Original Article

Pain Intensity and Its Objective Determinants Following Implant Surgery and Sinus Lifting: A 1-Year Prospective Study

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ABSTRACT

Objectives: The main goal of this study was to evaluate the relationship between postoperative pain and short-term implant survival. Objective parameters, such as implant-related factors (type, diameter, length) and the surgical approach were also assessed to correlate them with pain. **Materials and Methods:** This prospective, single-center study consisted of 144 patients scheduled for the surgical placement of one or more implants either with conventional surgery or with sinus-lifting together. All patients were asked to complete a questionnaire form of pain with a visual-analog scale (VAS, 1–10) for 7 days following surgery. The association of pain scores at each time-point was assessed on implant- and surgery-related factors. **Results:** The overall cumulative survival rate of 546 implants in 144 patients was 98.17 % (10 implants lost) after 1-year follow-up. No statistical difference was found in pain (VAS) scores between patients with loss and survived implants at any observation period. The length and diameter of placed implants and the presence of a sinus-lifting procedure did not influence the pain scores at any period ($P > 0.05$). In patients with bilateral sinus lifting, the decrease in pain scores was significant after 3 days ($P < 0.05$), whereas it was significant after 6 hours for the conventionally treated group ($P < 0.01$). Although no severe pain was reported at any time, this study found a significant difference in pain intensities among different implant brands. **Conclusions:** This study was able to show that increased postoperative pain is not a sign of early implant failure. In addition to this, the implant dimensions and presence of sinus lifting procedure did not influence the pain experience. However, the bilateral sinus lifting prolongs the recovery time.

Keywords: *Dental implant, pain, postoperative, sinus lifting, surgery*

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Introduction

Conventional surgical placement of dental implants mostly tends to result with mild-to-moderate postoperative pain,[1] and the degree of pain could be associated with patient factors, implant-related factors and surgical factors. In one study, the pain was found to be associated with gender.[2] However, others were not able to show any relationship between pain and patient-related factors, such as gender and age.[3,4] The effect of smoking on postoperative pain was evaluated in two studies,[1,2] only in one study the pain scores were found to be higher for smokers.[1] In addition to the patient-based factors, the surgical conditions also influence the postoperative outcome of the implant placement, as of other minor oral surgery procedures.[5] These surgical factors might include flap design, the presence of an augmentation procedure, wound closure technique, surgeons experience, and duration of operation.[6,7] Especially, the flapless approach for implant placement has been shown to result with a lower pain score than the conventional techniques.[4,8]

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Conventional implant surgery is normally one of the least painful approaches among different oral surgery applications. Only on the first operative day of implant placement, patients experience the highest level of pain that has been shown to decrease to about half the maximum level by the second or third day.[9] However, some patients can unusually report increased levels of pain. Different perception of pain among individuals should not be neglected, but surgical and implant-related factors might also have an effect on the extent of postoperative pain. Also, increased level of pain could be a sign of early implant loss. Until now, various studies evaluated the patient-based outcome of implant surgery using pain, swelling, postoperative complications, and satisfaction.[1,9] No study seems to have assessed the correlation of postoperative pain with the short-term survival of implants.

The aim of this study was to evaluate the relationship between postoperative pain and short-term implant survival. Implant-related factors (type, diameter, length) and type of the surgical approach (presence of sinus lifting) were also assessed to correlate them with pain.

Material and methods

Patients

The study was conducted at our clinics (School of Dentistry, Istanbul University) between November 2004 and January 2009. Patients of any age and gender were included in the study if they were in healthy systemic status, physically and psychologically able to undergo conventional implant surgery and restorative procedures (ASA class 1 or 2). Further inclusion criteria were absence of parafunctional habits (i.e., bruxing), the presence of residual bone sufficient to place the smallest available implant (8 mm long or 3.3 mm diameter) and infection-free implant site. The patients in need for uni- or bilateral sinus-lifting procedure were also included in the study. The patients are presenting severe systemic illness (i.e., hematologic disease, uncontrolled diabetes, and others) or a history of neck or head radiation, chemotherapy, or drug abuse, were excluded. Written and oral informed consent of the patients was obtained. The patient group comprised 144 patients [Table 1], consisting of 71 females and 73 males with a mean age of 46 years (range 14-74).

Implant surgery

Prior to surgery, no analgesics or sedatives were administered to any patient for avoiding bias. The included patients were operated by a single surgeon (H.O.) with considerable clinical expertise. In the conventional surgery group, the surgical site was infiltrated with 4% articaine hydrochloride local anesthetic (Ultracain D-S, Sanofi-Aventis, Istanbul, Turkey), and a midcrestal incision was performed. If necessary, vertical relieving incisions were also performed in the distal margins of the incision to improve the visibility. After reflection of the mucosal flap, the site, and alveolar ridge were carefully evaluated with consideration for both the aesthetic and biomechanical aspects to determine the optimal implant position. In the sinus lifting group, an osteotomy was performed on the lateral wall of the maxillary sinus to prepare a bony window using a round diamond bur, cooled with a sterile saline solution. The sinus mucosa was carefully elevated using sinus elevators, and the bony wall was gently pushed into the sinus cavity. Briefly, if the sinus membrane was intact, the cavity was filled with alloplastic graft material, and the implants were placed simultaneously, as described in the literature.[10]

A total of 546 implants from three brands, including Camlog Screw-Line (Camlog Biotechnologies AG, Basel, Switzerland), Frialit (Dentsply-Friadent, Mannheim, Germany), and MIS Seven (MIS Implants Technologies Ltd., Shlomi, Israel) was inserted. There was no combined use of different brands in the same patient. All implants were placed in a submerged fashion, and the dimensions of the placed implants were summarized in Table 2.

Postoperative period

Following surgery, all patients were given orally clindamycin 300 mg as antibiotics (Cleocin; Eczacibasi Pharmaceuticals, Istanbul, Turkey) every 12 h for 5 postoperative days. Three different types of analgesics: (a) nimesulide 100 mg (Mesulid; Pfizer Pharmaceuticals, Istanbul Turkey); (b) naproxen sodium 550 mg (Apranax Fort; Abdi Ibrahim Pharmaceuticals, Istanbul, Turkey), and (c) diflunisal 500 mg (Dolphin; Sanovel Pharmaceuticals, Istanbul, Turkey) were randomly prescribed to all patients for postoperative pain control twice a day for 5 days. Sutures were removed 1 week after surgery.

Data collection

All patients were asked to complete a questionnaire form 1-6 h postoperatively and for 7 days at the end of each day following surgery. This questionnaire included a visual-analog scale (VAS), where one represented the absence of pain and 10 was considered as severe pain, as described before.[3,11] The questionnaires were collected at the time of the first postoperative control 7-10 days after surgery. All patients handed in the questionnaire.

Statistics

The statistical data was analyzed using SPSS (Statistical Package for Social Sciences) Software for Windows 15.0 (SPSS Inc., Chicago, Illinois, USA). The suitability

of parameters to the normal distribution was evaluated using Kolmogorov-Smirnov test and parameters were found not normally distributed. In addition to the descriptive statistical methods (average, standard deviation, frequency), the comparison of quantitative data and comparisons between more than two groups of parameters were performed using Kruskal-Wallis test, and the Mann-Whitney *U* test was used to evaluate the discrepant group. Mann-Whitney *U* test was also used for comparisons between two groups of parameters. Wilcoxon signed-test was used for intergroup comparisons. Qualitative data were compared using $\chi 2$ test. A *P*-value < 0.05 was considered as significant.

Results

Implant failure and postoperative pain

Ten implants were lost within the 1-year follow-up. In the conventionally treated areas, nine implants of 446 implants were lost at the time of second stage surgery due to the absence of osseointegration. In the sinus-grafted sites, only one implant of 100 implants was lost before prosthetic rehabilitation due to severe resorption within 1 year. The overall cumulative survival rate of 546 implants was 98.17% (97.98 and 99% for implants placed conventionally and in the grafted sinus, respectively) after 1-year follow-up.

No statistical difference was found in pain (VAS) scores between patients with loss and survived implants at any observation period (Mann-Whitney *U* test, $P > 0.05$) [Figure 1]. The decrease of VAS scores with time compared with the initial observation period (1 h) was not significant within the implant loss group ($P > 0.05$), whereas a significant decrease in pain scores at any observation period after 6 h was observed for the group with survived implants (Wilcoxon signed-rank test, $P < 0.01$).

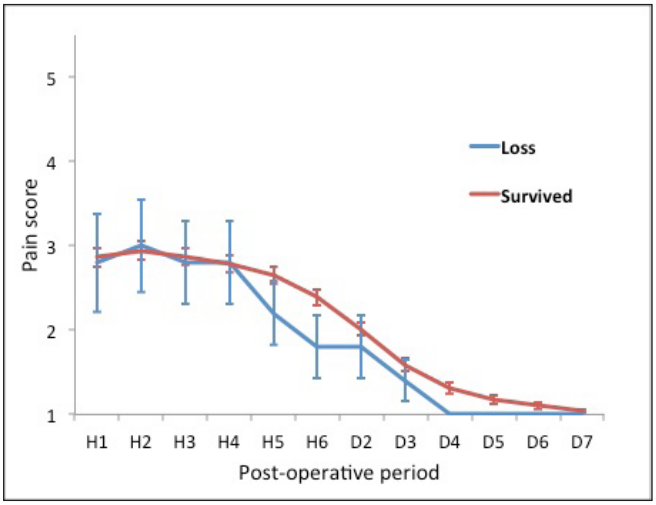

Figure 1: Mean visual-analog scale (VAS) scores of patients with lost and survived implants from 1 h to 7 days ($n = 5$ and $n = 139$, respectively). Vertical bars represent the standard error of the mean.

Implant length and postoperative pain

In this study, implants having a length ≥13 mm were considered as longer implants [Table 1]. No statistical difference in pain VAS scores was observed in patients with longer implants compared with patients with shorter implants at any time (Mann-Whitney *U* test, $P > 0.05$) [Figure 2a]. In patients with longer implants (length ≥13 mm), the decrease in VAS scores compared with the initial observation period (1 h) was found to be statistically significant at 5 h ($P < 0.05$), 6 h, 2 day, 3 day, 4 day, 5 day, 6 day, and 7 day (Wilcoxon signed-rank test, $P < 0.01$). In patients with shorter implants (length <13 mm), the decrease in VAS scores compared with the initial observation period (1 h) was found to be statistically significant at 2 day, 3 day, 4 day, 5 day, 6 day, and 7 day (Wilcoxon signed-rank test, $P < 0.01$).

Implant diameter and postoperative pain

In this study, implants having a diameter ≥ 4.5 mm were considered as wide implants [Table 1]. No statistical difference in pain VAS scores was observed in patients with wide implants compared with patients having narrower implants at any time (Mann-Whitney *U* test, $P > 0.05$) [Figure 2b]. In patients with wide implants (diameter ≥ 4.5 mm), the decrease in VAS scores compared with the initial observation period (1 h) was found to be statistically significant at 5 h ($P < 0.05$), and 6 h, 2 day, 3 day, 4 day, 5 day, 6 day, and 7 day (Wilcoxon signed-rank test, $P < 0.01$). In patients with narrow diameter implants (diameter < 4.5 mm), the decrease in VAS scores compared to the initial observation period (1 h)

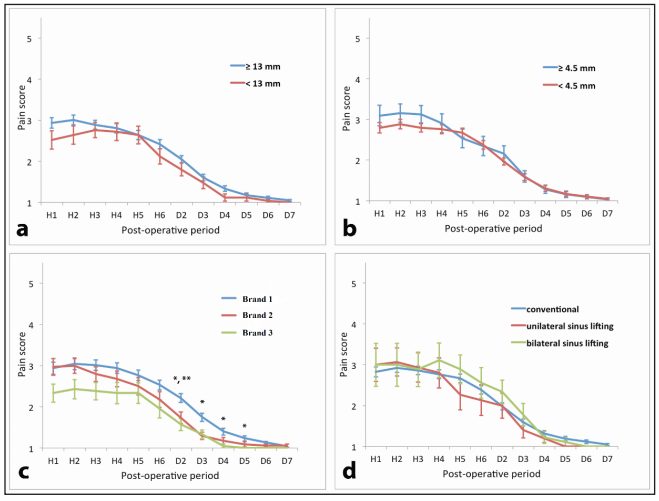

Figure 2: Mean visual-analog scale (VAS) scores of patients: (a) with longer (length ≥ 13 mm) and shorter implants, (b) with wide diameter implants (diameter ≥ 4.5 mm) and narrower implants, (c) with different implant brands, and (d) with different surgical implant placement strategies within an observation period from 1 h to 7 days. Vertical bars represent the standard error of the mean. *$P < 0.05$, **$P < 0.01$.

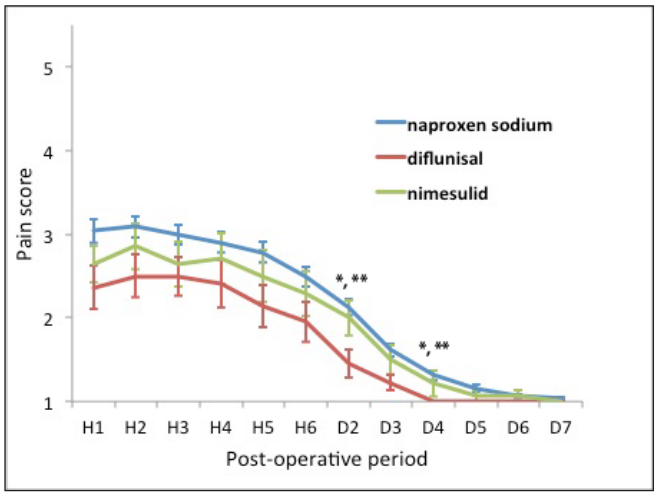

Figure 3: Mean visual-analog scale (VAS) scores of patients with different analgesic usage within an observation period from 1 h to 7 days. Vertical bars represent the standard error of mean. *$P < 0.05$, **$P < 0.01$.

was found to be statistically significant at 6 h, 2 day, 3 day, 4 day, 5 day, 6 day, and 7 day (Wilcoxon signed-rank test, $P < 0.01$).

Implant type and postoperative pain

A number of 368 Camlog implants (67.4%), 113 Frialit implants (20.7%), and 65 MIS implants (11.9 %) were included in the study. The cumulative survival rates for the Camlog, Frialit, and MIS implants were 98.64% (three loss), 99.11% (one loss) and 90.77% (six loss), respectively. No statistical difference in implant survival was found between different implant brands ($\chi 2$ test, $P > 0.05$). Camlog implants had significantly increased pain scores compared with Frialit implants after 2 and 3 days, and compared with MIS implants after 2, 4, and 5 days (Mann-Whitney *U* test) [Figure 2c], as summarized in Table 3.

Operation types and postoperative pain

In the study, the distribution of 144 patients according to the operation type varied as follows: conventional implant placement (120 patients), unilateral sinus-lifting + implant placement (15 patients), and bilateral sinus-lifting + implant placement (nine patients). The presence of the sinus-lifting procedure during implant placement did not influence the VAS scores significantly (Kruskal-Wallis test, $P > 0.05$) [Figure 2d]. Although a significant decrease in pain scores (compared with 1 h) at an early observation period of 6 h was observed for the groups with conventional placement and unilateral sinus lifting ($P < 0.01$), the group with bilateral sinus lifting had a significant decrease in pain scores only after 3 days (Wilcoxon signed-rank test, $P < 0.05$).

Table 1: Distribution of patients according to test criteria

		Number of patients	%
Implant survival	Failure	5	3.5
	Survived	139	96.5
Implant length	13	119	82.6
	<13	25	17.4
Implant diameter	4.5	32	22.2
	<4.5	112	77.8
Implant type	Camlog	89	61.8
	Frialit	34	23.6
	MIS	21	14.6
Implantation approach	Conventional	120	83.3
	Unilateral sinus lift	15	10.4
	Bilateral sinus lift	9	6.3

Table 2: Distribution of implant length and diameter (mm)

Diameter\length	8	10	11	11.5	13	15	16	Total
3.3		2			4		10	16
3.75		15		2	32		6	55
3.8			24		75	47	70	216
4.2	1	2			3			6
4.3			16		42		87	145
4.5		4			10	28		42
5			3		14		43	60
5.5					1	1		2
6					1		3	4
Total	1	23	43	2	182	76	219	546

Table 3: Post-hoc results of pain (VAS) scores according to implant brand

VAS	Camlog/Frialit	Camlog/MIS	Frialit/MIS
	P	*P*	*P*
2 day	0.015*	0.006**	0.543
3 day	0.013*	0.086	0.645
4 day	0.117	0.023*	0.249
5 day	0.126	0.044*	0.262

Mann–Whitney *U* test. *$P < 0.05$. **$P < 0.01$.

Discussion

The surgical placement of implants typically causes postoperative pain of mild-to-moderate intensity, as shown before.[2,8] However, some patients may experience severe pain that make the surgeon worry about the placed implant. Several studies suggested that the extent of postoperative pain in dental patients is closely related to their anxiety.[12] In addition to other subjective factors, such as gender, were found to be associated with postoperative pain since they influence directly the pain evaluation of the patient.[2] Although the design of surgical approach has a significant impact on the patient-

related outcome,[4,8] additional factors might also involve in the level of postimplantation pain. In a case study, it has been proposed that increased postinsertion pain can be one of the failure factors of dental implants.[13] Thus, the major purpose of this study was to find a correlation between postimplantation pain and implant loss.

In the present study, maximum pain levels were reported on the day of surgery and pain started to decrease at the first postoperative day [Figure 3]. The overall VAS scores were in agreement with the previously published results[1,2] and indicated that the conventional implant surgery resulted in mild-to-moderate pain, as defined in the literature.[14] Interestingly, no patient reported a VAS score of more than six at any observation period that is considered to be as severe pain.[14] This finding might be due to the absence of bacterial etiology of pain since no early postoperative infection was noted among the test subjects. In addition, in the present study the increase in postinsertion pain was not related to implant loss. This entails that increased VAS scores in the range of 3-6 were not an indicator of a failure in osseointegration if the postoperative infection is absent.

An important factor, which might influence postoperative pain, is the surgical trauma during insertion of the implants. The level of surgical stimuli in implant surgery can be affected by various parameters, making each operation an individual experience. Although surgeons experience and duration of operation have been shown to influence the postoperative outcome of implant placement,[4,15] additional implant-related factors, such as drilling and insertion protocol, implant length and diameter, can lead to enhanced surgical stress in bone, thereby resulting in increased pain. Several studies have documented that placement of implants sometimes results in peripheral nerve injury without sensory loss that can produce pain and neuropathic manifestations.[13,16] The assumption was that longer and wider implants would cause more pain, as the drill path and placed implant would be close to critical anatomical structures such as the inferior alveolar nerve. In a previous study, however, smaller implants were found to be associated with greater pain, and it was proposed that the surgical trauma and operational difficulty is increased when working in small bone size.[17] In the present study, the length of 13 mm and diameter of 4.5 mm were selected as critical sizes when evaluating the effect of implant dimensions on pain.[18,19] Patients either with longer or wider implants reported only a slight increase in pain intensity that was not statistically significant. First, the surgeons experience might have an influence on the present findings since no neuropathic complication was noted following surgery. Secondly, the bone strain is influenced more by the cortical bone thickness than by the implant length, as found in a study.[18] Thus, a bone strain derived from cortical thickness might be a possible determinant of postoperative implant pain.

This study found a significant difference in pain intensities between different implant brands. Although the difference in implant quantities between different brands might have an effect on these findings, other subjective factors, such as drill protocol, implant design, should also be considered. Although no severe pain was reported on any implant brand, the correlation between implant type and the intensity of pain may provide an important clue for the understanding of postoperative implant pain. The surgical bone trauma due to implant cavity preparation protocols and implant tread design may have an impact on the extent of the postoperative pain. Therefore, future studies are needed to find a relation between implant-related bone strain and postoperative pain, by correlating pain with the insertion torque value and implant stability quotient.

Previous studies[4,8] have shown that postoperative implant pain can be significantly reduced using a flapless image-guided approach. On the other hand, the bone dimensions are not always sufficient for the placement of implants, thereby requiring additional regenerative techniques. When an implant placement with a simultaneous regenerative approach is planned, commonly used techniques are bone splitting, sinus lifting, and guided bone regeneration. In a previous study, patients experienced little to moderate pain after immediate implant placement in molar regions involving regenerative techniques either with or without the autologous bone. In this study, in addition to the conventional placement also implant surgeries with simultaneous sinus grafting using alloplastic materials were included to assess the outcome of sinus lifting procedure. Although the presence of the sinus-lifting procedure during implant placement did not increase the average pain intensity, within the bilaterally sinus-lifted group the recovery was found to take longer according to the time-dependent decrease in pain scores.

Conclusions

According to the present results, it was concluded that increased pain (VAS) scores within the ranges of mild to moderate pain did not provide the evidence of the early failure of osseointegration. Although implant length and diameter did not influence the postoperative pain intensity, implant type was found to be related with pain. Implant design and drill protocol might be a possible determinant of the postoperative pain intensity. In addition, an implantation strategy combined with a sinus-lifting procedure did not increase the postoperative pain significantly, whereas it prolongs the recovery time.

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Conflicts of interest

There are no conflicts of interest

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