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Influence of Surgical Incision Size and Interleukin 6 in the Occurrence of Postoperative Hyperalgesia in Lubumbashi/DR Congo

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Abstract

Background: It appeared that the conjunction inflammation and nerve damage (caused by surgery) generate the hyperalgesic component. But the probability of predicting hyperalgesia from the size of the surgical incision and/or the resulting inflammatory reaction is not well elucidated. This survey aims to study the influence of the size of the surgical incision and the resulting inflammatory reaction (interleukin 6 levels) in the occurrence of postoperative hyperalgesia in the population of Lubumbashi. **Methods:** The present study was descriptive cross-sectional. The data collection was prospective over 5 months, from February 1, 2024 to June 30, 2024. This study included any patient over the age of 18 who underwent surgery under general anesthesia. We used indirect signs to define hyperalgesia: higher (ENS > 6) and prolonged pain, postoperative overconsumption of morphine. **Results:** During our survey, we collected 48 operated patients who had severe postoperative pain, 16 of whom had hyperalgesia, *i.e.* a prevalence of hyperalgesia of 33.33%. The size of the incision most represented was between ≥20 and <30, *i.e.* 62.50%. The type of surgery most affected by hyperalgesia was laparotomy. We observed an elevation of IL6 in 87.50% of patients. The largest elevation was 8.91 times the preoperative value and the smallest was 1.04 times. Pre- and postoperative IL6 levels were not associated with hyperalgesia ($p = 0.265$). Only the size of the surgical incision was associated with hyperalgesia ($p = 0.04$). Incision size values between [20 - 30] cm were those associated with hyperalgesia ($p = 0.027$). The model shows that making an incision greater than or equal to 20 cm increases the patient's risk of developing hyperalgesia by more than 7.222 times and this is statistically significant ($p = 0.004$). **Conclusion:** According to this survey, the size of the surgical incision was associated with postoperative hyperalgesia and a size of more than 20 cm increases the patient's risk of developing hyperalgesia by more than 7.222 times.

Keywords

Postoperative Hyperalgesia, Prevalence, Surgical Incision Size, Interleukin 6

1. Introduction

The taxonomy defined by the International Association for the Study and Treatment of Pain (IASP) defines hyperalgesia as a more intense pain response in response to a supraliminal nociceptive stimulus and allodynia as a painful sensation triggered by a normally non-nociceptive stimulus [1].

To define hyperalgesia or allodynia, nociceptive tests must be performed. Apart from nociceptive tests, the evidence of the existence of these phenomena can only be indirect, such as pain that seems high or a high consumption of Morphine. Therefore, in a reductive way, we often speak of hyperalgesia, generally postoperatively, if the pain seems more intense than anticipated, or if the patient uses analgesics in large quantities [2].

Hyperalgesia is associated with allodynia (pain produced by a non-nociceptive stimulus). Hyperalgesia is of two types, primary and secondary. Primary hyperalgesia is located at the level of the lesion, in the inflammatory zone, while secondary hyperalgesia is located outside the inflammatory zone. Primary hyperalgesia results from the phenomena of peripheral sensitization, and secondary hyperalgesia reflects a hyperexcitability of the central nervous system [2].

Any surgery generates pain that can be mild, moderate or severe and requires management because it can have serious consequences, including less favorable postoperative recovery and chronic post-surgery pain. Even with a better understanding of pain mechanisms and advances in perioperative pain management, inadequately controlled postoperative pain persists. This is related to the very high inter-individual/inter-ethnic variability, partly due to genetic, clinical and biological differences whose determinants are not fully understood/well elucidated, making it difficult to predict and prevent severe postoperative pain.

The surgical procedure causes the local and general proliferation of mediators of inflammation and can create nerve damage. It appeared that this conjunction—inflammation and nerve damage—generates the hyperalgesic component that sets in after a few minutes and contributes to increasing the painful sensation (hyperalgesia: increased sensitivity to a nociceptive stimulus) [2]. The probability of predicting hyperalgesia from the size of the surgical incision and/or the resulting inflammatory reaction is not well elucidated. This is what motivated this study.

2. Materials and Methods

Study sites: This study was carried out in three hospitals in the city of Lubumbashi, namely, the University Clinics of Lubumbashi, Medpark Clinic and Afia Don Bosco because of their technical platform, their capacity and their level of care.

Type and period of study: This study was descriptive cross-sectional. The data collection was prospective over 5 months, from February 1, 2024 to June 30, 2024.

Study population: Our study population consisted of patients with severe postoperative pain.

• **Inclusion criteria:** any collaborating patient with a postoperative Simple Numerical Scale >6, over the age of 18 who has agreed to undergo surgery under general anesthesia during our study period and who has agreed to participate in the study.

• **Non-inclusion criteria:** any patient who has undergone surgery under locoregional anesthesia or who has benefited from anti hyperalgesic drugs.

Sampling and sample size:

We conducted an exhaustive sampling that allowed us to include 48 patients who experienced severe postoperative pain.

Variables studied:

• **Dependent variable:** hyperalgesia

Fletcher's diagnostic criteria for hyperalgesia [3]:

Indirect signs:

- Higher pain (ENS > 6)
- Prolonged pain
- Overuse of morphine

• **Independent variables:**

- **Sociodemographic and anthropometric data:** age (year), sex, weight (Kg) with a scale weight, height (cm) with a wall mechanical measuring rod, BMI.

- **Clinical data:** type of surgery, incision size (centimeter) with a tape measure.

- **Biological data:** Interleukin 6 (pg/ml) by immunofluorescence on serum (Wondfo/finecare type device).

- **Specific data for pain/hyperalgesia:**

* **Predictors of severe postop pain:** history of depression and anxiety, notion of smoking, alcoholism/smoking, presence of preoperative chronic pain and use of preoperative analgesics.

* Pain intensity (ENS = Simple numerical scale).

Procedure

• **Preoperative:**

- Explanation to the patient and signing of the agreement.

- Blood test: Interleukin 6 (baseline) before surgical incision.

• Standard general anesthesia without antihyperalgesics, corticosteroids, or locoregional anesthesia.

• At the end of the surgical procedure:

- Interleukin 6 assay (control): 1 hour after surgical incision.

- Paracetamol + NSAIDs (Diclofenac).

• In the PACU (Post Anesthesia Care Unit):

- Morphine (titration) according to the ENS.

- Search for indirect signs of hyperalgesia (ENS score, morphine dose, prolonged pain or not).

Data collection:

- Data collection sheet.

- A code was given to all patients at the anesthesia consultation.

- Compilation of weekly data and recording in Excel 2010.

Statistical analyses

Data entry was performed using Excel version 2010 software, and then the data was imported into Epi info 7.2.5.0 and IBM SPSS statistics version 25 for analysis.

Univariate analyses

For the quantitative variables, we have described them in the form of tables (frequency distribution), in the form of statistical measures of localization reduction (mean, median, extreme values) and dispersion (standard deviation).

The qualitative variables were described in the form of tables (frequency distribution).

Bivariate analysis

We studied the association between the dependent variable (Hyperalgesia) and independent variables.

For the quantitative variables, we used the Shapiro-Wilk test to study the normality of the distribution, and then we used either the Student's T-test (for Gaussian distributions) or the Mann-Whitney test (for non-Gaussian distributions).

For qualitative variables, we looked for the association between hyperalgesia and independent variables using either the Chi-square test or the Fisher Exact test.

We found that there was a statistically significant association between hyperalgesia and the other variables, if $p < 0.05$.

Multivariate analysis

For the multivariate analyses, we did binary logistic regression where we included in the model all variables statistically significantly associated with hyperalgesia and the others that are theoretically known to be associated with hyperalgesia.

In the end, we produced a final model that allows us to predict hyperalgesia. We calculated the prediction probability with the formula:

Probability of developing hyperalgesia for a patient:

$$P(Y=1)=\frac{e^{(\beta_0+\beta_i.X_i)}}{1+e^{(\beta_0+\beta_i.X_i)}}$$

Probability for a patient not to develop hyperalgesia:

$$P\left(Y=0\right)=1-\frac{e^{\left(\beta_0+\beta_i.X_i\right)}}{1+e^{\left(\beta_0+\beta_i.X_i\right)}}$$

With

Y: Variable answer: Hyperalgesia.

$Y = 1$: Having presented hyperalgesia.

$Y = 0$: Not having presented hyperalgesia.

X_i: Independent variable.

β_0: Coefficient of the constant.

β_i: The coefficient of the independent variable that corresponds to the effect of the adjusted variable X_i on the effects of all other variables included in the model.

e: natural logarithm constant.

Ethical considerations

The ethical standards in force (Helsinki Treaty) in terms of confidentiality, non-harm and benefit will be rigorously respected.

Informed consent will be obtained from all patients prior to participation in the study.

Approval No.: UNILU/CEM/024/2024.

3. Result

3.1. General Presentation

3.1.1. Distribution of Patients

During our investigation, we collected 174 patients,48 of whom experienced severe postoperative pain *i.e.* a frequency of 27.59%. Of these 48 patients, 16 had hyperalgesia: *i.e.* a prevalence of 9.19% of all patients operated or 33.33% of patients with severe postoperative pain (as shown in **Figure 1**).

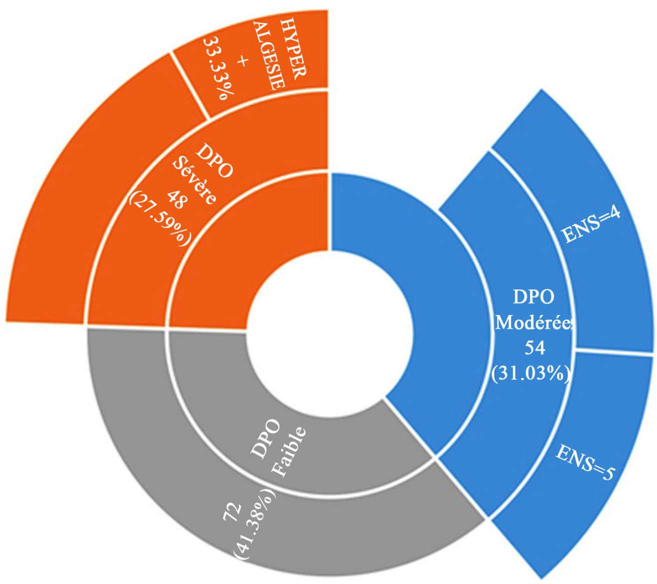

Figure 1. General distribution of patients.

3.1.2. Sociodemographic and Anthropometric Data

Male patients accounted for 58.04% of patients. The mean age was 40.96 ± 18.32 years and the mean BMI was 25.40 ± 5.77 (as shown in Table 1).

Table 1. Sociodemographic and anthropometric data.

Sex (n = 174)	
Male n (%)	101 (58.04%)
Female n (%)	73 (41.95%)
Age/year (means ± SD)	40.96 ± 18.32
IMC (means ± SD)	25.40 ± 5.77

3.1.3. General Risk Factors Predisposing to Severe Postoperative Pain

We observed in our environment that 3 factors contributed to severe postoperative pain. These are the female gender (54.17%), the preoperative use of opioids (43.75%) and the size of the tissue incision (58.33%) (as shown in Table 2).

Table 2. Factors predisposing to severe postoperative pain.

	n	%
Preoperative Factors		
Age (<25 years)	4/48	8.33
Sex (female)	26/48	54.17
Chronic preoperative pain	7/48	14.58
Preoperative use of opioid	21/48	43.75
State of dependance		
(Alcohol, tobacco, substance addiction)	4/48	8.33
Psychological vulnerability		
(anxiety, catastrophization/dramatization)	5/48	10.42
Intraoperative factors		
Significant tissue trauma (>15 cm)	28/48	58.33
Other factors		
Sensory disorders	2/48	4.17
BMI (≥30)	8/48	16.66

3.1.4. Surgical Incision Size and Interleukin 6

We observed an elevation of IL6 in 93.75% of patients (with a peak of 51.13-fold). Sepsis patients had a high preoperative IL6 level (the highest of which was 381 Pg/ml). The increase in the size of the surgical incision was not accompanied by an increase in IL6 (as shown in Figure 2).

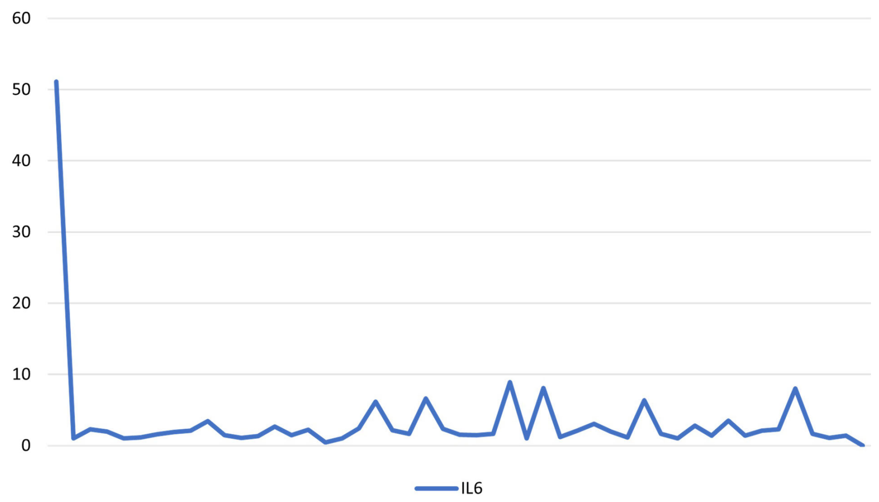

Figure 2. Postop modification of interleukin 6.

3.2. Study of Hyperalgesia

3.2.1. Epidemiological and Anthropometric Profile of Patients with Hyperalgesia

1) **Age distribution** (as shown in **Table 3**)

Table 3. Age distribution.

Age (years)	n	%
18 - 25	0	0.00
26 - 35	6	37.50
36 - 45	4	25.00
46 - 55	3	18.75
56 - 65	3	18.75

The mean age was 42.5 (±10.95) years with extremities ranging from 27 to 62 years. The most represented age group was 26 to 35 years old, *i.e.* 37.50%.

2) **Gender distribution** (as shown in **Figure 3**)

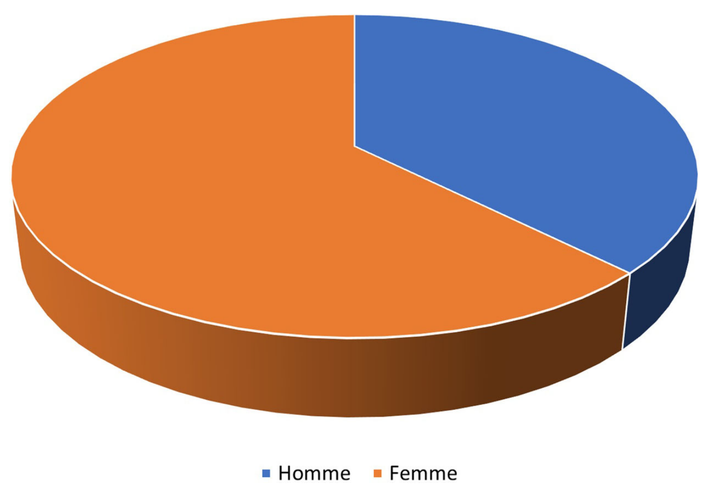

Figure 3. Gender distribution.

The sex ratio was 5/3 in favor of the female sex.

3) BMI distribution (as shown in Table 4)

Table 4. Distribution by BMI.

BMI	n	%
<18.5	0	0.00
18.5 - 25	7	43.75
26 - 30	6	37.50
>30	3	18.75

The mean BMI was 26.82 (±4.77) with extremities ranging from 20.06 to 37.37. The most represented BMI group was between 18.5 and 24.9, *i.e.* 37.50%.

3.2.2. Clinical Profile

1) Surgical incision size distribution (as shown in Table 5)

Table 5. Distribution by surgical incision size.

Incision size (cm)	n	%
<10	1	6.25
≥10 and <20	4	25.00
≥20 and <30	10	62.50
>30	1	6.25

The mean size of the surgical incision was 21.5000 (±6.5115) cm with extremities ranging from 5.0000 to 31.0000 cm.

2) Distribution by type of surgery (as shown in Figure 4)

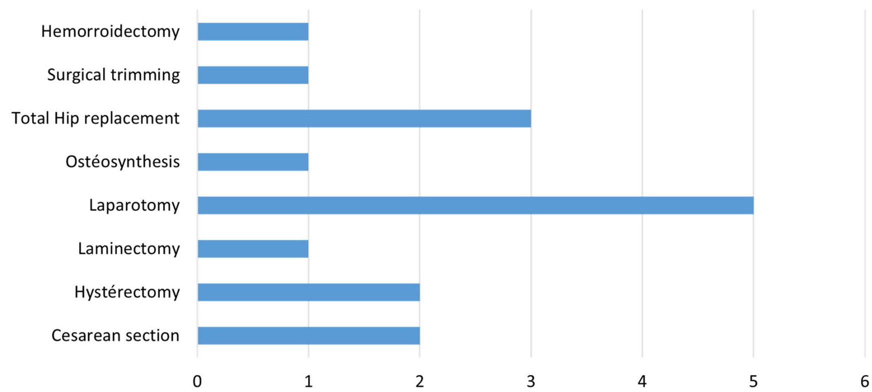

Figure 4. Distribution according to the type of surgery.

The type of surgery most affected by hyperalgesia is laparotomy followed by total hip replacement as well as hysterectomy and caesarean section.

3) Distribution according to the pre- and post-operative Interleukin 6 Profile (as shown in Figure 5)

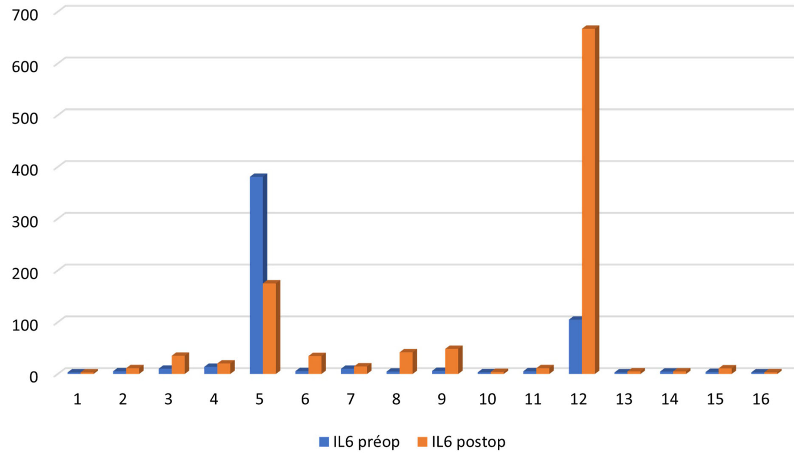

Figure 5. Profile of interleukin 6.

We observed that 87.50% of patients experienced an elevation of IL6. The mean elevation was 3.2780 (±2.8096) times the baseline value with extremities ranging from 1.0425 times to 8.9148 times. 6.25% (*i.e.* 1 patient) showed no change and 6.25% (1 patient) a 0.45-fold decrease in the preop value.

3.3. Bivariate Analysis

3.3.1. Association between Hyperalgesia and Qualitative Variables

The distributions of patients with hyperalgesia and those without hyperalgesia were not statistically significantly different in the categories of the following variables: gender, depression, psychological vulnerability, chronic postoperative pain, preoperative analgesics, and sensitivity disorder; $p \geq 0.05$.

The distributions of incision size values considered as an interval of patients who had hyperalgesia and those who did not were statistically significantly different ($p < 0.05$) (as shown in Table 6).

Table 6. Hyperalgesia and qualitative variables.

		HYPERALGESIA							
		Yes (n = 16)		No (n = 32)		TOTAL			
Variables		Effective	%	Effective	%	Effective	%	statistic test	p-value
SEX	F	10	36.5	16	61.5	26	100	Chi-carré	0.413
	M	6	27.3	16	72.7	22	100		
DEPRESSION	Yes	16	36.4	28	63.6	44	100	Fisher	0.286
	No	0	0	4	100	4	100		
PSYCHOLOGICAL VULNERABILITY	Yes	14	32.6	29	67.4	43	100	Fisher	1
	No	2	40	3	60	5	100		
PREOP CHRONIC PAIN	Yes	14	34.1	27	65.9	41	100	Fisher	1
	No	2	28.6	5	71.4	7	100		
PREOP ANTALGIC	No	7	25.9	20	74.1	27	100	Fisher	0.217
	Yes	9	42.9	12	51.1	21	100		
SENSIBILITY DISORDERS	No	15	32.6	31	67.4	46	100	Fisher	1
	Yes	1	50	1	50	2	100		
INCISION SIZE	≤10	1	11.1	8	88.9	9	100	Chi-carré	0.023

Continued

	≥10 and <20	4	21.1	15	78.9	19	100
	≥20 and <30	10	62.5	6	37.5	16	100
	>30	1	25	3	75	4	100

3.3.2. Association between Hyperalgesia and Qualitative Variables

The mean age of patients with hyperalgesia was not statistically significantly different from that of patients without hyperalgesia with $p \geq 0.05$.

The BMI, IL6 (1), IL6 (2), IL6 (D) values of patients with hyperalgesia and those without hyperalgesia were not statistically significant different ($p \geq 0.05$).

The mean incision size of patients with hyperalgesia and those without hyperalgesia were statistically significant $p < 0.05$ (as shown in Table 7).

Table 7. Hyperalgesia and qualitative variables.

Variables	Hyperalgesia	Effective	Min	Q1	Average	*St. dev.	Q3	Max	statistic test	p-value
AGE	Yes	16	27	34.25	42.5	10.95	49	62	Student test	0.576
	No	32	18	31.75	44.88	14.96	58	65		
	Total	48	18		44.08	13.68		65		
BMI	Yes	16	20.06	23.85	26.82	4.77	28.56	37.37	Mann-Withney	0.388
	No	32	17.78	22.44	25.56	4.47	18.83	37.37		
	Total	48	17.78		25.98	4.56		37.37		
IL6 (1)	Yes	16	3	3.38	35.31	95.5	9.4	381	Man-Withney	0.152
	No	32	3	3	6.87	11.92	6.4	71		
	Total	48	3		16.35	56.46		381		
IL6 (2)	Yes	16	3	4.93	66.61	165.56	40.1	667.1	Man-Withney	0.265
	No	32	3	5.15	21.94	43.86	13.88	230.1		
	Total	48	3		38.83	102.32		667.1		
INCISION SIZE	Yes	16	5	16.25	21.5	6.51	25.75	31	Student test	0.04
	No	32	4.5	10.25	16.42	8.4	21.75	32		
	Total	48	4.5		18.12	8.12		32		

*St.dev. = Standard deviation, IL6 = Interleukin 6.

3.4. Multivariate Analysis Based on Binary Logistic Regression

3.4.1. Model 1

After the introduction of incision size in the multiple model and the other variables theoretically associated with hyperalgesia, these include age, sex, preoperative chronic pain, preoperative analgesic, sensitivity disorder, depressive state and psychological vulnerability; incision size remains statistically significantly associated with hyperalgesia ($p < 0.05$, Ora = 1.30 [1.02 - 1.26] with a coefficient B = 0.123) (as shown in Table 8).

Table 8. Multivariate analysis Model 1.

Variables of the equation								
							95% confidence interval for EXP (B)	
	B	E.S	Wald	ddl	Sig.	Exp(B)	lower	superior
AGE	−0.005	0.030	0.028	1	0.868	0.995	0.938	1.055
SEX	−0.602	0.834	0.521	1	0.470	0.547	0.107	2.808
INCISION SIZE	0.123	0.055	4.977	1	0.026	1.130	1.015	1.259
PREOP CHRONIC PAIN	0.882	1.135	0.603	1	0.437	2.415	0.261	22.328
PREOP ANALGESIC	−1.620	0.899	3.249	1	0.071	0.198	0.034	1.152
SENSITIVITY DISORDERS	−704	1.730	0.165	1	0.684	0.495	0.017	14.684
DEPENDANCE	20.536	19008.075	0.000	1	0.999	829378036.045	0.000	
***PSY.VULN.**	−0.279	1.162	0.058	1	0.810	0.757	0.078	7.374
Constant	−21.977	19008.075	0.000	1	0.999	0.000		

*PSY.VULN. = Psychological vulnerability.

3.4.2. Model 2

The incision size values between [20 - 30] cm were those that explained the occurrence of hyperalgesia in patients with as $p = 0.027$ (*i.e.* $p < 0.05$) (as shown in **Table 9**).

Table 9. Multivariate analysis Model 2.

Variables of the equation								
							95% confidence interval for EXP (B)	
	B	E.S	Wald	ddl	Sig.	Exp (B)	lower	superior
AGE	−0.024	0.034	0.496	1	0.481	0.977	0.914	1.043
SEX	−0.063	0.916	0.005	1	0.945	0.939	0.156	5.654
PREOP CHRONIC PAIN	0.159	1.246	0.016	1	0.899	1.172	0.102	13.472
PREOP ANALGESIC	−1.091	0.951	1.315	1	0.252	0.336	0.052	2.168
SENSITIVITY DISORDERS	−1.252	1.831	0.468	1	0.494	0.286	0.008	10.351
DEPENDANCE	20.422	18730.667	0.000	1	0.999	740108698.39	0.000	
*PSY.VULN.	−0.487	1.279	0.145	1	0.703	0.614	0.050	7.535
SIZE 2	1.239	1.458	0.723	1	0.395	3.453	0.198	60.103
SIZE 3	3.404	1.542	4.871	1	0.027	30.073	1.464	617.818
SIZE 4	1.810	1.893	0.914	1	0.339	6.112	0.150	149.885
Constant	−19.855	18730.667	0.000	1	0.999	0.000		

*PSY.VULN. = Psychological vulnerability.

3.4.3. Predictive Model

$Y = -2.303 + 0.085.X$ with

Y: the response variable = Hyperalgesia

X: The explanatory variable = height in centimeters.

This model shows that making an incision of any size increases the risk of developing hyperalgesia by more than 1088 times in the patient and this is statistically significant $p = 0.046$, $p < 0.05$ (as shown in Table 10).

Probability of prediction:

Probability of developing Hyperalgesia for a patient:

$P(Y = 1) = e^{((-2.303 + 0.085x))}/(1 + e^{((-2.303 + 0.085x))})$

Probability for a patient not to develop hyperalgesia:

$P(Y = 0) = 1 - e^{((-2.303 + 0.085x))}/(1 + e^{((-2.303 + 0.085x))})$

With x: size of the surgical incision in centimeters

Table 10. Predictive Model 1.

Variables of the equation								
							95% confidence interval for EXP (B)	
	B	E.S	Wald	ddl	Sig.	Exp (B)	Lower	Superior
INCISION SIZE	0.085	0.043		1	0.046	1.088	1.001	1.183
Constant	−2.303	0.902	6.515	1	0.011	0.100		

Table 11. Predictive Model 2.

Variables of the equation								
							95% confidence interval for EXP(B)	
	B	E.S	Wald	ddl	Sig.	Exp (B)	Lower	Superior
INCISION SIZE	1.977	0.687	8.286	1	0.004	7.222	1.879	27.755
Constant	−1.466	0.453	10.482	1	0.001	0.231		

$\mathbf{H} = -1.466 + 1.977.\ \mathbf{T}$

H: the response variable = Hyperalgesia

T (TAILLE3): The explanatory variable = height in centimeters between [20 - 30].

This model shows that making an incision with a dimension between [20 - 30] cm, increases the risk of developing hyperalgesia by more than 7.222 times and this is statistically significant $p = 0.004$, $p < 0.05$ (as shown in Table 11).

4. Discussion

4.1. General Distribution of Patients

During this survey, we collected 174 operated patients. 48 of them (27.58%) had presented severe postoperative pain, of which 16 presented hyperalgesia, *i.e.* a prevalence of hyperalgesia of 9.19% among all those operated on and 33.33% among those operated on who presented severe pain. Male patients accounted for 58.04% of patients. The mean age was 40.96 ± 18.32 years and the mean BMI was 25.40 ± 5.77.

4.2. General Risk Factors Predisposing to Severe Postoperative Pain

Among the known general preoperative risk factor predisposing to severe postoperative pain, we observed that in our environment only 3 factors contributed to severe postoperative pain. These are the female sex (54.17%), the preoperative use of opioids (43.75%) and the size of the tissue incision (58.33%).

This is a little different from the meta-analysis done by Yang who found that significant preoperative predictors of poor postoperative pain control included younger age, female sex, smoking, history of depressive symptoms, history of anxiety symptoms, sleep difficulties, higher body mass index, presence of preoperative pain and use of preoperative analgesia [3].

Other authors did not find the difference between the sexes [4] [5]. while others have found that preoperative use of primarily opioid analgesics is a risk factor for severe postoperative pain [6] [7]. The factor that we have found in our environment and on which many authors have not found is the size of the surgical incision (the degree of tissue abrasion).

4.3. Study of Hyperalgesia

The prevalence of postoperative hyperalgesia is not well elucidated, but studies that have evaluated acute postoperative pain agree on the presence of severe pain (VAS score > 6/10, especially at mobilization) in 30% of patients during the first 24 hours [8], a figure that despite all efforts has remained unchanged for years. The recent introduction of "pain trajectories", *i.e.* a measure of postoperative pain of longer duration than the 24 to 48 hours usually reported in the literature, clearly shows that on day 5 - 6 post-surgery, about 37% of patients have an unresolved pain problem that could persist longer, or even progress to a subacute and possibly chronic pain state [9].

The prevalence of severe postoperative pain in this study appears to be lower than that found by Fletcher *et al.* [8] who in 2008 found that 51% of patients described severe pain—defined by a simple numerical rating scale (SNS) ≥ 7. This difference can be explained by several situations, including the nature of the surgical act and the analgesia protocol. But is close to the rate found in a systematic review of the literature in which pain scores were pooled from 165 studies of acute pain following major surgery (abdominal, thoracic, orthopedic, and gynecological), in the first 24 hours after surgery, the mean incidence of moderate to severe pain and severe pain was 30% and 11%, respectively [10]. Unlike our study where all patients had benefited from the same analgesia technique, here, the incidence of these pain levels varied according to the analgesic technique: a lower incidence was reported with patient-controlled and epidural analgesia compared to intramuscular analgesia [10].

In a cross-sectional observational study based on a desk audit in 5 hospitals in France, the prevalence of severe pain was 41.8% [11].

An audit carried out in 2021 by the SFAR, showed that out of three thousand three hundred and fifteen patients were included in 70 centers, 81% of the patients were not very painful in the ICU and 6% had severe pain [12].

The mean age was 42.5 (±10.95) years with extremities ranging from 27 to 62 years. This was almost within the age limits that Benamou had found in 2020 for postoperative pain in general, the average age of patients was 44 years with age extremes ranging from 6 years to 82 years [13]. The same was true in a survey carried out in Rabat where the average age was 49.9 years with age extremes between 17 and 72 years [14].

The sex ratio was 5/3 in favour of the female sex. This is in line with most literatures where it is the female sex that is predominant [15]-[18] and the female sex is a predictive factor of a more intense OPD in some studies [19].

The type of surgery most affected by hyperalgesia is laparotomy. This is explained by the fact that visceral/abdominal surgery is the most practiced in Lubumbashi.

We observed an elevation of IL6 in 87.50% of patients. The largest elevation was 8.91 times the preoperative value and the smallest was 1.04 times. Postoperative serum elevations of IL6 proportional to the extent of surgical stress have been described [20]-[22].

Systemic IL6 concentrations increase with surgical procedures [23]. The degree of elevation is correlated with the extent of the tissue damage, and therefore varies according to the surgical approach, e.g. laparoscopic surgery versus open surgery, as well as the complexity of the procedure, e.g. cholecystectomy versus colon resection [24].

In this study, the pre- and postoperative interleukin 6 level was not associated with hyperalgesia ($p = 0.265$).

Only the size of the surgical incision was associated with hyperalgesia ($p = 0.04$). The values of the incision size between (20 - 30) cm were the ones that explained the occurrence of hyperalgesia in the patients with as $p = 0.027$.

The model shows that making an incision with a dimension between (20 - 30) cm, increases the risk of hyperalgesia by 7.222 times in the patient to develop hyperalgesia and this is statistically significant $p = 0.004$. Kalkman *et al.* found that the size of the surgical incision was a predictor of severe early postoperative pain after general surgery [25].

5. Conclusion

The prevalence of hyperalgesia was 9.19% in all operated patients and/or 33.33% in those operated with severe postoperative pain. We observed an elevation of IL6 in 87.50% of patients with hyperalgesia: The mean elevation was 3.2780 (±2.8096) times baseline with extremities ranging from 1.0425-fold to 8.9148-fold. The pre- and postoperative interleukin 6 level was not statistically associated with hyperalgesia ($p > 0.05$). Only the size of the surgical incision was associated with postoperative hyperalgesia. The predictive model shows that making an incision of more than 20 cm increases the risk of developing hyperalgesia by more than 7.222 times in the patient and this is statistically significant $p = 0.004$ ($p < 0.05$).

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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