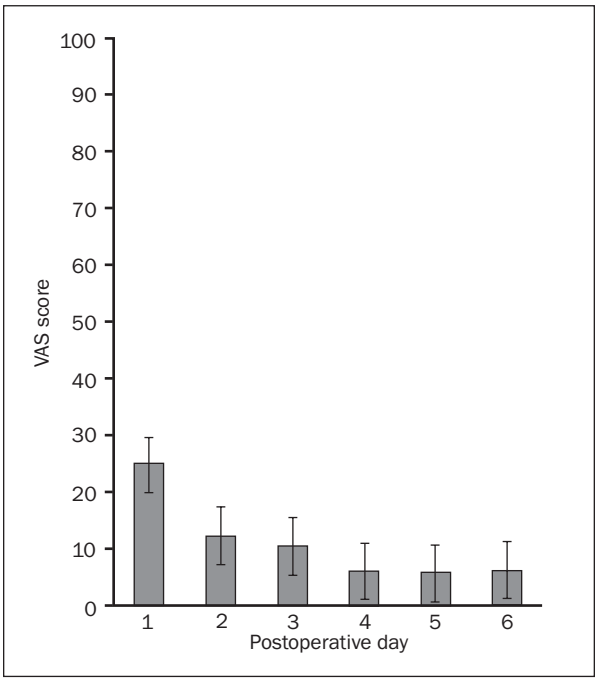

Fig 3 Means and SDs of the VAS scores for interference with daily activities.

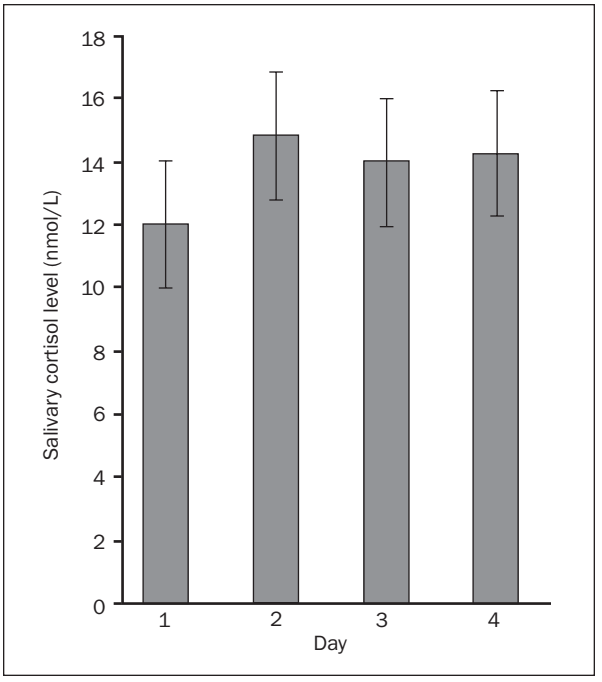

Fig 4 Means and SDs of the salivary cortisol levels at *(1)* 7 days before surgery, *(2)* the day of surgery, *(3)* 3 days after surgery, and *(4)* 6 days after surgery.

DISCUSSION

The purpose of this study was to assess pain experience following the placement of dental implants and also to measure anxiety levels related to the surgical procedure of implant placement. Questionnaires, including a recovery diary, were used to assess pain, while the Spielberger self-evaluation questionnaire and salivary cortisol were used to assess anxiety.

Based on this study, few patients would experience severe or persistent pain following implant placement. Most patients may expect to experience mild symptoms and limitation of activities for 5 days or fewer after implant placement surgery. Some interference with routine activities, such as work or school, may be expected for the first 3 days after surgery, with pain decreasing steadily over the first 6 days postsurgery. Bleeding, swelling, and nausea are relatively minimal and limited to the first 2 days postsurgery. Bruising may also be expected to be minimal. Problems of food impaction, although initially minimal, may increase gradually over the recovery period and taper off toward the end of the 6-day period. This increase may be caused by a change of diet and change again with return to normal dietary habits.

VAS scores for average pain, worst pain, and interference with daily activities revealed significant differences in patients' responses over time. The highest mean scores on the 100-mm scale were in the first postoperative day for the average pain (24), for the worst pain (31), and for the interference with daily activities (25). These scores decreased substantially by the sixth postoperative day.

Shugars and associates[19] used the same recovery diary to evaluate pain after surgical removal of third molar teeth. The median VAS scores in the first postoperative day were mild for implant placement as compared with removal of third molar teeth; 20 versus 48 for average pain, 22.5 versus 81 for worst pain, and 21 versus 78 for interference with daily activities. In agreement with other studies of postoperative pain following the surgical removal of third molars, there was no significant relationship between the operative trauma, as measured by the duration of surgery, and the magnitude of the postoperative pain experienced.[10,25,26]

While a definitive view of postoperative pain could only be obtained by instructing patients to abstain from taking analgesics, this would be unethical, and to do so would not demonstrate the true clinical picture. Compliance with a regime of non-use of analgesics would probably be poor, further compromising the results. In the present study, 13 of the 18 patients reported using analgesics in the first 3 postoperative days, and this dropped to 5 patients by the fourth postoperative day and 3 patients on the sixth postoperative day.

This study confirmed previous findings that oral surgery provokes high levels of anxiety.[9,27,28] Subjects participating in the study were not initially classified as suffering from a high level of dental anxiety. Nevertheless, their state of anxiety showed significant fluctuations over time, peaking immediately before surgery. No significant changes of trait anxiety scores were measured over time. This was expected, as trait anxiety is a personality component and should reflect patients' background and remain stable.

The salivary cortisol levels were in agreement with other studies. Benjamins and colleagues[29] reported a mean cortisol level of 14.69 nmol/L for his anxious patients, and Kirschbaum and associates[17] found the mean levels to range between 14.7 ± 1.8 nmol/L for males and 10.7 ± 1.8 nmol/L for females. Here the salivary cortisol levels were generally higher on the day of surgery (14.84 nmol/L) as compared to other time points, but the difference was not statistically significant. Salivary cortisol was not correlated with the state anxiety scores registered at the same time points. This could be a problem with methodology related to a total reliance on patients' cooperation in collecting saliva at the appropriate times, given that free cortisol concentration in serum and saliva show a diurnal variation.

Although some studies report higher levels of anxiety among women as compared to men,[9,30,31] in this study there were no significant gender differences in state anxiety or cortisol levels. Similarly, no significant interaction was found between gender and pain evaluation. However, this should be validated with a larger sample size.

Oral surgery is one of the most stressful and anxiety-provoking procedures in dentistry.[27,28] Therefore, it is important that surgeons who perform these procedures are aware of the effect of anxiety on the patient's experience of pain. Administrating local anesthesia may not always be sufficient to alleviate anxiety. Proper management of the patient's anxiety is, in many cases, essential to reducing their subjective pain experience before, during, and after treatment.

This study demonstrates that a range of outcomes is associated with implant placement surgery. This information may help create realistic expectations for similar patients considering implant placement. Better-informed patients who believe that they actively participate in treatment decisions may be more satisfied, independent of outcomes. Thus, good counseling may benefit both patients and surgeons.

CONCLUSIONS

Based on the results of this study it can be concluded that

- Some symptoms and limitations of daily activities, though mild, are expected in the first 3 days following implant placement.
- Mild to moderate pain is expected after implant placement; this pain decreases substantially with time for the first 6 postoperative days.
- Implant placement can be a mildly or moderately stressful and anxiety-provoking procedure, and proper management of patients' anxiety can play a role in reducing their subjective pain experience.

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REFERENCES

1. de Jongh A, Muris P, ter Horst G, Duyx MP. Acquisition and maintenance of dental anxiety: The role of conditioning experiences and cognitive factors. Behav Res Ther 1995;33:205–210.
2. Vassend O. Anxiety, pain and discomfort associated with dental treatment. Behav Res Ther 1993;31:659–666.
3. Locker D, Shapiro D, Liddell A. Negative dental experiences and their relationship to dental anxiety. Community Dent Health 1996;13:86–92.
4. Eli I. Oral Psychophysiology: Stress, Pain and Behaviour in Dental Care. Boca Raton: CRC Press, 1992.
5. Dworkin SF, Chen AC. Pain in clinical and laboratory contexts. J Dent Res 1982;61:772–774.
6. Weisenberg MI. Pain and pain control. Psychol Bull 1977;84:1008–1044.
7. von Graffenried B, Adler R, Abt K, Nuesch E, Spiegel R. The influence of anxiety and pain sensitivity on experimental pain in man. Pain 1978;4:253–263.
8. Robin O, Vinard H, Vernet-Maury E, Saumet JL. Influence of sex and anxiety on pain threshold and tolerance. Funct Neurol 1987;2:173–179.
9. Eli I, Schwartz-Arad D, Baht R, Ben-Tuvim H. Effect of anxiety on the experience of pain in implant insertion. Clin Oral Implants Res 2003;14:115–118.
10. Seymour RA, Meechan JG, Blair GS. An investigation into post-operative pain after third molar surgery under local analgesia. Br J Oral Maxillofac Surg 1985;23:410–418.
11. Holland CS. The development of a method of assessing swelling following third molar surgery. Br J Oral Surg 1979;17:104–114.
12. Muller E, Rios Calvo MP. Pain and dental implantology: Sensory quantification and affective aspects. Part I: At the private dental office. Implant Dent 2001;10:14–22.
13. Miller CS, Dembo JB, Falace DA, Kaplan AL. Salivary cortisol response to dental treatment of varying stress. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1995;79:436–441.
14. Veerman EC, van den Keybus PA, Vissink A, Nieuw Amerongen AV. Human glandular salivas: Their separate collection and analysis. Eur J Oral Sci 1996;104:346–352.
15. Bonnin R, Villabona C, Rivera A, et al. Is salivary cortisol a better index than free cortisol in serum or urine for diagnosis of Cushing syndrome? Clin Chem 1993;39:1353–1354.
16. Kirschbaum C, Hellhammer D. Response variability of salivary cortisol under psychological stimulation. J Clin Chem Clin Biochem 1989;27:237.
17. Kirschbaum C, Wust S, Hellhammer D. Consistent sex differences in cortisol responses to psychological stress. Psychosom Med 1992;54:648–657.
18. Umeda T, Hiramatsu R, Iwaoka T, Shimada T, Miura F, Sato T. Use of saliva for monitoring unbound free cortisol levels in serum. Clin Chim Acta 1981;110:245–253.
19. Shugars DA, Benson K, White RP Jr, Simpson KN, Bader JD. Developing a measure of patient perceptions of short-term outcomes of third molar surgery. J Oral Maxillofac Surg 1996;54:1402–1408.
20. Torrance GW. Utility approach to measuring health-related quality of life. J Chronic Dis 1987;40:593–603.
21. Bader JD, Shugars DA. Variation, treatment outcomes, and practice guidelines in dental practice. J Dent Educ 1995;59:61–95.
22. Spielberger CCR, Luchene R. STAI manual for state-trait anxiety. Palo Alto, CA: Consulting Psychologist Press, 1970.
23. Campbell IT, Walker RF, Riad-Fahmy D, Wilson DW, Griffiths K. Circadian rhythms of testosterone and cortisol in saliva: Effects of activity-phase shifts and continuous daylight. Chronobiologia 1982;9:389–396.
24. McCartan BE, Lamey PJ, Wallace AM. Salivary cortisol and anxiety in recurrent aphthous stomatitis. J Oral Pathol Med 1996;25:357–359.
25. Van Buren J, Kleinknecht RA. An evaluation of the McGill pain questionnaire for use in dental pain assessment. Pain 1979;6:23–33.
26. Seymour RA, Blair GS, Wyatt FA. Post-operative dental pain and analgesic efficacy. Part I. Br J Oral Surg 1983;21:290–297.
27. Wong M, Lytle WR. A comparison of anxiety levels associated with root canal therapy and oral surgery treatment. J Endod 1991;17:461–465.
28. Eli I, Uziel N, Baht R, Kleinhauz M. Antecedents of dental anxiety: Learned responses versus personality traits. Community Dent Oral Epidemiol 1997;25:233–237.
29. Benjamins C, Asscheman H, Schuurs AH. Increased salivary cortisol in severe dental anxiety. Psychophysiology 1992;29:302–305.
30. Smyth JS. Some problems of dental treatment. Part 1. Patient anxiety: Some correlates and sex differences. Aust Dent J 1993;38:354–359.
31. Frazer M, Hampson S. Some personality factors related to dental anxiety and fear of pain. Br Dent J 1988;165:436–439.