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Pain evaluation after day-surgery using a mobile phone application

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INTRODUCTION

Few studies assess postoperative outcomes after discharge in the ambulatory setting. The aim of this study was to investigate postoperative pain and adverse effects at 24 hours and at 7 days after day surgery using an e-health follow-up smartphone-based application named SATELIA®.

MATERIALS AND METHODS

This retrospective, observational and monocentric cohort study was conducted at the University Hospital of Bordeaux. All eligible patients for SATELIA® follow-up between May 2018 and June 2019 were screened for the analysis. Data were extracted from two databases. Those with a missing primary outcome were excluded from the analysis.

The main outcome was the worst pain score on POD 1, self-reported via SATELIA®. The secondary outcomes were the incidence of adverse effects on POD1, as well as the worst pain score and adverse effects on POD7.

Quantitative data were reported by the median (IQR) and categorical data were presented as absolute numbers (%).

RESULTS

A total of 2283 patients were screened for analysis, from which 592 were excluded due to missing data for the main outcome; 1691 patients were thus finally included. The median worst pain score at POD 1 was 3.0 (1.0-5.0); 35.5% (n = 601/1691) and 29.1% (n = 492/1691) of the patients reported moderate-to-severe pain at POD1 and POD7, respectively.

CONCLUSION

This retrospective study shows that 35.5% of patients experience moderate-to-severe pain after day surgery. Even if SATELIA® should be further developed and evaluated, it also demonstrates the interest of using phone based software to follow patients after discharge and ensure a better personalised management.

Keywords: postoperative pain, day surgery, postoperative outcome assessment, mobile application

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1. Introduction

With improvements in anaesthesia care and the development of minimally invasive surgical techniques, a clear trend toward day surgery has occurred worldwide. In 2022, day surgeries will account for more than 70% of all elective procedures (1). This transition to day surgery requires developing optimal strategies to ensure quality and safety of care despite early discharge. Several studies have shown that pain is the main reason for unanticipated primary care consultations, return hospital visits, or readmissions (2,3). Thus, adequate analgesia is one of the key factors for successful day surgery.

Even recently, studies have shown that the prevalence of moderate-to-severe pain is still around 30% on the first postoperative day (POD) (4,5) and up to 43% on POD 7 (1,6). Despite the perceived improvement in day surgery organisation and patient care, the prevalence of moderate-to-severe pain does not seem to have decreased over the last decades (4,7). Insufficient postoperative analgesia is associated with decreased patient satisfaction (8,9).

In order to ensure better follow-up of patients after their discharge, many tools have been developed, such as teleconsultation or Short Message Service (SMS) follow-up (10). With recent technological advances and the widespread use of smartphones, connected solutions could be the ideal media to follow these patients. The Bordeaux Hospital University Centre (CHU) has recently co-developed SATELIA®, a connected solution to assist patients in their day surgery pathway. We progressively implemented this tool in our institution and evaluated its practical feasibility and pertinence. We moreover conducted a retrospective analysis from the prospective database obtained by SATELIA®. The main objective of our analysis was to investigate the severity of pain at POD1. We also evaluated postoperative pain and specific patient-reported outcome measures (PROMs) up to 7 days after discharge.

2. Methods

2.1 Study design and ethical considerations

After registration to the National Commission for Data Protection and Liberties (CNIL-France) (approval number: 2218360v0), we conducted this retrospective, observational, monocentric cohort study. All data were collected at the Francois-Xavier Michelet Centre, which is affiliated to the CHU of Bordeaux, France. The analysis was conducted from a prospectively

collected and validated database supplied by SATELIA®. Data collection was completed from Dxcare® (Medasys), the medical clinical software used at the CHU of Bordeaux. The Ethics Committee of the CHU of Bordeaux approved the use of these data for research and publication (N°CE-GP-2020-26) according to the current French Law (11).

2.2. Study Setting and Participants

All patients undergoing day surgery at the Francois-Xavier Michelet Centre between May 2018 and June 2019 were considered for analysis. Surgeries performed at this facility included the following: Ophthalmologic, otorhinolaryngology (ENT), plastic, oral and maxillofacial. The inclusion criteria for analysis were the same as for SATELIA® follow-up: age > 6 years, understanding of written and spoken French, and possession of a cell phone with a valid phone number. For minor patients, the parents' phone was used with their consent.

2.3. SATELIA®: description of the digital solution

SATELIA® was a software hosted by the servers of the CHU of Bordeaux and directly connected to the electronic patient medical record (DxCare, Medasys). Many data were automatically extracted (name, age, sex, phone number), and others had to be manually entered in the application by the healthcare team (date of intervention, type of surgery, anaesthesia). The computer languages used were HTML5, JavaScript, CSS and PHP. The General Data Protection Regulation was applied and respected.

The web application has two interfaces. The patient interface was based on SMS messages reception. The day before the procedure, all patients received an SMS message including a link to the digital solution. Once connected to SATELIA®, they obtained access to general informative videos *(https://sfar.org/pour-le-grand-public/)* in addition to instructions and information about their planned procedure. Three forms had to be completed by the patients at three different moments: the day before surgery, on POD 1, and on POD 7. The two postoperative forms consisted of closed and multiple-choice questions assessing pain severity, side effects from anaesthesia (nausea, vomiting, dizziness) and surgical complications (surgical site bleeding, swelling, redness and oozing). Questionnaires also investigated unexpected consultations of primary care providers or visits to the emergency department, or unanticipated surgery-related hospitalisations (appendix). Patients had the possibility to review their responses before submitting the surveys. Reminder messages were automatically sent at 10.00 AM on POD 1 and

POD 7. Between the standardised forms, if any problem occurred, patients could communicate directly with the healthcare team by phone.

The healthcare interface was a control centre, where the healthcare workers had access to the questionnaire's answers sent by the patients. Responses were colour-coded (green, yellow, red) and led to intervention from nurses or anaesthesiologists, when needed. In the event of an alert, patients were contacted to receive appropriate counselling on treatment and to be oriented to the appropriate resource if it cannot be addressed only by phone.

2.4. Perioperative protocol

All ambulatory patients were evaluated by an anaesthesiologist during the pre-operative consultation, which is systematically realised at least 48 hours before the procedure. After disclosure of all relevant information, they were enrolled in SATELIA®. Patients received SMS at predetermined timings, with direct links to questionnaires (appendix). On POD 1, if surveys were not spontaneously completed by the patients at 4.00 PM, a research nurse called the patients and filled out the form with the answers obtained during the phone interview. For POD 7, patients were not systematically called if they did not complete the questionnaire.

The prescription of postoperative analgesia and all the relevant information regarding postoperative pain management were given to the patient during the preoperative consultation, as recommended by the French Society of Anaesthesia and Intensive Care (SFAR) (12). All patients received regular Paracetamol (500 mg to 1000 mg Q6h) and Ketoprofen (NSAID) (50 mg to 100 mg Q8-12h) if there was no contraindication. If this was expected to be insufficient based on the patient's evaluation and on the surgery to be performed, tramadol (50 to 100 mg up to a maximum of 3 times per day) or nefopam (20 mg up to a maximum of 4 times) were also prescribed as needed. The decision to prescribe tramadol, nefopam, or both, was left to the anaesthesiologist who did the preoperative consultation. No specific antiemetic was prescribed after discharge. The type of anaesthesia for each surgery was not standardised and was decided by the attending anaesthesiologist on the day of surgery.

2.5. Outcomes measures

The primary outcome was the worst pain on POD 1. It was self-reported by patients on a numeric rating scale (NRS) of 0–10 (0 = no pain and 10 = worst pain imaginable). Moderate-to-severe pain was defined by an NRS score higher than 4 (13–15).

The secondary outcome was the incidence of adverse effects on POD1 (nausea, vomiting, or dizziness).

The presence of adverse effects and pain were also assessed on POD7. Worst pain on POD7 was described using a simplified five-level scale: absent, low, moderate, severe, or very severe.

Surgical complications, unexpected primary care or emergency department consultation, and unanticipated surgery-related hospitalisations were also collected.

2.6. Data record and statistical analysis

Data were extracted from two databases. Main and secondary outcomes, type of surgery, and type of anaesthesia were prospectively and automatically collected by SATELIA®. Demographic data (age, sex, ASA score, height, weight, body mass index (BMI), and Apfel score) were obtained from Dxcare®. All data were anonymously exported to Microsoft® Excel software and were cross-referenced with the patient's identification numbers.

Types of Surgery were grouped into 5 categories:

- Ophthalmologic: anterior or posterior segment, or other (strabismus, blepharoplasty)
- Oral and maxillofacial: mandibular, wisdom teeth extractions, other dental extraction, or dental care
- ENT: middle and inner ear, vocal cords, tonsillectomy, rhinoplasty, otoplasty, and other cervicofacial procedures
- Plastic: cosmetic, skin surgery, skin graft, minor hand surgery, and other

Data with missing main outcome measures were excluded from the analysis. Data were systematically reported on the total sample of responders at POD 1. Continuous data were reported by the median and interquartile range (IQR). Categorical data were presented as absolute numbers and percentages.

3. RESULTS

A total of 2283 patients were screened for analysis, from which 592 were excluded due to missing data for the main outcome; 1691 patients were thus finally included, with a median (IQR) age of 37.0 years (23.0-55.0), including 203 children < 18 years old. On POD1, 74.1% (1691/2283) of patients completed the survey: 1253 answered spontaneously, and another 438 patients were joined by the research nurse to help them complete the survey. Among these, 1191 completed the form spontaneously on POD 7. Demographic characteristics are presented in **Table 1**.

3.1. Postoperative pain at POD 1

The median worst pain intensity at POD 1 was 3.0 (1.0-5.0). The specific results for each surgical procedure are detailed in **Figure 1**. Among 1691 patients, 601 (35.5%) experienced moderate-to-severe pain in the first 24 hours after surgery (**Table 2**). Among the 203 patients, 108 (53.2%) reported moderate-to-severe pain in the first 24 hours. Wisdom teeth extraction, otoplasty, and tonsillectomy were the surgeries with the highest proportion of patients with moderate-to-severe pain on POD1 (**Table 2**).

3.2 Postoperative pain at POD 7

Data for postoperative pain at POD 7 were available for 70.4% of patients included in the study (1191/1691); 29.1% of patients (492/1691) reported moderate-to-severe pain at POD7. Results specific to each surgical procedure are detailed in **Figure 2**. The proportions of patients with moderate-to-severe pain at POD7 are also indicated for each type of surgery. Among 203 children, 123 (60.6%) responded at POD7 and 51 still reported moderate-to-severe pain at POD7. Oral and maxillofacial surgery was the surgical specialty with the highest proportion of patients who experienced moderate-to-very severe pain on POD7.

3.3. Side effects at POD1 and POD7

Side effects after procedures are reported in **Table 3**: 13.2% (224/1691) and 4.6% (79/1691) of patients had nausea or vomiting at POD 1 and 7, respectively; 11.5% (n = 195/1691) presented dizziness at POD 1 and 10.4% (176/1691) at POD 7; and 7.2% (122/1691) of patients reported on POD7 at least two of these symptoms at surgical site: swelling, redness or oozing.

3.4. Postoperative follow-up at POD7

Among 1691 patients, 112 (6.6%) and 141 patients (8.3%) visited a general practitioner or an emergency department, respectively, for a reason related to surgery. Unanticipated hospitalisation was reported for 0.3% (n = 5) of patients.

4. DISCUSSION

This monocentric retrospective cohort analysis from prospective data from a large patient database showed that 35.5% of patients experienced moderate-to-severe pain at POD 1 and 29.1% at POD 7 after day surgery. To our knowledge, it is one of the largest studies to describe postoperative pain and adverse outcomes as far as POD7 after day surgery.

In our cohort, wisdom teeth extraction, amygdalectomy, and otoplasty were the most painful surgeries on POD 1. The incidence of moderate-to-severe pain at POD 1 obtained in our study (35.5%) is consistent with the current literature, where an incidence between 30 and 60% is reported (5,16,17). Gerbenshagen et al. evaluated the postoperative pain after 179 different procedures in 50,523 patients (18). In their study, amygdalectomy and otoplasty were also among the most painful surgeries.

Our results at POD 7 are quite surprising, with 29.1% of patients reporting still experiencing pain superior to 4 on the NRS scale. Gramke et al. have shown in 2007 that pain intensity rapidly decreases during the postoperative period, with only 14% of patients presenting moderate-to-severe pain 4 days after discharge (17). They did not evaluate pain at 7 days. Our results must be weighted by the amount of missing data at POD 7 and we can hypothesise that those having pain were more likely to respond compared to those without pain.

The results of our work are relevant as they indicate that we can still improve our practices in the early postoperative period. Poorly controlled acute postoperative pain is associated with decreased satisfaction and more cardiac and pulmonary complications (8,9,19). The percentage of time in severe pain during POD 1 could be associated with an increased incidence of chronic pain at 6 and 12 months (20).

In our centre, multimodal postoperative analgesia is partially standardised. Patients received the prescriptions from the anaesthesiologist during the preoperative interview, as recommended by SFAR (12). The choice of giving Tramadol as a first-line rescue analgesic was questionable. This medication possesses a complex pharmacology, with partial mu agonist activity and inhibition of both serotonin and norepinephrine reuptake (21). The opiate effect is subject to an interindividual variability secondary to its metabolism by the cytochrome 2D6. This could partially explain the discrepancy obtained in pain scores for similar surgeries, as shown in **Figure 1**. However, the interindividual variability in pain sensation per se is also well known, since various pain sensitivity profiles are described in the literature (22). For all these reasons, it seems difficult to anticipate the individual response to pain for a specific procedure. This underlines the importance of a personalised follow-up after discharge.

In our study, the follow-up was done using a connected solution. To our knowledge, there is no consensus or recommendations on which modality must be used after day surgery. However, the importance of this follow-up is emphasised in many guidelines. In their recent guidelines, the International Association for Ambulatory Surgery (IAAS) recommended extending the follow-up period from the habitual 14 days up to 30 days (23,24). In many European countries, telephonic follow-up is the most used method, but it is far from being perfect. Patients do not always understand the provided instructions and they are not always contactable. Moreover, the process can be time-consuming and mobilise human resources.

Digital solutions like SATELIA® could provide a more efficient way to follow patients. Such a system can alleviate the workload on the health care team, since only patients who have not spontaneously answered or those who present a complication should be called. This can translate to an economic advantage for health care systems (25). Another benefit is that they are patient-centred, so they can promote adherence of patients to treatment and follow-up (26,27). They can feel safer, knowing that their potential complications and their pain will be followed and addressed if needed.

Data collected by patient-centred solutions could even be more accurate than data collected by telephonic follow-up. In the literature, many papers have shown that pain levels differ significantly if they are self-reported by the patient or if they are assessed by a healthcare professional (28). It could then be a useful tool locally and internationally to have a better and more accurate evaluation of pain levels after each specific surgical procedure. Anaesthesia and

surgical providers could use these data to better tailor their practice and their postoperative analgesia prescriptions. With the opioid epidemic, it can be another tool to better rationalise their usage after surgery (29,30). We demonstrated, with this work, the technical possibility and feasibility of patients' self-assessment after discharge via a connected solution.

Another potential advantage of automated follow-up using connected technologies is the ability to extend follow-up and assess the presence of delayed complications. Data concerning complications occurring more than 72 hours after discharge are scarce in the literature (31). In our study, 4,6% and 10,4% of patients still suffered at POD 7 of nausea or vomiting and dizziness, respectively. These results are similar to those of Pfisterer et al., who reported a 3% incidence of nausea or vomiting at POD 5 (32). Campagna et al. have shown in 2016 that up to 12% of patients interrupted their analgesic treatment because of side effects (16). In this study, weak opioids were prescribed for postoperative pain after discharge. In our cohort, primary care non-programmed consultations and readmissions were 6.6% and 8.3%, respectively. Here again, it seems consistent with the actual literature, since reported incidences are between 1.2% and 32% (2). Unfortunately, we do not know, in our study, the reasons for these unanticipated consultations.

There are limitations to our study. It is a descriptive, monocentric and retrospective cohort study, evaluating only 5 surgical specialties. We then cannot extrapolate our results to other ambulatory centres that perform other types of surgical procedures. Moreover, all procedures were not equally represented in our cohort. For some surgeries, we only included a small number of patients. It limits the external validity of our data for these procedures. Another limitation is that data were self-reported by patients on a voluntary basis at POD7. This led to many missing data. As the responders were probably more likely to present moderate-to-severe pain and in order not to overestimate our results, we decided to report prevalence of postoperative pain at POD7 on all patients included in the study. This should be taken into consideration while interpreting these results. Moreover, very few questionnaires have been validated for the collection of data by digital solutions, especially to assess pain as far from surgery as POD7. We used simplified, non-validated questionnaires for POD7 that differed from the scale used at POD1 and prevented the comparison between patients. This point represents a major limitation of our study and we suggest that SATELIA® should be further developed and evaluated. The impact of pain on daily life or activities is an important information when

assessing pain and SATELIA® did not support this feature. For future works, the use of standardised questionnaires, like the Revised American Pain Society Patient Outcome Questionnaire (APS-POQ-R) (33), could be of clinical interest. It would have been also interesting to know the exact anaesthetic regimen and the antalgic prescription for each patient. A longer follow-up, as recommended by the IAAS, would also be of clinical interest. Finally, we excluded patients who did not possess a cell phone. Socially disadvantaged patients could have been over-represented in this category, and it is regrettable that they cannot benefit from this new healthcare pathway.

5. CONCLUSION

In conclusion, our study shows that a significant proportion of patients still have moderate to severe pain after day surgery, even with a multimodal pain approach. It illustrates again the important interindividual variation in pain perception among patients. For the same procedure performed and the same analgesics administered, there is still a significant variation in postoperative pain. It emphasises the importance to maintain communication with the patients after discharge and to ensure a personalised and close follow-up.

In this context, our work also demonstrates the interest and feasibility of using connected solutions such as SATELIA® to achieve this follow-up. It can be a useful tool to optimise individual patient care, but also to macroscopically evaluate and improve our practices. If pain treatment is better tailored, the patient's journey through day surgery would be improved, unanticipated consultation and readmission could be decreased, and this could even reduce unnecessary opioid prescription and use. We can hypothesise that the use of connected solutions could even lead to an economic gain for health care systems. However, these potential advantages will need to be quantified in well-conducted future studies.

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Table 1: Characteristics of patients undergoing day-surgery and followed up by SATELIA® (n = 1691)

Age, years (IQR)	37.0 (23.0-55.0)
Sex:	
Male, n (%)	782 (46.2%)
Female, n (%)	909 (53.8%)
ASA classification:	
ASA 1, n (%)	725 (42.9%)
ASA 2, n (%)	870 (51.4%)
ASA 3, n (%)	95 (5.6%)
ASA 4, n (%)	1 (0.1%)
Height, cm (IQR)	168.0 (162.0-175.0)
Weight, kg (IQR)	68.0 (58.0-80.0)
BMI, kg/m^2 (IQR)	23.6 (20.7-27.0)
Apfel score:	
Apfel 1, n (%)	396 (23.4%)
Apfel 2, n (%)	436 (25.8%)
Apfel 3, n (%)	164 (9.7%)
Apfel 4, n (%)	46 (2.7%)
Missing*, n (%)	649 (38.4%)
Type of Anaesthesia:	
General, n (%)	1478 (87.4%)
Regional, n (%)	213 (12.6%)
Type of Surgery:	
OPHTALMOLOGY	203 (12.0%)
Anterior segment, n (%)	115 (6.8%)
Posterior segment, n (%)	35 (2.1%)
Other, n (%)	53 (3.1%)
ORAL AND MAXILLOFACIAL	514 (30.4%)
Mandibular, n (%)	57 (3.4%)
Wisdom teeth extractions, n (%)	237 (14.0%)
Other dental extractions, n (%)	198 (11.7%)
Dental Care, n (%)	22 (1.3%)
ENT	623 (36.8%)
Middle and inner ear, n (%)	236 (14.0%)
Vocal cords, n (%)	71 (4.2%)
Tonsillectomy, n (%)	21 (1.2%)
Rhinoplasty, n (%)	118 (7.0%)
Otoplasty, n (%)	14 (0.8%)
Cervicofacial, n (%)	163 (9.6%)
PLASTIC	351 (20.8%)
Cosmetic, n (%)	34 (2.0%)
Skin, n (%)	99 (5.9%)
Skin graft, n (%)	17 (1.0%)
Minor Hand, n (%)	166 (9.8%)
Other, n (%)	35 (2.1%)

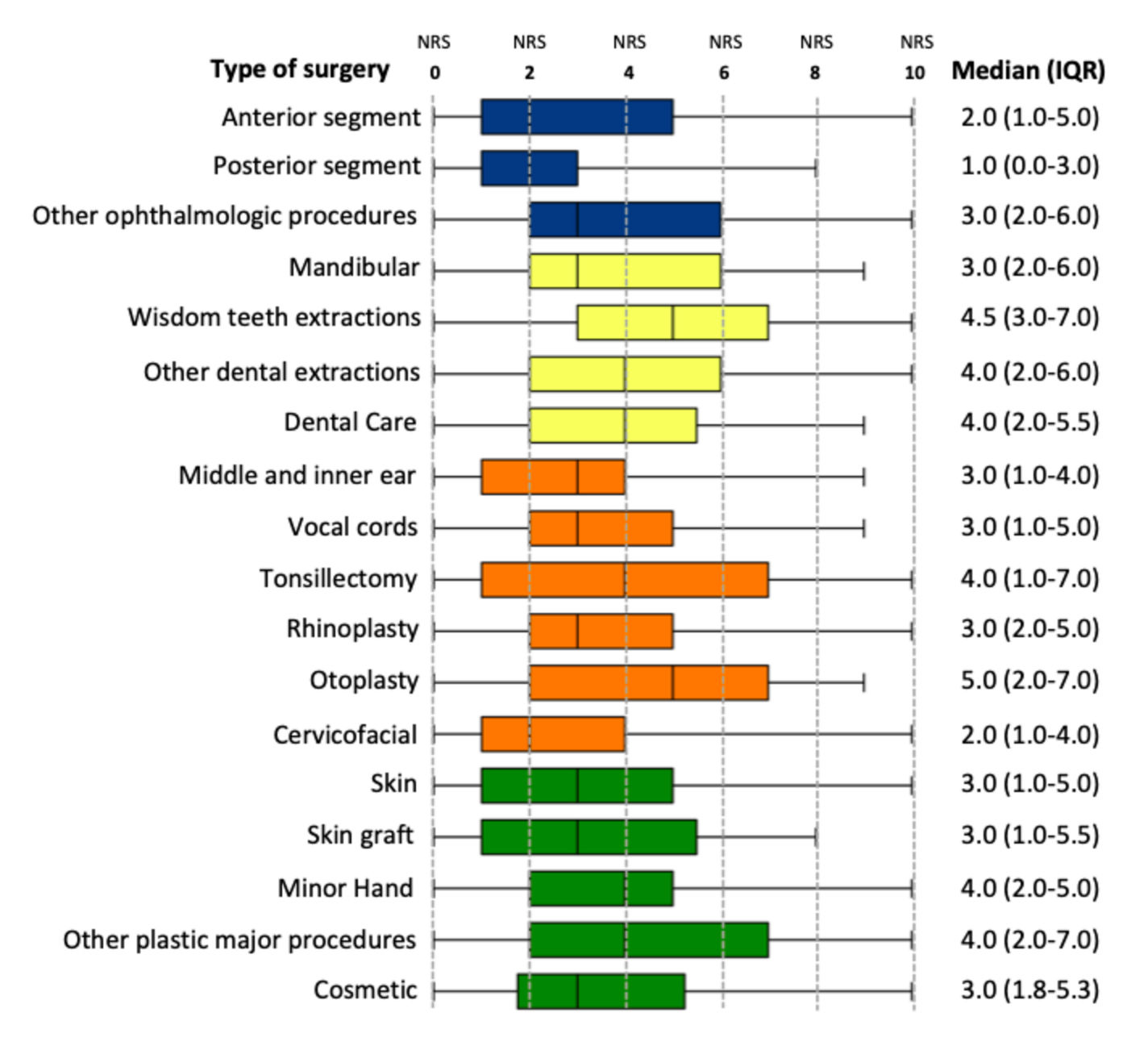
Quantitative data are presented as median (IQR) and other values are presented as numbers and percentages, n (%). *Data are missing for this variable.

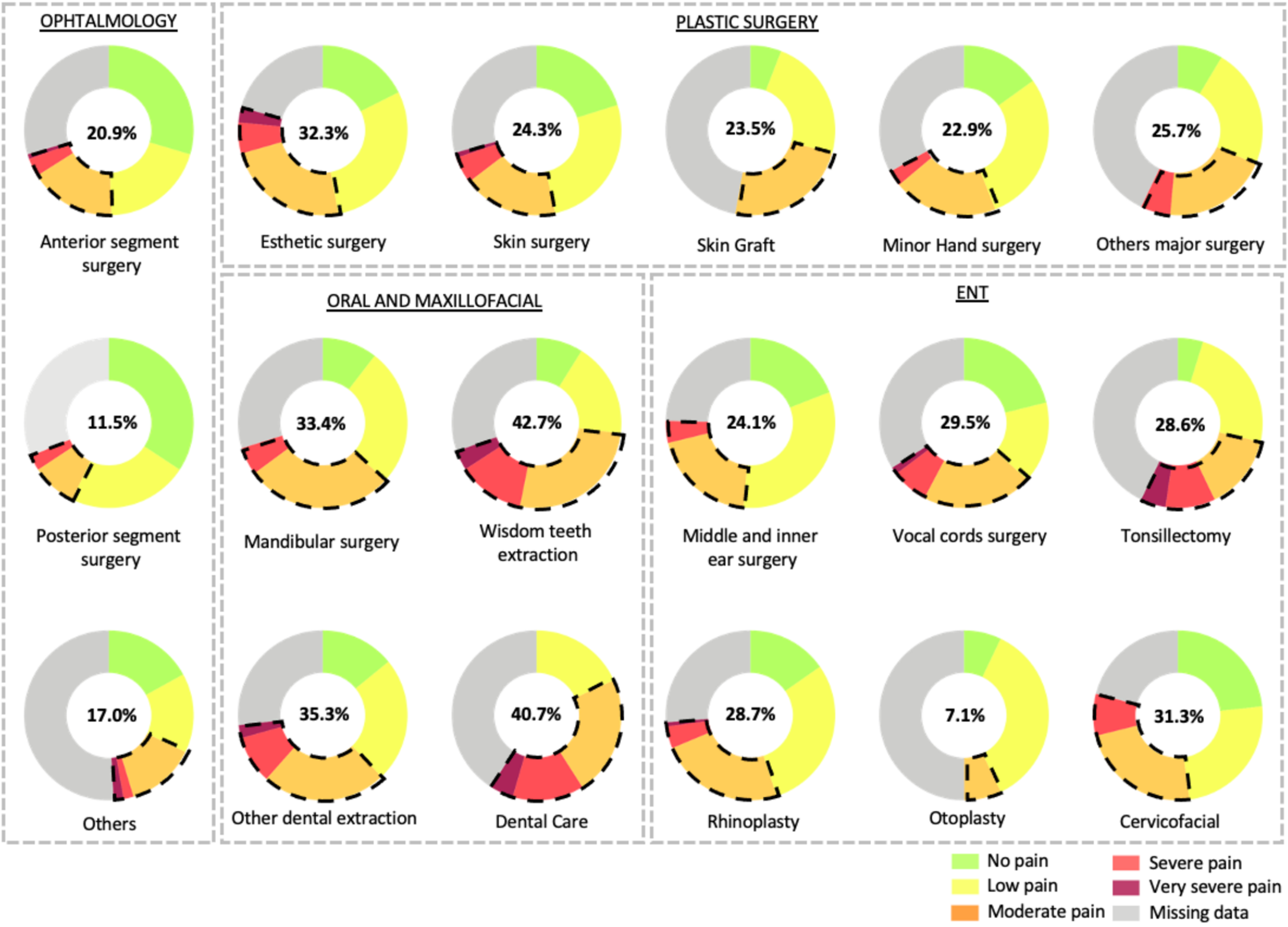
Table 2: Patients with moderate-to-severe pain at POD 1 (NRS > 4) for different types of day surgery (n = 1691)	POD 1
OPHTALMOLOGY	
Anterior segment, n (%)	30 (26.1%)
Posterior segment, n (%)	5 (14.3%)
Other, n (%)	22 (41.5%)
ORAL AND MAXILLOFACIAL	
Mandibular, n (%)	20 (35.1%)
Wisdom teeth extractions, n (%)	137 (57.8%)
Other dental extractions, n (%)	80 (40.4%)
Dental Care, n (%)	9 (40.4%)
ENT	
Middle and inner ear, n (%)	54 (22.9%)
Vocal cords, n (%)	18 (25.4%)
Tonsillectomy, n (%)	10 (47.6%)
Rhinoplasty, n (%)	34 (28.8%)
Otoplasty, n (%)	8 (57.1%)
Cervicofacial, n (%)	37 (22.7%)
PLASTIC	
Cosmetic, n (%)	12 (35.3%)
Skin, n (%)	33 (33.3%)
Skin graft, n (%)	5 (29.4%)
Minor Hand, n (%)	71 (42.8%)
Other, n (%)	16 (45.7%)
TOTAL	**601 (35.5%)**

Values are presented as numbers and percentages, n (%)

Table 3: Side effects of patients followed up by SATELIA® at POD 1 and POD7 (n = 1691)	POD 1	POD 7
Nausea, n (%)	176 (10.4%)	60 (3.5%)
Vomiting, n (%)	48 (2.8%)	19 (1.1%)
Dizziness, n (%)	195 (11.5%)	176 (10.4%)
At least two of symptoms: swelling, redness or oozing, n(%)	NA	122 (7.2%)
Missing Data, n (%)	0 (0.0%)	500 (29.5%)

Values are presented as numbers and percentages, n (%). NA: Non available.


NRS 0
NRS 2
NRS 4
NRS 6
NRS 8
NRS 10
Type of surgery
Median (IQR)
Anterior segment
2.0 (1.0-5.0)
Posterior segment
1.0 (0.0-3.0)
Other ophthalmologic procedures
3.0 (2.0-6.0)
Mandibular
3.0 (2.0-6.0)
Wisdom teeth extractions
4.5 (3.0-7.0)
Other dental extractions
4.0 (2.0-6.0)
Dental Care
4.0 (2.0-5.5)
Middle and inner ear
3.0 (1.0-4.0)
Vocal cords
3.0 (1.0-5.0)
Tonsillectomy
4.0 (1.0-7.0)
Rhinoplasty
3.0 (2.0-5.0)
Otoplasty
5.0 (2.0-7.0)
Cervicofacial
2.0 (1.0-4.0)
Skin
3.0 (1.0-5.0)
Skin graft
3.0 (1.0-5.5)
Minor Hand
4.0 (2.0-5.0)
Other plastic major procedures
4.0 (2.0-7.0)
Cosmetic
3.0 (1.8-5.3)


OPHTALMOLOGY
20.9%
Anterior segment surgery
PLASTIC SURGERY
32.3%
Esthetic surgery
24.3%
Skin surgery
23.5%
Skin Graft
22.9%
Minor Hand surgery
25.7%
Others major surgery
ORAL AND MAXILLOFACIAL
11.5%
Posterior segment surgery
33.4%
Mandibular surgery
42.7%
Wisdom teeth extraction
ENT
24.1%
Middle and inner ear surgery
29.5%
Vocal cords surgery
28.6%
Tonsillectomy
17.0%
Others
35.3%
Other dental extraction
40.7%
Dental Care
28.7%
Rhinoplasty
7.1%
Otoplasty
31.3%
Cervicofacial
No pain
Low pain
Moderate pain
Severe pain
Very severe pain
Missing data