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Intraoperative pressure injury and risk factors in long-term surgical interventions[1]

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Abstract

Background: If the operation time is 60 minutes or longer, the patient's risk of intraoperatively acquired pressure injury (IAPI) increases.

Aim: This study aims to determine the prevalence and risk factors for IAPI in patients who underwent surgery for 60 > minutes in a private university hospital in Turkey.

Methods: The research is a cross-sectional, descriptive, prospective design. Data were collected in the perioperative period (N=200). Sociodemographic and Clinical Characteristics Form and 3S intraoperative risk assessment scale (3S-IRAS) for PI and Braden Scale were used for data collection.

Findings: IAPI occurred in 18.0% of participants. Although the risk of pressure injury was higher in women, those with chronic disease, those with major surgery, and those with chronic disease, this risk was weaker. However, the intraoperative position of the patient was 2.6 times (95% CI [Confidence Interval]: 0.552-12,674), the operative time was 2.0 times (95% CI: 1.113-3.780), the magnitude of the surgery was 11.5 times (95% CI: 2.029). -65.954), intraoperative skin stress constituted a 4.3-fold (95% CI: 1.815-10.369) risk of pressure injury.

Conclusion: IAPI is an important risk factor for the patient in the operating room. Although sociodemographic characteristics are weakly associated with pressure injury, nurses should closely monitor patients with these risk factors. Especially in major surgical interventions and long-term surgeries, the position of the patient gains importance. It can be said that the management of IAPI requires the cooperation of the perioperative nurse.

Keywords: Surgery; pressure injury; pressure ulcer, intraoperative; intraoperative care

1. Introduction

It is defined as a pressure injury that develops within the first 48-72 hours after surgery by the American Association of Perioperatie Registered Nurses (AORN 2016). If the patient is receiving general anesthesia, the duration of the operation becomes very important. Because it is a matter of complete inactivity.

Despite all prevention efforts, PI remains a challenge (Padula, Black, Davidson, Kang & Pronovost, 2018; Park , Park H & Wang, 2019; Konateke, 2021; Webster *et al.,* 2015). Intraoperative pressure injury constitutes a significant portion of hospital-acquired PI (Padula *et al.,* 2018; Park *et al.,* 2019).

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Surgical patients are indicated to be at high risk of PI due to their complex medical condition and prolonged surgical intervention (Aydın, Savcı & Karacabay, 2021; Konateke, 2021; Webster *et al.*, 2015). Intraoperatively acquired pressure injury (IAPI) is the result of many factors of causative origin. They are injuries that can vary in appearance from spotted epidermis to hard, necrotic tissue (Vermillion, 1990; Primiano *et al.,* 2011; Yoshimura *et al.,* 2016). Risk factors for surgery-related pressure injuries are generally categorized as preoperative, intraoperative, or postoperative (Primiano *et al.,* 2011; Fred, Ford, Wagner & Vanbrackle, 2012; Gül & Karadağ 2015). However, the contribution of potentially modifiable IAPI risk factors to overall risk factors is unclear and needs to be investigated (Park *et al.,* 2019; Webster *et al.,* 2015). Various experimental and descriptive studies suggested some intraoperative risk factors: patient's body mass index, type of anesthesia (Karayurt & Celik, 2017; Lumbley, Ali & Tchokouani, 2014), surgical procedure type (Lumbley *et al.,* 2014; O'Brien, Shanks, Talsma, Brenner & Ramachandran, 2014) and duration (Lumbley *et al.,* 2014; Papantonio, Wallop & Kolodner, 1994; Tschannen, Bates, Talsma & Guo, 2012; Rao, Preston, Strauss, Stamm & Zalman, 2016), intraoperative position (Lumbley *et al.,* 2014; Yılmaz & Basli, 2021), material used for positioning (Webster *et al.,* 2015; Primiano *et al.,* 2011; Papantonio *et al.,* 1994), surface type of the operating theater table and bed (Primiano *et al.,* 2011; Fu Shaw, Chang, Lee, Kung & Tung, 2014), skin moisture and flexibility (Primiano *et al.,* 2011; Yılmaz & Basli, 2021; Armstrong & Bortz, 2001), intraoperative use of vasopressors (Karayurt & Celik, 2017; Tschannen, *et al.,* 2012), intraoperative hypotension, intraoperative hypothermia or hyperthermia, and use of warming devices (Gül & Karadağ 2015; Lumbley *et al.,* 2014). However, it has been reported that these risk factors are often not noticed because they are not associated with IAPI, or they are not observed when skin checks are not performed because patients leave the operating theater without going to the postanesthesia care unit (PACU) (Webster *et al.,* 2015). However, reporting any changes in the patient's skin examination in the PACU is important to ensure early care interventions. The inability of both the operating room and surgical nurses to establish a connection between the surgical procedure or the process in the operating theater and PI development may be due to their unfamiliarity with the differences between traditional and IAPI. It is important for nurses to understand the characteristics of the intraoperative period and the relationship between pressure ulcers and the consequences of being hospitalized in the clinic. This may lead to improper management of PI (Yilmaz & Basli, 2021; Dalvand, Ebadi & Gheshlagh, 2018). However, the focus is on determining the prevalence and risks of IAPI for early treatment and prevention (Webster *et al.,* 2015; Aronovitch, 1999; Yilmaz & Basli, 2021; Lewicki, Mion, Splane, Samstag & Secic, 1997).

A systematic review reported that the incidence of surgery-related PI ranged from 0.3% to 57.4% (Chen, Chen & Wu, 2012). A descriptive study with a sample of 1.128 patients reported the prevalence of IAPI to be 8.5% (Aronovitch, 1999). Studies conducted in recent years reported surgery-related pressure injuries ranging from 1.3% to 8.3%. In their study in Turkey, Yilmaz and Basli (2021) demonstrated that 6.7% of 164 patients developed stage I IAPI. In another study conducted in Turkey by Akan and Sayin (2021), stage I IAPI was reported in 24.1% of 170 major surgical intervention patients.

Tschannen *et al.* (2012) drew attention to the relationship between operations lasting more than 3 hours and PI and reported that this risk increases for each hour spent in surgery. In their study, Fu Shaw *et al.* (2014) reported IAPI incidence immediately and 30 minutes after surgery as 9.8% (29/297) and 5.1% (15/297), respectively.

It is recommended that nurses evaluate preoperative, intraoperative and postoperative IAPI risk factors in efforts to reduce hospital-acquired PI. In this way, the cost of patient care can be reduced, and more effective care can be provided against PI (Webster *et al.,* 2015; Primiano *et al.,* 2011; Gul & Karadag, 2015).

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2. Background

The conditions of the patient in the intraoperative period are different. While the patient is in surgery, she is immobile and cannot change position. Patients do not feel discomfort under the effect of sedation and anesthesia. This can result in abnormal pressure increase, poor tissue perfusion, ischemia, causes tissue destruction and pressure sores (Nilsson, 2013) In patients who have undergone surgery, the coccygeal/sacral region, hips, genital area and heels are at risk (Lumbley *et al.,* 2014).

In Turkey, the incidence of IAPI risk is high (%24.1-%25.0) (Akan & Sayin, 2021; Gul & Karadag, 2015). Prevention of PI is possible by first evaluating risky patients. Risk assessment, on the other hand, should be done with risk diagnosis scales that are valid, reliable and determine risk factors. The IAPI scale used in this study allows distinguishing intraoperative site-specific risks (Soyer & ozbayir, 2018).

2.1 Aim

This study aims to determine the prevalence and risk factors for IAPI in patients who underwent surgery for 60 > minutes in a private university hospital in Turkey.

Research questions:

- This study seeks answers to the following research questions.
- What is the IAPI incidence?
- Do the sociodemographic and clinical characteristics of the patients show a relationship with PI?
- Are there risks specific to PI in the intraoperative period?

3. Methods

3.1 Study design and setting

The research was established on a cross-sectional, descriptive, prospective design. Purposive sampling method was used in the research. The study was performed in general surgery, neurosurgery, orthopedics and traumatology, urology, gynecology and plastic surgery operating theatres of a private university hospital in Istanbul, Turkey.

3.2 Participants

We attempted to exclude general risk factors in efforts to differentiate the sampling criteria, especially the intraoperative risks.

Immobilization time in patients undergoing surgical intervention; It starts with the application of premedication in the pre -operation period and it is a process that continues until the patient's waking period after the surgery. Studies draw attention to the risk of pressure injury for 2-5 hours or more (. The reason why it was taken over 60 minutes in this study was to include the cases in which general anesthesia was applied and to obtain a sample for statistical comparison (Wu *et al.,* 2021; Webster *et al.,* 2015; Aydin *et al.,* 2021).

Patients who were at least 18 years old, were literate, were conscious, had no mental health problems, were not bedbound, were scheduled for surgical intervention under general anesthesia, had undergone an elective surgical procedure longer than 60 minutes), had no anemia or hypoalbuminemia, underwent postoperative skin diagnostics, and agreed to participate in the study were included in the study. All of them were able to orally feed preoperatively, and oral intake of all patients was stopped 8-12 hours before surgery.

Research was a postgraduate degree. Therefore, the data collection period of the study was limited. The sample size for three months was calculated according to the number of surgeries in the last year of the research hospital. According to G power analysis, 200 patients had to be reached in three months. Between October 2019 and January 2021 (5% acceptable error and 95% confidence level), the following n= 200 patients who met the sample criteria were contacted: general surgery n= 54, brain and neurosurgery n= 15, orthopedics and traumatology n=58, urology n = 30, gynecology

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n= 21, and plastic surgery n= 22. A total of 139 (69.5%) of the patients were hospitalized, and 61 (30.5%) came to the surgery clinic from home on the morning of their scheduled surgery day.

3.3 Instruments

Sociodemographic and clinical characteristics form

A short survey was created by the researcher in line with the literature (Webster *et al.,* 2015; Rao *et al.,* 2016; Yilmaz & Basli, 2021; Fu Shaw *et al.,* 2014; Armstrong & Bortz, 2001; Aronovitch, 1999; Peixoto *et al.,* 2019), which includes particulars such as age, sex, vital findings, diagnosis and comorbidity history, operation type and intraoperative position support tools, preoperative Braden score, and staging of NPUAP' PI Staging form (NPUAP 2021).

3S-IRAS

The 3S-IRAS of pressure injury refers to the acronym shou, shu and shi (the Chinese spelling of surgical operation), or strict, safe and satisfactory. 3S-IRAS was developed by Gao *et al* in 2015, and Cronbach α: 0.71. The validity and reliability of the Turkish version of the scale was performed by Soyer and Ozbayir in 2018, and the Cronbach α value was reported as 0.68 (medium). In the present study, (N=200) Cronbach's α value was 0.741.

The basic contents of this assessment scale were designed, including: conditions of skin of whole body (1 point for good, 2 for mild edema, 3 for medium edema, and 4 for serious edema); preoperational limb exercise (1 point for no limitation; 2 for slight limitation, 3 for partial limitation and 4 for complete limitation); body height/weight ratio (1 for standard, 2 for slight obesity or emaciation, 3 for obesity or emaciation, and 4 for excessive obesity or emaciation); skin under stress (1 for good, 2 for red spot and dampness, 3 for ecchymosis and blister, and 4 for damaged skin); intraoperative influencing factors: intraoperative amount of bleeding (1 point for less than 200 mL, 2 for between 200 and 400 mL, 3 for between 400 and 800 mL, and 4 for over 800 mL); operating time (1 point for less than 1 h, 2 for between 1 and 3 h, 3 for 3 to 5 h, and 4 for over 5 h); intraoperative stress (1 point for no stress, 2 for slight stress, 3 for medium stress, and 4 for serious stress); intraoperative body temperature (1 for between 36.1 and 37.2°C, 2 for between 37.2–37.7°C, 3 for between 37.7–38.3°C and 4 for over 38.3°C or less than 36.1°C); operative position (1 point for supine position, 2 for lateral position, 3 for lithotomy position, and 4 for prone position). The total score that can be obtained from the scale is a minimum of 9 and a maximum of 36; patients above 23 are defined as high-risk, and those below 23 are defined as low-risk (Gao *et al.* 2015).

Staging of pressure injury form

The European Pressure Ulcer Advisory Panel (EPUAP - European Pressure Ulcer Advisory Panel)/National Pressure Ulcer Advisory Panel (EPUAP/NPUAP - National Pressure Ulcer Advisory Panel) developed a Pressure Ulcer Classification System (PUCS) guide to prevent and treat pressure injuries. In this guideline, NPUAP published the term "PI" and revised the term "PI staging system" in 2016 (NPUAP, 2021).

In our study, participants' IAPI was assessed using this PUCS. The PUCS is staging system is the widely used method for staging pressure injuries in Turkey.

The NPUAP' PI staging system is shown below.

NPUAP' PI Staging System*

Category/Stage	Definition
I: Non blanchable Erythema	• Skin intact • Non blanchable redness of a localized area, usually over a bony prominence • Darkly pigmented skin may not have visible blanching; however, its pigment may differ from the surrounding area
II: Partial Thickness Skin Loss	• Partial-thickness loss of dermis • Presents as a shallow open injury with a red–pink wound bed • No slough • May also present as an intact or open serum-filled blister

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III: Full Thickness Skin Loss	• Full-thickness loss of tissue • Subcutaneous fat may be visible • No exposure of bone, tendon, or muscle • Slough may be present but does not obscure the depth of tissue loss • May have undermining and tunneling
IV: Full Thickness Tissue Loss	• Full-thickness loss of tissue • Bone, tendon, or muscle exposed • Slough or eschar may be present on parts of the wound bed • Often has undermining and tunneling
Unstageable: Depth Unknown	• Full-thickness loss of tissue • Slough (yellow, tan, gray, green, brown) or eschar (tan, brown, black) covers the base of the injury in the wound bed • Unable to determine stage until enough slough/eschar is removed to expose the base of the wound
Suspected Deep Tissue Injury: Depth Unknown	• Skin intact • Discolored (i.e., purple, maroon) localized area of skin or blood-filled blister • Damage of underlying soft tissue from pressure or shear • Area may be preceded by tissue that is painful, firm, mushy, boggy, or warmer or cooler compared with adjacent tissue
New Definitions:	
Medical Device Related Pressure Injury:	• Medical device related pressure injuries result from the use of devices designed and applied for diagnostic or therapeutic purposes. • The resultant pressure injury generally conforms to the pattern or shape of the device. The injury should be staged using the staging system.
Mucosal Membrane Pressure Injury:	• Mucosal membrane pressure injury is found on mucous membranes with a history of a medical device in use at the location of the injury. • Due to the anatomy of the tissue these injury cannot be staged.

* *National Pressure Ulcer Advisory Panel (NPUAP) announces a change in terminology from pressure ulcer to pressure injury and updates the stages of pressure injury*. Washington, 2016. http://www.npuap.org/national-pressure-ulcer-advisory-panel-npuap-announces-a-change-in-terminology-from-pressure-ulcer-to-pressure-injury-and-updates-the-stages-of-pressure-injury/. Accessed November 20, 2021.

Braden scale

The Braden score is routinely evaluated when all patients are admitted to the clinic in the present research hospital. Therefore, Braden scores were obtained from the patients' files. In this study, the Braden score belongs to the preoperative period. it is only used to get a brief information about the risk diagnosis of the patient. Patients with high risk are thoroughly examined by a physician. Although the Braden score is not recommended for use in the evaluation of IAPI (Munro 2010; Fred *et al.,* 2012), these data may be of interest to nurses.

The scale was developed by Bergstrom *et al* in 1987. The scale has six subdimensions: sensory perception, skin moisture, activity, mobility, nutritional status, friction, and shear. The total score ranges from 6 to 23. A score of 15-23 represents mild risk, 13-14 represents moderate risk, 10-12 represents high risk, and 9 or lower represents very high risk. Oguz and Olgun validated the scale in Turkey in 1998, and the Cronbach alpha coefficient was 0.88. The validity coefficient varies between 0.77 and 0.94. In the present study, the Cronbach α value was also found to be 0.88. The Braden Scale is used throughout the hospital where we conducted the study and in surgical clinics.

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3.4 Data collection

In this study, data were collected by the researcher, who is a nurse in the operating theater in the institution where the research was conducted. Data were collected using three instruments perioperatively in face-to-face interviews and a review of patient records: the Sociodemographic and Clinical Characteristics Form and the 3S-intraoperative risk assessment scale (IRAS) (3S-IRAS) for PI. The researcher collected data preoperatively using the "Sociodemographic and Clinical Characteristics Form".

Data in the Sociodemographic and Clinical Characteristics Form were collected preoperatively: age, sex, diagnosis, last measured blood pressure and oxygen saturation, and surgery to be performed.

Data were collected perioperatively with 3S-IRAS. The 3S-IRAS was used to record data regarding skin condition in the whole body, preoperative activity status, body mass index (BMI), and the stress state of the skin just before the operation. Other data of the scale were recorded from electronic patient records during and at the end of the operation: body temperature during the operation, body position in the operation, amount of bleeding, and operation duration. Among the patients, 57 (28.5%) were directly transferred to the intensive care unit. The researcher received help from intensive care nurses for these patients. In the first 30 minutes after surgery, PI diagnosis was made in the PACU using the NPUAP (2021) staging system used by the research hospital for PI diagnosis.

3.5 Data protection

Only the investigators of the study had access to the data of the patients who agreed to participate. Data were stored in a password protected computer and only investigators had access to it.

3.6 Data analysis

Data analysis using IBM Statistical Packages for Social Sciences (SPSS) version 24.0 (Turkey, İstanbul, 30 days: trial version) was done after data entry, data cleaning and audit for accuracy. Significance was considered $p < 0.05$ for all test. The data tests used in the research are as follows: number, percentage, mean, independent samples two-tailed *t* test, chi-square, and univariate logistic regression for the data analysis. We used the Minitab 18 program to calculate the power of this study; it was found to be 0.82.

3.7 Ethical considerations

We informed the participants that their data would be used for scientific research and that we would not share their personal information in our publication. We also informed the patients who they would not undergo any interventions and that they would not receive any rewards or compensation. We acquired approval from The University Hospital's ethics committee (IRB: 16.07.2019-12692/14/269) and written permits from the research hospital. We obtained both written and verbal consent from the participants.

4. Results

4.1 Descriptive analyzes and primary comparisons

Table 1 shows the relationship between the sociodemographic, clinical characteristics of the participants. In this study, the mean age of the patients was 50.25±17.30 (min-max: 18-86), 53.5% were female, 40.0% had a chronic disease (n=40 had more than one underlying medical condition), and all had intraoperative oxygen saturation (SpO_2) at 98% and above. The majority of patients with and without PI (88.9%) (89.6%) had diastolic blood pressure above 60 mmHg and the intraoperative position was supine (52.8%/ 56.7%). A total of 58.5% of the patients were major surgery patients, and the mean operation time was 3.55±0.84 hours. Fourteen percent had activity limitations due to orthopedic problems.

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Table 1. Relationship between patients' sociodemographic and some clinical characteristics, and intraoperative pressure injury (N=200)

Characters	Total	IAPI Yes (n=36)	IAPI No (n=164)	*t* test or X^2 / *p*	β	*p*	RR	95% CI
Age * (Mean±SD) min-max	50.25±17.30 (18-86)	57.69±19.05 (18-86)	48.62±16.52 (18-82)	2.900; **.004**	0.020	.091	1.021	0.997-1.045
Gender n (%)				6.186; **.013**	-0.866	**.038**	0.421	0.185-0.954
Male	93 (46.5)	10 (27.8)	83 (50.6)					
Female	107 (53.5)	26 (72.2)	81 (49.4)					
Chronic Disease n (%)				4.426; **.035**	0.217	.652	**1.242**	0.484-3.190
Yes	80 (40.0)	20 (55.6)	60 (36.6)					
No	120 (80.0)	16 (44.4)	104 (63.4)					
Smoking/alcohol (years) n (%)				3.477; .062	-0.553	.335	0.575	0.187-1.771
Yes	59 (29.5)	6 (16.7)	53 (32.3)					
No	141(70.5)	30 (83.3)	111 (67.7)					
Surgery size n (%)				23.364; **.001**	2.448	**.006**	**11.569**	2.029-65.954
Large	117** (100.0)	34 (94.4)	83 (70.9)					
Medium	83(100.0)	2 (5.6)	81 (97.6)					
Preoperative Braden score (Mean±SD) min-max	14.40±3.13 (8-23)	14.43±3.06 (8-23)	14.27±3.48 (8-23)		.038	.561	1.039	0.913-1.182
Intraoperative Diastolic blood pressure (Mean±SD) min-max				6.115; **.0.001**	-1.145	**.001**	0.318	0.194-0.522
≤60 mmHg	21 (10.5)	4(11.1)**	17(10.4)	-				
>60mmHg	179(89.5)	32(88.9)	147(89.6)					
Preoperative Oxygen saturation (SpO_2) (Mean±SD) min-max								
≥98	200 (100.0)	36 (100.0)	164 (100.0)	-				
Intraoperative body position n (%)				6.052; .109	0.973	.224	**2.646**	0.552-12.674
Supine	112 (56.0)	19 (52.8)	93 (56.7)					
Lateral	12 (6.0)	5 (13.9)	7 (4.3)					
Lithotomy	60 (30.0)	8 (22.2)	52 (31.7)					
Prone	16 (8.0)	4 (11.1)	12 (7.3)					

*Levene's test Equality of Variances, mean age of cases with and without chronic disease:59.76±14.66 min-max:23-86)/ 43.92±16.02 (min-max:18-86).

X^2: Pearson Chi-Square.

**All of the patients were patients who were administered intraoperative vasopressor, underwent major surgery, and had lower extremity edema in preoperative skin examinations.

NOTE. Bold indicates significance is met ($p < .05$).

β = Regression coefficient; RR = Relative Risk; CI = confidence Interval.

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4.2 3S-IRAS results and IAPI characteristics

Table 2 shows 3S-IRAS characteristic of the participants and the risk status according to this scale. A total of 14.0% (n=28) had poor tissue turgor and/or underwent surgery with mild lower extremity edema (n=9). In 18.0% of patients (n=36), stage I PI was observed in the sacrum (n=19), lumbar and thoracic vertebrae (n=6) (spine position), heels (spine position), ankles (n=5) and hips (lateral position) (n=5). All patients had these injuries, which were painful, red in color and did not fade with physical pressure. In addition, 9 (%4.5) of the patients also had red spots, maceration and tiny bullae.

In this study, there was a statistically significant correlation with women (RR [relative risk]:1.242, 95%, CI [confidence interval]: 0.484-3.190) at risk of PI, those with chronic diseases and those who had major surgery (RR: 11.569, 95%, CI: 2.029-65.954). In addition, the patient's position during surgery posed a 2.6times (95% CI: 0.552-12.674) risk for PI.

Table 2. Frequency distribution of 3S-IRAS

Characteristics	n	%
Skin of whole body		
Normal	200	100.0
Mild ecchymosis and edema*	28	14.0
Preoperative limb activity		
No restrictions	129	64.5
Slight limitation	43	21.5
Partial limitation	28	14.0
Body mass index		
Standard	53	26.5
Mild obesity	87	43.5
Obesity	41	20.5
Extreme Obesity	19	9.5
Skin under stress		
Normal	172	86.0
Mild ecchymosis and edema	28	14.0
Intraoperative body temperature		
36.10-37.20 °C	200	100.0
Intraoperative body position		
Supine	112	56.0
Lateral	12	6.0
Lithotomy	60	30.0
Prone	16	8.0
Operating time (hour)		
1-3 hours**	112	56.0
> 3 hours	88	44.0
Intraoperative bleeding (ml)		
less than 200 ml	34	17.0
200-400 ml	105	52.5
400-1000 ml	61	30.5
Total 3S-IRAS risk		
Low risk	195	97.5
High risk	5	2.5

3S-IRAS: 3S= 3S-intraoperative risk assessment scale
* lower extremities were mild ecchymosis and edematous
**60 minutes -3 hours

Patients with pressure injuries were predominantly female with a significant difference (β = -0.866, p= .038), had chronic diseases (X^2 = 4.426, p= .035) and underwent major surgery, with an operation time over 3 hours (β = 2.448, p=.006; β = -0.718, p= .021), the amount of bleeding was greater (t = 3.279, p= .001), the intraoperative diastolic blood pressure was ≤60 and the blood pressure was (β =1.145, p= .001).

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Table 3 shows correlation of 3S-IRAS and IAPI. Based on IRAS score, there was a significant relationship between the time of the operation (RR:2.051, 95% CI: 1.113-3.780), and the intraoperative stress (RR:4.338, 95% CI: 1.815-10.369) for the risk of PI. However, skin of whole body, pre-operational limb activity, body mass index, skin under stress, intraoperative body temperature, position and bleeding score were not significantly associated with IAPI (p> .05, RR ≤ 1).

The amount of intraoperative bleeding (2435.83 ± 191.94 / 324.03 ± 135.03) was significantly higher in patients with pressure injuries than those without (t = 4.133, p= .002; . However, this difference did not show a significant association for PI risk (RR: 0.995, 95% CI: 0.993-0.998).

Table 3. Correlation of 3S-IRAS and IAPI (N=200)

3S-IRAS Characteristics	**IAPI**							
	Yes (n=36) (Mean±SD) (min-max)	**No (n=164) (Mean±SD) (min-max)**	***t*-test**	***p***	**β**	***p***	**RR**	**95% CI**
Skin of whole body	1.13±0.35 (1-2)	1.14±0.34 (1-2)	-.021	.983	-0.616	.294	0.541	0.171-1.707
Pre-operational limb activity	1.47±0.50 (1-2)	1.32±0.47 (1-2)	1.626	.106	-.087	.840	0.917	0.394-2.136
Body mass index	1.75±0.43 (1-2)	1.73±0.44 (1-2)	0.224	.823	-0.169	.705	0.745	0.353-2.022
Skin under stress	1.11±0.31 (1-4)	1.10±0.36 (1-2)	0.020	.984	-0.620	.242	0.538	0.191-1.519
Intraoperative bleeding (ml)	2435.83±191.94 (100-1000)	324.03±135.03 (100-800)	4.133	**.002**	-0.005	**.001**	0.995	0.993-0.998
Operating time (hour)	3.55±0.84 (2-4)	2.73±0.96 (2-4)	4.733	**.001**	-0.718	**.021**	**2.051**	1.113-3.780
Intraoperative body temperature (°C)	36.16±0.69 (36.10-36.29)	36.25±0.40 (36.10-37.20)	1.296	.197	-0.159	.645	0.853	0.433-1.680
Intraoperative body position	1.91±1.10	1.89±1.08	0.102	.919	-0.377	.065	0.686	0.460-1.024
Intraoperative stress	3.02±0.69 (2-4)	2.42±0.56 (1-4)	5.527	**.001**	1.467	**.001**	**4.338**	1.815-10.369
Total 3S -IRAS	17.61±2.98 (11-24)	15.48±2.66 (10-25)	4.23	**.001**	0.273	**.001**	**1.314**	1.136-1.519

3S-IRAS: intraoperative risk assessment scale
β = regression coefficient; RR = Relative risk; CI = confidence interval

5. Discussion

5.1 Descriptive characteristics

The PI occurs 2 to 3 times more frequently, especially in the postoperative critical patient population, drew attention to the characteristics of the intraoperative period (Park *et al.,* 2019; Webster *et al.,* 2015). It is reported to be 12.2% (Menezes *et al.,* 2013) in Portugal, 12.7% (Bulfone, Marzoli, Quattrin, Fabbro & Palese, 2012) in Italy and 13% (Saraiva, Paula & Carvalho, 2014) in the United States (USA). In Turkey, study conducted with 151 surgical patients in 2017, they found the incidence of pressure ulcers to be 40.40% (Celik, Karayurt & Ogce, 2019).

In this study, the incidence of IAPI (18.0%) (Yilmaz & Basli, 2021; Fu Shaw *et al.,* 2014; Chen *et al.,* 2021; Akan & Sayin; 2021) and the areas where it was observed (such as the sacrum, heels, thorax and over the vertebrae) were in line with other studies (Lumbley & Ali, 2014; Lindholm *et al.,* 2008) and indicated that these risks could be significant. In a similar study conducted by Webster *et al., (2015)*, this rate was much lower (1.3%). Unlike our study, Webster *et al.,* (2015) included patients whose operation time was less than one hour and who underwent other types of anesthesia other than general anesthesia. In addition, the support surfaces used in our hospital's operating theater do

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not have any features to prevent pressure on the patient, and objects such as folded operating covers being used in most operations as positioning tools may have played a role in our IAPI incidence. The fact that our sample did not include some risk factors, as in other studies (Webster *et al.,* 2015; Yilmaz & Basli, 2021; Piexoto *et al.,* 2019; Spruce, 2016), can be explained by the low preoperative PI risk score.

It is reported in the literature that the relationship between pressure injuries and age, gender, and chronic diseases is not clear. Attention is drawn to chronic diseases that cause bed dependence. (Primiano *et al.,* 2011; Yoshimura *et al.,* 2016; Tschannen *et al.,* 2012). The fact that the patients in this study did not have a high BMI was an important factor in reducing intraoperative skin stress. this may have also reduced the risk of injury due to age and gender. Although these variables appeared to be important in our study, the RR values do not suggest that they are a strong risk factor for IAPI. However, there are studies reporting that chronic diseases such as hypertension, vascular diseases, diabetes or congestive lung disease that cause peripheral vascular perfusion failure are among the risk factors that threaten the skin integrity of the surgical patient. This information indicates that precautions for IAPI in elderly patients with long-term chronic diseases require intraoperative preparation planning (Papantonio *et al.,* 1994; Rao *et al.,* 2016).

5.2 3S-IRAS results and IAPI characteristics

Healthy skin has an important role in preventing PI. In particular, patients with edema and poor skin turgor may be more susceptible to external factors, such as friction and slipping, as their skin elasticity decreases (Webster *et al.,* 2015; Sanada *et al.,* 1997). In the present study, 86.0% of the patients had intact skin health in the preoperative period, and only 28 patiets had mild edema and tiny ecchymoses, spots, maceration and tiny bullae in their lower extremities. Nine of these edematous patients required intraoperative diastolic blood pressure regulation with vasopressors. When they came out of the operation, they had pressure injuries in their heel and sacrum regions. Although these findings support the literature, the presence of IAPI in patients with intact tissue integrity in our study drew attention to the effect of intraoperative conditions (lack of adequate position support device, prolonged surgery, blood pressure changes of patients, intraoperative stress, blood loss) on IAPI. According to the literature, hypnotics and sedatives used for their general anesthetic effects can cause peripheral hypoperfusion by lowering blood pressure (Bliss & Simini, 1999). It has been reported that in long-lasting operations and anesthesia administration, bleeding over 300 ml requires the use of vasopressors and may increase the risk of PI (Papantonio, *et al.,* 1994; Tschannen *et al.,* 2012; Rao *et al.,* 2016; Aronovitch, 1999). The use of vasopressors may affect hemostasis due to hypotension, which develops in patients for various reasons during the operation. It is suggested that these acute changes significantly increase the risk of IAPI because they prevent skin perfusion (Tschannen *et al.,* 2012; Fu Shaw *et al.,* 2014). Patients with PI and severely disordered peripheral perfusion were not included in our study. The reason for this was to better observe the effect of intraoperative factors.

A strong risk factor in this study was the intraoperative position. It has been reported that patient position during surgery is a risk factor and that support surfaces are important for its prevention (Konateke, 2021; Yoshimura *et al.,* 2016).

The Braden Scale does not show a significant relationship with the risk of perioperative PI (Munro, 2010; Fred *et al.,* 2012), which is consistent with our study. It has been suggested that since this scale is specific to evaluating patients in home care conditions, it may be insufficient to diagnose surgical process conditions (Munro, 2010; Fred *et al.,* 2012; He, Liu & Chen, 2012). However, there are studies that report a relationship with IAPI in patients with high Braden scores and suggest using the scale with an additional scale (Akan & Sayın, 2021; Kim, Lee, Ha & Na, 2018). It can be said that it is difficult to observe and distinguish the risk for IAPI. Therefore, it is thought that it may be beneficial to use more than one scale that diagnoses risk.

In this study, we concluded that insufficient positioning support tools in operating theaters may lead to a higher incidence of IAPI in the case of a higher population of high-risk patients.

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5.3 Limitations

In this study, the wide confidence interval of some risk factors (size of the surgery, intraoperative position, intraoperative stress) created uncertainty. It may be useful to work with large samples to confirm these risk factors. In this study, the fact that sampling criteria were created with patients who underwent operations shorter than 60 minutes, were scheduled for general anesthesia and had intact tissue to better determine risks specific to operating theatres may have limited the generalizability of the data. Patients were not monitored for a long time after surgery, and some pressure injuries may not have appeared during the study period.

6. Conclusion and recommendations

Intraoperative factors stronger than sociodemographic characteristics played a role as the cause of IAPI in the patients in this study.

In this study, according to sociodemographic characteristics, being female, having a history of chronic disease and being a candidate for major surgery may cause the risk of IAPI. According to 3s- IRAS, long operative time and high skin stress score may create a significant risk of IAPI.

It is important that perioperative nurses conduct skin examinations and monitor IAPI.

Evaluating the risks associated with IAPI, it is understood that these risks are difficult to manage.

The results of this study showed that IAPI can be caused by a decrease in intraoperative diastolic blood pressure, the length of the operation time, the size of the surgical intervention, and intraoperative stress. Even though it shows a weak relationship, age, gender can be evaluated as a sociodemographic characteristic that should be considered an IAPI risk factor in a history of chronic disease.

However, perioperative nurses should assess the risk of each surgical patient and provide position support for the patient during the surgical procedure.

The attention of the patient's nurse or caregiver may be drawn to IAPI identified in the PACU in the surgical patient.

In cases of intraoperative hypotension, team cooperation can be utilized to reposition the patient and arrange vasopressor therapy.

Since it is difficult to determine the risks of IAPI, it may be useful to work with more than one scale.

Due to the wide confidence interval of the relationship between IAPI and some variables (surgery size, intraoperative position, intraoperative stress), studying with a larger sample may help confirm the risk factors. In order to determine the intraoperative risk factors according to the type of surgery, studies that include PI evaluation in specific surgeries are recommended.

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Author contributions:

The authors certify that have participated sufficiently in the work to take public responsibility fort he content. They agreed to be accountable for all aspects of the work. Furthermore, each author certifies that this material has not been and will not be submitted to or published in any other publication.

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The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

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