High Volume Local Anesthesia as a Postoperative Factor of Pain and Swelling in Dental Implants

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ABSTRACT

Objective: To determine whether the administration of high-volume local anesthesia can influence postoperative pain and swelling, and the degree of patient satisfaction, following dental implant placement.

Material and Methods: One hundred patients (45 women and 55 men) between 19 and 80 years old were divided into two groups: group A ($n = 50$, with placement of an implant using an atraumatic approach in each patient, with sub-periosteal injection of a volume of Ultracain® ≤0.9 mL [half a carpule]) and group B ($n = 50$, involving the same surgical procedure but infiltrating a local anesthetic volume of ≥7.2 mL [four carpules]). Visual analog scales were used in all patients to rate intraoperative pain and postoperative pain and swelling. After the first week, the patients completed a questionnaire evaluating satisfaction with treatment.

Results: The intraoperative pain scores were similar in both groups ($p = 0.363$), while the postoperative pain and swelling scores were significantly lower in group A at all time points. Patient rated satisfaction with the surgical treatment was higher in group A.

Conclusions: Excess injected volume of local anesthetic in dental implant surgery has a negative impact upon both postoperative pain and swelling, and on patient rated satisfaction.

KEY WORDS: dental implant, local anesthesia, pain, postoperative, swelling

INTRODUCTION

Following dental implant surgery, patients typically experience pain and swelling as a direct consequence of the surgical procedure.[1] The intensity of these symptoms is dependent upon the degree of tissue damage caused. Both symptoms are closely related, develop in parallel, and share the same physiopathology. Some studies have shown conventional dental implant treatment to be associated with mild or moderate postoperative pain, and patients reportedly experience the greatest pain intensity on the day of the operation.[2] Swelling tends to be mild in minor oral surgery,[3] with a peak intensity after 48 hours.[4] Postoperative pain is of a multifactorial origin, and some of its underlying influencing factors remain unclear. Pain occurs as a result of the nociceptive stimulus produced by surgery, ligament distension, muscle spasms and tissue inflammation – in general, all those circumstances related to the surgical operation. Few studies have been published on the factors that can influence or worsen postoperative swelling and pain. In this context, patient gender,[2] age,[5] the type of surgical technique,[5] flapless guided surgery,[6] smoking,[7] and the degree of patient fear and anxiety can all influence pain perception.[2]

Local anesthetics are a good example of the type of drugs affording maximum patient benefit, since they allow us to perform complex and invasive operations safely and with only minimum pain. Nevertheless, there is a small risk of both local and systemic adverse reactions to local anesthetics.[8,9] In this sense, their correct use is essential in order to avoid complications. Excess anesthetic volume can be counterproductive in terms of

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postoperative swelling and pain. The present study aims to demonstrate that the local infiltration of high volume anesthesia causes increased postoperative swelling and/or pain.

MATERIAL AND METHODS

A prospective study was made of 100 patients (45 women and 55 men) between 19 and 80 years old.

Inclusion criteria: Patients over 18 years of age with a single missing tooth. Exclusion criteria: Patients with allergy to non-steroidal anti-inflammatory drugs, diabetes, moderate or severe periodontal disease, diseases of the oral mucosa or connective tissue, gastritis, gastric ulcer or requiring guided tissue regeneration techniques.

Case diagnosis and planning was based on the I-CAT® conical beam X-ray study (Imaging Science International, LLC, Hatfield, PA, USA).

We placed a total of 100 Biotech® implants (Biotech-International, Paris, France) – one per patient. The study sample was divided into two groups: group A ($n = 50$, with sub-periosteal injection in the edentulous zone of a volume of Ultracain® [Laboratorios Normon, S.A., Madrid, Spain] [articaine with 0.5% epinephrine] of ≤0.9 mL [half a carpule]) and group B ($n = 50$, involving the same surgical procedure but infiltrating a volume of ≥7.2 mL of the same anesthetic [4 carpules]).

The implants were placed by the same surgeon, using the same surgical technique (crestal incision without releasing incisions, drill sequence, and two suture stitches [Lorca Marin S.A., Murcia, Spain]). In no cases was guided tissue regeneration used. none of the implants were left submerged. The 100 Biotech® implants were conical, with internal connection diameters of 3.6, 3.9, 4.4 and 5.4 mm. The lengths used were 10, 12 and 14 mm. All patients received ibuprofen 600 mg upon demand, as well as antibiotic coverage (amoxicillin 500 mg/8 hours during 6 days).

Before implant placement, the patients completed the Corah® dental anxiety questionnaire. Immediately after implantation, an intraoperative visual analog scale (VAS)[1–10] was used to score patient pain perception during surgery. Posteriorly, the patients again scored pain and swelling after 2, 6 and 12 hours on the first day, and again daily for 7 days.

Lastly, at the end of the postoperative period, the patients completed a questionnaire evaluating benefit and satisfaction with treatment. We recorded the mean days of ibuprofen use in each group, along with the cumulative dose administered. The study was approved by the Ethics Committee of the University of Murcia (Spain).

Statistical Analysis

Data were analyzed using the SPSS version 12.0 statistical package (SPSS® Inc., Chicago, IL, USA). A descriptive study was made of each variable. The associations between the different qualitative variables were studied using Pearson's chi-squared test. We in turn used the Student *t*-test for two independent samples in application to quantitative variables, in each case determining whether the variances were homogeneous. Statistical significance was accepted for $p \leq .05$.

RESULTS

There were no systemic adverse effects associated to local anesthesia. Table 1 shows the two study groups to be homogeneous in terms of age, gender, smoking, alcohol consumption, implant length and diameter, location, level of anxiety, and dental fear.

The intraoperative pain scores were similar in both groups, with no statistically significant differences between them (Table 2). Maximum pain intensity was recorded after two hours in group A and after 6 to 24 hours in group B. The patients administered high volume anesthesia (≥7.2 mL) (group B) showed significantly higher pain scores during the entire 7-day postoperative period (Table 3).

Maximum swelling in group A was recorded after 6 hours, and proved almost insignificant (VAS = 1.4). In group B, maximum swelling occurred after 48 hours.

Table 3 shows the pain and swelling scores in group B to be significantly higher than in group A. Likewise, the patients subjected to high volume anesthesia consumed ibuprofen for significantly longer than the patients in group A (≤0.9 mL of local anesthetic). The cumulative ibuprofen dose was also significantly higher in group B (Table 4).

Patient rated benefit and satisfaction with the surgical treatment received was higher in group A, though in this case statistical significance was not reached ($p = .208$) (Table 5).

DISCUSSION

Few studies have been published on postoperative swelling and pain and their associated factors in dental implant surgery.[1–5,10] No studies have associated the

TABLE 1 Homogeneity of the Study Groups in Terms of the Demographic Characteristics, Toxic Habits, Body Mass Index, Dental Anxiety, Location and Characteristics of the Dental Implants (Student's *t* and Pearson χ^2 Test)

	GROUP A ($n = 50$)	GROUP B ($n = 50$)	*p*-Value
Age: mean ± SD*	46.76 ± 12.14	51.02 ± 15.66	0.132
Sex: n (%)			0.546
Male	26 (52)	29 (58)	
Female	24 (48)	21 (42)	
Smoking behavior: n (%)			0.817
Yes	13 (26)	12 (24)	
No	37 (74)	38 (76)	
Alcohol consumption: n (%)			0.134
Yes	7 (14)	13 (26)	
No	43 (86)	37 (74)	
Body mass index (kg/m^2): mean ± SD	24.28 ± 2.93	24.04 ± 3.84	0.726
MDAS score: n (%)			0.463
No (0–5)	9 (18)	14 (28)	
Mild (6–11)	32 (64)	27 (54)	
Moderate (12–18)	8 (16)	9 (18)	
Severe (19–25)	1 (2)	0 (0)	
Maxilla/Mandible: n (%)			0.836
Maxilla	19 (38)	18 (36)	
Mandible	31 (62)	32 (64)	
Anterior/Posterior: n (%)			0.065
Anterior	3 (6)	9 (18)	
Posterior	47 (94)	41 (82)	
Length: n (%)			0.469
10 mm	9 (18)	14 (28)	
12 mm	33 (66)	30 (60)	
14 mm	8 (16)	6 (12)	
Diameter: n (%)			0.601
3.6 mm^2	2 (4)	1 (2)	
3.9 mm^2	16 (32)	22 (44)	
4.4 mm^2	26 (52)	23 (46)	
5.4 mm^2	6 (12)	4 (8)	

*SD = standard deviation.

TABLE 2 Incidence and Severity of Intraoperative Pain (Student's *t*-Test)

	GROUP A ($n = 50$) Mean ± SD*	GROUP B ($n = 50$) Mean ± SD	*p*-Value
Intraoperative pain	0.81 ± 3.41	1.60 ± 5.09	0.363

*SD = standard deviation.

injection of excess local anesthetic volume to postoperative pain and swelling. The amount of anesthetic needed for implant placement has not been established, and in some cases excess anesthetic use is observed. The present study was designed to demonstrate that the local infiltration of high volume anesthesia influences postoperative swelling and/or pain.

Maximum pain was recorded in the first 24 hours in both groups. In group A, the peak intensity of pain was observed after two hours, due to the limited volume of anesthetic used. In comparison, maximum pain

TABLE 3 Incidence and Severity of Pain and Swelling during the 7 Days after Dental Implants Placement (Student's *t*-Test)

Pain	GROUP A ($n = 50$) Mean ± SD*	GROUP B ($n = 50$) Mean ± SD	*p*-Value
2 hours	5.20 ± 9.73	12.10 ± 20.18	0.032
6 hours	3.40 ± 6.88	13.20 ± 19.11	0.001
12 hours	2.60 ± 5.99	13.70 ± 19.37	<0.001
1 day	0.60 ± 2.39	13.20 ± 17.95	<0.001
2 days	0.80 ± 3.41	11.90 ± 18.18	<0.001
3 days	1.80 ± 8.01	8.00 ± 15.01	0.011
4 days	0.60 ± 3.13	6.80 ± 15.11	0.005
5 days	0.60 ± 3.13	6.00 ± 12.33	0.003
6 days	0.40 ± 2.82	4.70 ± 10.71	0.007
7 days	0.20 ± 1.41	3.40 ± 7.38	0.003
Swelling	**GROUP A ($n = 50$) Mean ± SD**	**GROUP B ($n = 50$) Mean ± SD**	***p*-Value**
2 hours	0.20 ± 1.41	9.60 ± 20.79	0.002
6 hours	1.40 ± 4.95	9.20 ± 20.71	0.001
12 hours	0.80 ± 3.41	10.70 ± 21.68	0.002
1 day	0.20 ± 1.41	11.70 ± 20.41	<0.001
2 days	0.00 ± 0.00	10.20 ± 18.43	<0.001
3 days	0.00 ± 0.00	8.40 ± 16.17	<0.001
4 days	0.20 ± 1.41	6.20 ± 13.94	0.003
5 days	0.20 ± 1.41	4.20 ± 11.54	0.012
6 days	0.00 ± 0.00	4.00 ± 11.61	0.017
7 days	0.00 ± 0.00	3.80 ± 11.54	0.022

*SD = standard deviation.

intensity was recorded after 6 to 24 hours in group B. These observations coincide with those of other authors. Muller et al., in a series of 221 implants, found 45% of the patients to describe maximum pain in the first 24 hours.[1] This is consistent with the literature, where most studies report maximum pain in the first 24 hours.[2,4,6] Postoperative swelling can be regarded as an indicator of the invasiveness of the surgical procedure. In our series, we kept invasiveness to a minimum, placing a single implant in order to determine whether the resulting inflammatory response is fundamentally influenced by the volume of local anesthetic used. Postoperative swelling was significantly greater in group B, reaching a maximum after the first 24 hours, in agreement with the findings of most authors.[4] A number of studies have identified different factors that may influence postoperative pain and swelling, such as patient gender,[2] age,[2] smoking,[5] the number of implants placed,[2] and anxiety.[2,10] In contrast, other investigators have observed no such influence.[4,11,12] For this reason, we established two

TABLE 4 Comparison of the Amount of Analgesic Consumed (Ibuprofen 600 mg) (Student's *t*-Test)

	GROUP A ($n = 50$) Mean ± SD*	GROUP B ($n = 50$) Mean ± SD	*p*-Value
Days in treatment	1.30 ± 1.11	4.92 ± 2.18	<0.001
Cumulate doses in mg	1,376.00 ± 1,690.13	8,856.00 ± 3,930.83	<0.001

*SD = standard deviation.

TABLE 5 Patient Perception at the End of Implants Placement, Regarding the Satisfaction with the Surgical Treatment (Pearson χ^2 Test)

	GROUP A ($n = 50$) n (%)	GROUP B ($n = 50$) n (%)	p-Value
Satisfaction			0.208
Extremely satisfied	8 (16)	5 (10)	
Satisfied	32 (64)	27 (54)	
A little satisfied	9 (18)	11 (22)	
No change	1 (2)	6 (12)	
Dissatisfied	0 (0)	1 (2)	

patient groups that were homogeneous in relation to the aforementioned factors (Table 1).

No studies similar to our own can be found in the dental implant literature – though there are other studies in other medical fields. In this context, Hartrick et al. described the benefits of reducing local anesthetic volume in arthroscopic shoulder surgery, with similar intraoperative pain scores in the low and high anesthesia volume groups, and a lesser incidence of postoperative local and systemic side effects in the low volume group.[13] In turn, Fredrickson et al.,[14] performing the same type of surgery, showed a lesser volume of local anesthetic to yield intraoperative pain scores equivalent to those obtained with a larger volume of anesthetic, but with greater patient postoperative satisfaction scores. In dental practice, a number of studies have analyzed the postoperative repercussions of increasing the concentration of certain anesthetics. In this sense, a prolongation of anesthetic effect was observed in relation to nerves such as the dental nerve and lingual nerve.[15] In the same way that an increase in concentration has local repercussions, a high volume of local anesthetic can also give rise to increased postoperative symptoms.

In the present study, we postulated that the administration of high-volume (≥7.2 mL) anesthesia is associated with increased local tissue distension, including epithelium connective tissue, ligaments and muscles. On the other hand, the injected drug volume must be reabsorbed, at the expense of local vasodilatation, which entails inflammation and the release of pro-inflammatory mediators that in turn stimulate the nociceptive amielinic nerve endings, causing pain. The benefits of limiting anesthetic volume include the absence of intraoperative pain, less postoperative pain and swelling, improved patient satisfaction, and a lesser use of anti-inflammatory medication.

CONCLUSIONS

The injection of large volumes of local anesthetic in dental implant surgery is associated to higher postoperative pain and swelling scores, and to lesser patient rated satisfaction, compared with patients who receive lesser volumes of anesthetic.

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