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Retrospective Study

Postoperative pain evaluation and pain management in implantology: retrospective study and literature review

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ABSTRACT

To evaluate post-operative pain in a sample of patients undergoing implant prosthetic rehabilitation. To accomplish a literature review about pain perception and pain management in implantology; to assess patient satisfaction according to current studies. A sample of 23 consecutively treated patients was enrolled in the study. To fulfill the research inquiries, a questionnaire about postoperative pain was administered to all patients every day for the first 7 days following implantology. Data were collected, and statistical analysis was performed. A literature review was conducted to compare our results to those of other similar studies. Post-operative pain is a fairly common problem in patients undergoing implant-prosthetic rehabilitation, and it varies in intensity and duration.

INTRODUCTION

Post-operative pain management after implant surgery is a rather important issue to consider in dental care (1-4). Post-operative pain is mainly due to the surgical insult to the tissue: the inflammatory process that develops in the surgical site releases prostaglandins and simultaneously sensitizes peripheral nerve endings, resulting in electrophysiological changes and pain sensation (5, 6). Moreover, an emotional reaction to surgery has been demonstrated (7). Tingting et al. investigated the degree of pain after implantation. They noted that most patients and surgeons consider postoperative pain as a natural phenomenon that can only be endured (7). Still, despite this belief, pain should be managed and kept under control. Pain management is closely related to patient satisfaction in implantology.

In 1986, Albrektsson et al. first described principles for successful implantology: health of the surgical site, surgical technique, prosthetic elements, the biocompatibility of materials, implant macroscopic structure, and surface. None of these features should be considered second to the others to achieve optimal results (8). Since the 80s, implant technologies have dramatically improved with the introduction of short implants, the design of new implant-abutment interfaces, and new implant surfaces (9).

Today, implant surfaces are classified as smooth, minimally rough, moderately rough, or rough. Smooth and minimally rough surfaces have reduced bone integration in comparison to other surfaces. Conversely, some research indicated that moderately rough surfaces may elicit a more favorable bone response than excessively rough surfaces. Some authors have proposed that moderately rough surfaces (with a roughness between 1 and 2 μm) offer the optimal balance between adhesion and promotion of osseointegration(10-20). In addition, there are now numerous implant surface lavage techniques that increase the roughness of the implant and promote its osseointegration process, such as acid treatment of titanium implant surfaces, which promotes the adhesion and growth of new tissue (10, 21-23, 23-27). Today, we might add these principles to the list for successful pain management.

The aim of this study was to evaluate post-operative pain in a sample of patients undergoing implant prosthetic rehabilitation. Moreover, we wanted to conduct a literature review about pain perception and pain management in implantology to evaluate patient satisfaction according to current studies.

MATERIALS AND METHODS

Retrospective observational study

This is a retrospective observational study. The sample of patients consisted of 23; all of them met the inclusion and exclusion criteria. The type of implants employed for the prosthetic rehabilitation was anodized, ultra-hydrophilic, and multi-zone; moreover, all implants were characterized by a gradually changing topography from the collar to the apex, becoming porous and moderately rough towards the apex. To fulfill the research inquiries, the patients completed an ad hoc questionnaire to assess postoperative pain. The questionnaire included the Visual Analogue Scale (VAS) from 0 to 100 and assessed the patient's pain from the surgery date until day 7 (Table I).

Table I. *Visual analogic scale.*

1- Indicate pain intensity from 0 (no pain) to 100 (maximum pain) in the 24 hours following implantology.
0_____50_____100

2- Indicate pain intensity from 0 (no pain) to 100 (maximum pain) 2 days after implantology.
0_____50_____100

3- Indicate pain intensity from 0 (no pain) to 100 (maximum pain) 3 days after implantology.
0_____50_____100

4- Indicate pain intensity from 0 (no pain) to 100 (maximum pain) 4 days after implantology.
0_____50_____100

5- Indicate pain intensity from 0 (no pain) to 100 (maximum pain) 5 days after implantology.
0_____50_____100

6- Indicate pain intensity from 0 (no pain) to 100 (maximum pain) 6 days after implantology.
0_____50_____100

7- Indicate pain intensity from 0 (no pain) to 100 (maximum pain) 7 days after implantology.
0_____50_____100

In addition, information about pain medications was noted down by the patients in order to record the adopted analgesic regimen (Table II).

Table II. *Painkillers survey.*

- How many and which analgesics did you take in the 24 hours after surgery?
- How many and which analgesics did you take on the 1st day after surgery?
- How many and which analgesics did you take on the 2nd day after surgery?
- How many and which analgesics did you take in the 3rd day after surgery?
- How many and which analgesics did you take on the 4th day after surgery?
- How many and which analgesics did you take on the 5th day after surgery?
- How many and which analgesics did you take on the 6th day after surgery?

Once data were collected, statistical analysis was performed to determine the influence that each considered patient's variable had on pain management following implant surgery. The considered items were gender, rehabilitated arch, implant location in the maxilla (anterior, posterior, both anterior and posterior or All-On-Four), surgical technique (classic or guided), the timing of insertion, mini sinus lift performance, use of membrane and bone substitutes (e.g., heterologous). Diagrams and tables with data from patients who joined the study are presented below. The sample is homogenous in terms of patients' gender and treated arch. At the same time, there is less homogeneity concerning implant location in the maxilla, surgical technique adopted, and timing of implant insertion, as well as there is little or no homogeneity in the sample for patients undergoing mini lift of maxillary sinus and treated with heterologous bone substitute and membrane.

Patient satisfaction: literature review

A systematic literature review was conducted to identify relevant studies on the topic. Initially, 107 studies were identified, and afterward, 13 papers met the inclusion criteria and were selected for review. All studies were published in PubMed, Scopus, Ovid, and Cochrane. Results are presented in the dedicated section.

RESULTS

In the sample of patients, there were 11 males and 12 females; 48% of patients underwent inferior arch treatment, 52% underwent superior arch treatment, 91% had classic implantology, and 9% had prosthetically guided implantology (Fig. 1).

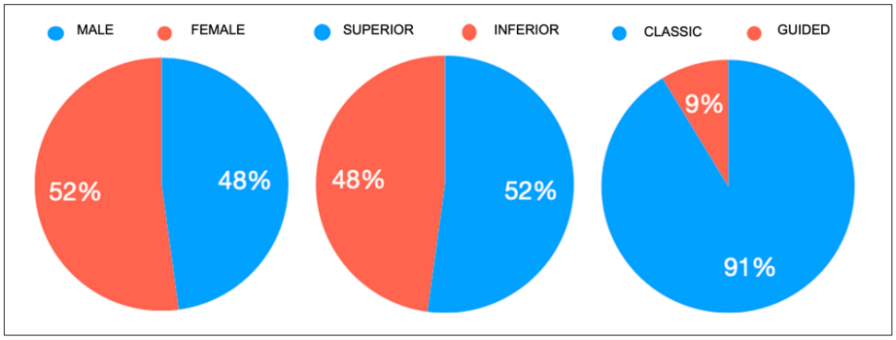

Fig. 1. *The graphs present the following data: gender percentages within the sample (on the left); percentages of the treated dental arch upper or lower (in the center); percentages of applied implantology planning.*

To collect data about postoperative pain, an Excel spreadsheet was created and filled in with patient data and information about surgery type. Graphs were then created, and statistical analyses were performed. Figure 2 shows the pain trend from the day of surgery (t0) to day 7 (t6). Pain was scored on a VAS scale from 0 to 100.

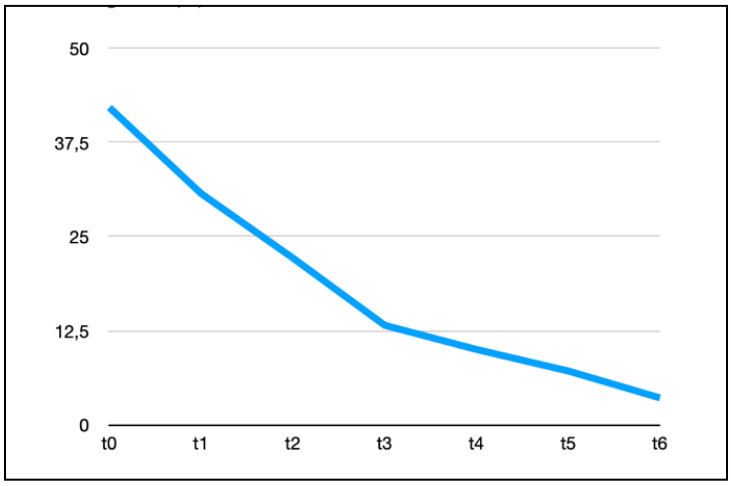

Fig. 2. *Pain trend from implantology day (t0) to the 7th day after the procedure (t6). Values were assested on a Visual Analogic Scale from 0 (no pain) to 100 (extreme pain).*

The graph analysis shows that pain peaks 24 hours after surgery, contrary to the common belief that it occurs between 24 to 48 hours following the procedure.

Statistical analysis

ANOVA test was employed to perform statistical analysis of the collected data. ANOVA evaluates whether there are statistically significant differences between the average value of considered variables among different groups of observations. Multiple variables were considered (gender, sex, implant location, type of surgery, etc.); moreover, the pain score for each patient at different pre-fixed time points was evaluated (t0, t1, t2, t3, t4, t5, t6). The aim was to determine whether there was a statistically significant difference in the pain experienced by patients relating to explanatory variables.

To perform the ANOVA test, dedicated statistical software was used: the software automatically calculated p-values corresponding to each variable. The p-value represents the probability that the observed differences between the groups are due to chance rather than to a true difference in means. A p-value inferior to the predetermined significance level (typically 0.05) indicates that the observed differences are statistically significant (Table III).

Table III. *Statistical analysis of the collected data (ANOVA test).*

Item	Test ANOVA
Gender	0.3969
Involved Arch	0.6895
Maxillary localization	0.1274
Number of Implants	0.0581
Surgical Technique	0.2085
Implantology timing	0.3493
Mini-sinus-lift	0.1368
Membrane and synthetic bone	0.0496

The following inferences can be drawn:

- *Sex*: The p-value obtained for the variable "Sex" is 0.3969. The study also determined whether there were any statistically significant differences in pain experience depending on patient gender. The p-value indicates that there were no statistically significant differences between male and female patients.
- *Upper arch vs Lower arch*: The p-value for this item is 0.6895, indicating that there are no statistically significant differences related to the dental arch involved in implantology.
- *Maxillary Localization*: The p-value obtained for this variable was 0.1274, indicating that there are no statistically significant differences in the pain experienced by patients according to the area of the arch involved in implantology.
- *Number of implants*: The p-value for the variable “Number of implants” is 0.0581, indicating no statistically significant differences in the pain experienced by patients depending on the number of implants.
- *Surgical technique*: The p-value obtained for the variable "surgical technique" was 0.2085. This indicates that there are no differences between surgical approaches to implantology.
- *Timing of Insertion*: The p-value for the variable "Timing of Insertion" is 0.3493, indicating that there are no statistically significant differences in pain levels based on the timing of insertion.
- *Mini Rise*: The p-value obtained for the variable “Mini Rise” is 0.1368. This indicates that there are no statistically significant differences in the pain experienced by patients undergoing or not Mini Rise.
- *Membrane and heterologous bone substitute*: The p-value for the variable "membrane and heterologous bone substitute" is 0.0496, below the 0.05 significance level, indicating that there are statistically significant differences in the pain experienced by the patient depending on the use of the membrane or heterologous bone substitute.

Considering the results, the only factor that can be regarded as statistically significant is the use of membrane and heterologous bone substitutes, with a p-value of 0.0496. It is important to note that the number of implants also contributed to the analysis. A value approaching significance ($p = 0.0581$) was observed. Another study with a larger sample size (n=137) indicated that the number of implants is associated with greater pain in the 24 hours postoperative ($p<0.05$). The result was statistically significant at the 0.001 level (7).

Table IV summarizes the study results. The table reveals that the duration of surgery is a significant factor affecting the pain experienced by patients in the 24 hours following the procedure.

Table IV. *Study results of pain experienced by patients.*

Related factors	Case	NRS score 24 h after operation	t	P
Number of implants				
Single	110	1.78±0.49	7.229	0.000
Multiple	27	2.55±0.52		
Gender				
Male	76	2.11±0.42	1.781	0.077
Female	61	2.25±0.50		
Degree of education				
High school and below	81	2.35±0.87	1.685	0.094
College or above	56	2.11±0.74		
Smoking history				
Yes	36	2.22±0.39	1.539	0.126
No	101	2.09±0.45		
Operation time				
<1 h	95	1.47±0.43	15.160	0.000
≥1 h	42	2.60±0.33		

Related factors	Case	NRS score 24 h after operation	t	P
Experience of implant surgery				
Yes	25	2.05±0.66	1.759	0.081
No	112	2.26±0.51		
Postoperative ice compress				
Yes	103	2.10±0.52	1.509	0.134
No	34	2.26±0.47		
Preoperative anxiety				
Yes	39	2.29±0.55	1.678	0.096
No	98	2.08±0.70		

Analgesic therapy: study results

In the sample of 23 patients, 17 declared having taken analgesic therapy. Data regarding the drugs taken by patients are summarized in the graph below (Fig. 3).

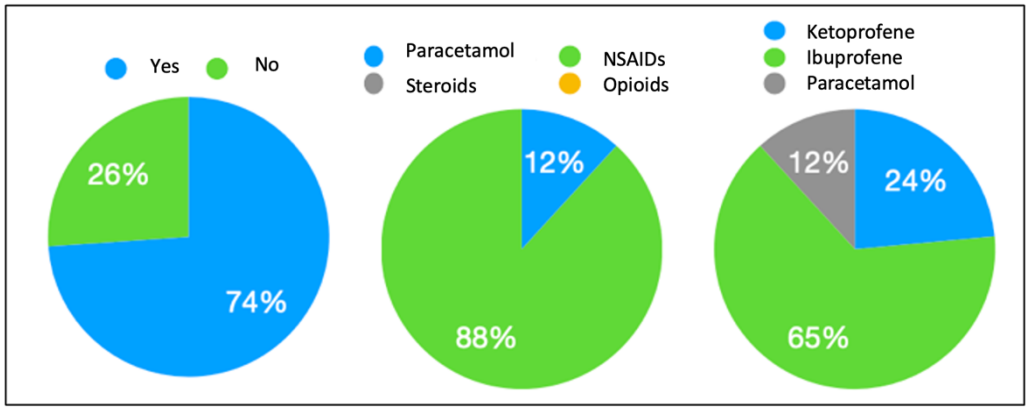

Fig. 3. *The graphs present the following data: percentages of patients who did and did not took drugs after implantology (on the left); percentages of patients who took non-steroidal anti-inflammatory drugs and paracetamol, respectively (in the center); percentages of painkillers taken by the patient within the sample.*

Nonsteroidal anti-inflammatory drugs (NSAIDs) were taken by 15 patients. Among the patients who took NSAIDs as analgesics, 11 patients employed ibuprofen, 4 patients took ketoprofen, Paracetamol was taken by 2 patients, and Corticosteroids as well as Opioids were not taken by any patient. Overall, 74% of patients received analgesic therapy after implantology. Among non-steroidal anti-inflammatory drugs (NSAIDs), 88% utilized ibuprofen, followed by ketoprofen. Finally, the number of tablets taken per day on different days was recorded: the graph below illustrates the trend. Data clearly demonstrate a reduction in analgesic intake over time (Fig. 4).

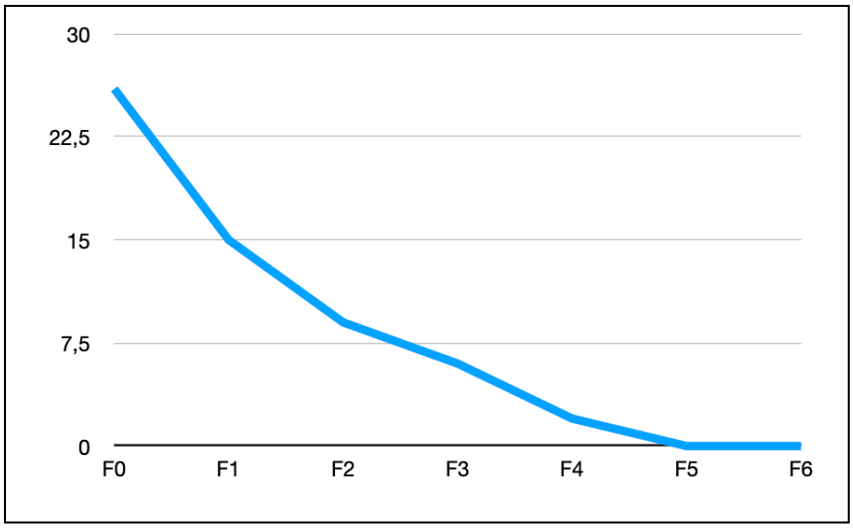

Fig 4. *Decreasing trend in analgesics intake in the hours/days following the procedure.*

Patient satisfaction: literature review

The literature review found that patients' satisfaction with comfort ranged from 75.3% to 99.5%, with a mean of 90.8% and a standard deviation of ±2.6% (Fig. 5). The perception of improved chewing function takes satisfaction values ranging from 69.9% to 100%, with a mean of 92.1% and a standard deviation of ±2.4%. Table V shows the results of the 13 studies included in the review.

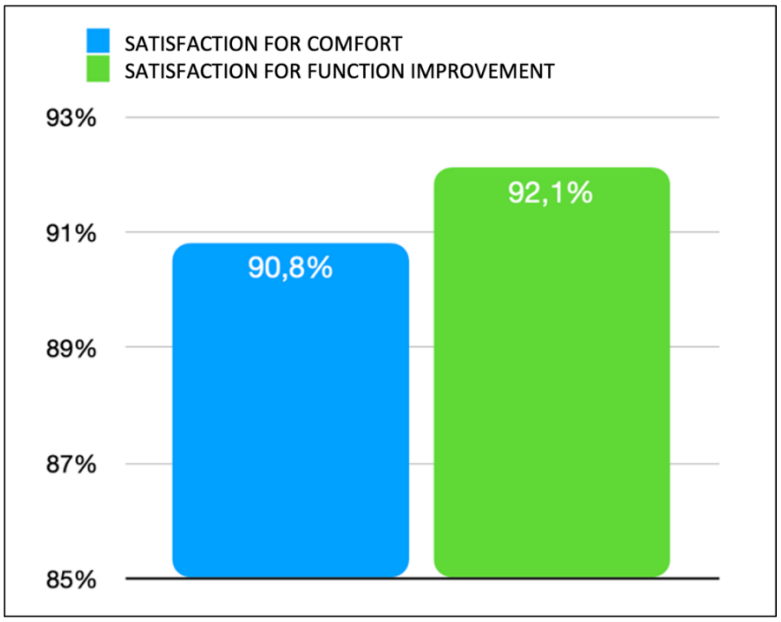

Fig. 5. *Data reported from literature: average extent of patient satisfaction in terms of comfort and function improvement.*

Table V. *Results of the 13 studies included in the review.*

Author	Sample size	Intervention	Comfort outcome	Function outcome
(**Hammerle et al. 2011**)	127	Single implants. Submerged versus transmucosal healing	Submerged: 75% excellent 24% good 0% fair 1% poor Transmucosal: 80% excellent 20% good 0% fair 0% poor	Submerged: 72% excellent 28% good 0% fair 0% poor Transmucosal: 76% excellent 24% good 0% fair 0% poor
(**Cochran et al. 2011**)	200	Single or multiple implants for fixed partial arch restoration	Submerged: 92.1% excellent 7.4% good	Submerged: 92.4% excellent 6.8% good
(**den Hartog et al. 2011**)	62	Single implants; Immediate non-occlusal loading versus conventional loading	N/A	18 months: 97% satisfied
(**Adler et al. 2016**)	400	Single or multiple implants for screw or cement retained crowns	'I have experienced felt problems with my implants": Yes: 10% Yes once: 22% I don't know: 4% No: 64%	'I am comfortable chewing with my implants": Yes: 81% Enough: 15% I dont know: 2% No: 2%
(**Pjetursson et al. 2005**)	104	Single or multiple implants for crowns or fixed partial dentures	"Chewing comfort": Definitely: 90% Enough: 7% I don't know: 1% Not so: 0% Definitely not: 1% No answer: 1%	N/A
(**Hartog et al. 2014**)	153	Single implants in the maxillary esthetic zone	N/A	18 months: 4.8
(**Dierens et al. 2009**)	50	Immediate loading of dental implants with a provisional bridge and then a fixed prosthesis	One year (mean): 94.2%	One year (mean): 97.5%
(**Derks et al. 2015**)	3827	Single or multiple implants for implant-supported restorative therapy	Have you experienced any complications?: Never: 64.6% Yes, but rarely: 24.7% Yes, frequently: 6.0% No answer: 4.7%	Greatly improved: 53.9% Somewhat improved: 16.0% No improvement: 28.1% No answer: 2.0%
(**Bruyn et al. 1997**)	61	Single or multiple implants for implant-supported restorative therapy	N/A	"Eating comfort" after 3 years: 5: A&B 92%, C85% 4: A&B 5%, C 15% 3: A&B 0%, C 0% 2: A&B 0%, C 0% 1: A&B 3%, C 0% 0: A&B 0%, C 0%
(**Kronstr et al. 2004**)	42	21 with tooth and implant supported fixed prosthesis and 21 with implant supported fixed prosthesis	TISP: 8.5 ISP: 8.4	TISP: 8.2 ISP: 8.8

(Tey et al. 2016)	206	Single or multiple implants for implant-supported single crown	23.8% felt more secure with teeth 50.5% perceived no difference 24.8% preferred implants	83.6%
(De Lima et al. 2012)	52	Single or multiple implants for implant-supported fixed partial treatment or single crowns	Mean: FPDs: 9 Implant- Supported Single Crowns: 9.4	Mean: FPDs: 9 Implant- Supported Single Crowns: 9.3
(Preciado et.al 2013)	131	Patients wearing screw-retained implant restorations	N/A	91.6%

DISCUSSION

Postoperative pain

Data analysis revealed that the intensity of postoperative pain reaches its peak within the first 24 hours following surgery. This finding is contrary to the commonly held belief that postoperative pain persists for a far more extended period. Diversely to what is generally reported in the literature, the peak in the study group postoperative pain lasts 24 hours after surgery, as rarely infections and inflammations hesitate in persistent nerve damage (28). Statistical analysis demonstrated that using a membrane and heterologous bone substitute significantly impacted postoperative pain. In contrast, other variables, including gender, arch involvement, maxillary location, surgical technique, timing of insertion, and the presence of a mini sinus lift, exhibited no statistically significant differences. Finally, as reported in a study with a larger sample size, the number of implants inserted might increase postoperative pain.

Therapy management

In their systematic review of randomized clinical trials, Khouly et al. stated that postoperative pain following implant surgery might be effectively treated by a short-term therapy; notwithstanding, the authors could not precisely identify what the most effective analgesic medication in dental implant surgery is. According to the authors, there is insufficient evidence to recommend or discourage painkillers or analgesics after dental implant surgery(1). In the present study, 74% of patients received drug therapy as part of their treatment protocol. Of these, 80% utilized nonsteroidal anti-inflammatory drugs (NSAIDs), and the remaining 20% of patients opted for paracetamol. No statistically significant differences emerged between the use of NSAIDs and steroids. Drug intake decreased gradually in the 6 days following the procedure. Undoubtedly, we concord with the findings by Khouly et al., who affirmed that analgesic prescription should always consider the patient's medical history as this often increases the success of pain treatment and shortens the treatment period, reducing potential adverse effects. Owing to these results, an algorithm for pain management was developed to optimize analgesic and anti-inflammatory therapy and to minimize side effects in implantology.

Patient satisfaction

Most studies included in the review reported high levels of patient satisfaction, with an average of 90.8% of patients. Functional results were also highly evaluated, averaging 92.1% of satisfied patients. A comparison of submucosal and transmucosal healing methods revealed that both methods are valid and produce satisfactory results in terms of comfort and function. However, transmucosal healing appears to offer additional advantages in terms of aesthetic results.

In our study, most patients expressed a high level of satisfaction with treatment outcomes. Moreover, both single and multiple implants have demonstrated a high success rate, with a low incidence of complications in the long term. Patients reported a high degree of comfort in the chewing and good function of implant-supported fixed prostheses. Moreover, the technique of immediate loading seemed to achieve optimal outcomes both in terms of aesthetics and functionality.

CONCLUSIONS

The study broadens the knowledge of postoperative pain in implant-prosthetic rehabilitation and offers an assessment of patient experiences, most used pharmacological therapies, and pain-management strategies. The quality of care provided to implantology patients in the postoperative period should never be underestimated. Adequate pain control seems to guarantee greater patient satisfaction.

- implantology patients' satisfaction is a key indicator of the success achieved by implant-prosthetic rehabilitation. Patients' satisfaction is generally high, and both function, comfort, and aesthetics are scored positively.
- the number of positioned implants, the duration of surgery, and the use of a membrane and heterologous bone substitute have been associated with an increase in postoperative pain.
- in the postoperative period, patients taking nonsteroidal anti-inflammatory drugs or corticosteroids seemed to obtain adequate control of postoperative pain. No significant differences in terms of efficacy have been observed between these molecule categories. Selective COX-2s have been proven to interfere with the osseointegration process.
- the proposed algorithm considers the multiplicity of treatment variables: we suggest considering it to manage pain and potentially reduce implant failure risk.
- further research is recommended to ascertain the efficacy of specific drugs, particularly anti-inflammatory and anti-edematous drugs, which will undoubtedly require further investigation to better identify key factors that influence the degree of patient satisfaction in implant surgery.

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