Pressure ulcer risk factors in patients undergoing surgery

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Aim. This paper reports a study to identify risk factors associated with pressure ulcer development among a mixed group of adult patients undergoing surgery.

Background. Few studies have been carried out with patients undergoing surgery to assess the risk of pressure ulcer development, and so there is a little knowledge of the risk factors for this group. However, studies among non-surgical patients have shown that nutritional predictors such as low serum albumin level and low body mass index (BMI) are of great importance. An additional predictive factor may be low blood pressure. It is important to study these predictors further among patients undergoing surgery, using techniques such as multiple regression techniques, designed to identify the most important predictors for pressure ulcer development.

Methods. A prospective comparative study was carried out in 1996–1998 with 286 adult patients undergoing surgical treatment. The data were collected from patient records by Registered Nurses preoperatively, for seven days postoperatively and thereafter once a week for up to 12 weeks. Perioperative data were also collected. The Risk Assessment Pressure Sore Scale was used, and data were collected on general physical condition, activity, mobility, moisture, food intake, fluid intake, sensory perception, friction and shear, body temperature and serum albumin.

Results. Forty-one (14·3%) patients developed pressure ulcers during the observation period. The most common type was non-blanchable erythema. Those who developed pressure ulcers were significantly older, weighed less, and had a lower BMI and serum albumin. More women than men developed pressure ulcers. Risk factors identified in multiple stepwise regression analyses were female gender, American Society of Anaesthesiologists (ASA) status or New York Heart Association (NYHA) status and food-intake.

Conclusion. Special attention, with regard to risk of pressure ulcer development, should be paid to patients undergoing surgery who have low ASA or NYHA scores, low food intake and/or are women.

Keywords: nursing, pressure ulcers, risk assessment, Risk Assessment Pressure Sore Scale, risk factors, surgery

Introduction

When people are immobilized, the risk of developing pressure ulcers increases (Lindgren *et al.* 2004). Patients undergoing surgery are immobile and unable to change position. They cannot feel the discomfort prolonged pressure will cause because of the sedation and anaesthesia. They may thus be at high risk of developing pressure ulcers (Kemp *et al.* 1990). The incidence of pressure ulcers in previous studies among patients undergoing cardiac surgery was reported as 27·2% (Tubman Papantonio *et al.* 1994) and for hip-fracture patients 42% (Unosson *et al.* 1995). In more heterogeneous surgical groups, the reported incidence varied between 12% and 13·7% (Kemp *et al.* 1990, Hoshowsky & Schramm 1994). In all these studies similar definitions and grading systems for pressure ulcer were used, including non-blanchable erythema.

Kemp *et al.* (1990) performed a prospective study with a mixed group of patients undergoing surgical treatment to determine the relationship between time spent on the operating table, diastolic hypotensive episodes, age, preoperative albumin levels, preoperative Braden Scale scores and the development of pressure ulcers. No statistically significant relationship was found between any of these variables and pressure ulcer development. However, when discriminant analysis was performed, time on the operating table, extracorporal circulation and age emerged as the best predictors of pressures ulcers. Hoshowsky and Schramm (1994) found that time on the operating table and age (over 40 years) were significant predictors.

Few studies have been carried out relating to patients undergoing surgery and the risk of pressure ulcer development, and so there is a little knowledge of the risk factors for this group. However, studies among non-surgical patients have shown that nutritional predictors such as low serum albumin level and low body mass index (BMI) are of great importance for pressure ulcer development (Ek 1987, Ek *et al.* 1991, Allman *et al.* 1995). An additional predictive factor may be blood pressure. Ek *et al.* (1991) demonstrated that systolic and mean arterial blood pressure were significantly lower in patients who had pressure ulcers on admission. The lowest frequency of pressure ulcers was found among those with hypertension. Low diastolic blood pressure was also a predictor in a study by Schubert (1991). It is important to study these predictors further among patients undergoing surgery, using techniques such as multiple regression techniques, designed to identify the most important predictors for pressure ulcer development (Cullum & Clark 1992).

There is thus a need for additional prospective studies comparing patients who develop pressure ulcers with those who do not, in an attempt to identify risk factors. In a previous analysis of 530 patients, we found that patients undergoing surgical treatment differed from medical patients (Lindgren *et al.* 2004). Further analysis of these patients' data, in an attempt to gain more specific information, is reported in this paper.

The study

Aim

The aim of this study was to identify risk factors associated with pressure ulcer development among a mixed group of adult patients undergoing surgical treatment.

Design

This prospective study was performed at a university hospital and at a county hospital in Sweden from 1996 to 1998 as part of a larger study. This identified that the problems among patients undergoing surgical treatment differed from those of medical patients. These findings are reported here, and there is no reason to suggest that the situation has changed. Thus, we believe that the data are still valid today.

Participants

A total of 286 patients undergoing orthopaedic ($n = 121$), abdominal ($n = 80$) or cardiovascular surgery ($n = 60$), together with the remainder ($n = 25$) arriving on an emergency or elective basis, were included in the study. To be eligible for inclusion, patients had to be 17 years of age or older, to have an expected hospital stay of at least 5 days, and to have an expected time on the operating table of at least 1 hour. Those with pressure ulcers on admission were excluded.

Data collection

The definition of a pressure ulcer used in this study was an area of skin damage appearing after a prolonged period of ischaemia in the skin (Nyhlén 1979, Ek 1987). Pressure ulcers were graded from I to IV: grade I, non-blanchable erythema,

with intact skin surface; grade II, epithelial damage, abrasion or blister; grade III, damage to the full thickness of the skin without a deep cavity and grade IV, damage to the full thickness of the skin with a deep cavity [Ek *et al.* 1991, European Pressure Ulcer Advisory Panel (EPUAP) 1999].

The Risk Assessment Pressure Sore (RAPS) Scale was used to identify patients at risk of pressure ulcer development (Lindgren *et al.* 2002). The scale measures the following variables: general physical condition, activity, mobility, moisture, food intake, fluid intake, sensory perception, friction and shear, body temperature and serum albumin. It is an additive ordinal scale, with the score ranging from 10 to 39. The variable of friction and shear is rated between 1 and 3 and the remaining variables are rated between 1 and 4. The lower the score, the greater the risk of pressure ulcer development. The RAPS Scale has been shown to be reliable in terms of internal consistency and equivalence for the prediction of pressure ulcer development (Lindgren *et al.* 2002).

Information meetings for nurses were held on each ward where participants were nursed, with the following topics being covered: study procedure, grading system used for pressure ulcers, how to use the RAPS Scale and skin assessment. The patient's skin condition was to be observed over the whole body, especially over bony prominences. The information was given both in writing and orally by a member of the scientific team. The data were collected by Registered Nurses within 24 hours of patient admission, over a period of approximately 3 months for each ward. Patients admitted during three defined days per week were consecutively included up to a maximum of nine per week per ward. A member of the scientific team visited the wards three times a week, in order to recruit the patients and to support the nurses during the data collection.

The preoperative period was defined as the time from the first data collection (performed within 24 hours of admission) until the patient was lying on the operating table. The perioperative period was defined as the period from the start of anaesthetic until the end of anaesthetic, and the postoperative period lasted from the end of the anaesthetic until discharge from hospital, at the most 12 weeks.

The preoperative data collection comprised the RAPS Scale score, skin condition, diagnosis, drug treatment, weight and height and whether the patient was a smoker or not. Preoperatively, anaesthesiologists assessed all patients according to the American Society of Anaesthesiologists (ASA) classification (Aitkenhead & Smith 1998) ($n = 236$) or New York Heart Association (NYHA) classification (Aitkenhead & Jones 1996) ($n = 20$). The ASA classification system was used to describe the physical state of the patients preoperatively. The assessments categories ranged from I to V: I, normal healthy; II, mild systemic diseases; III, severe systemic diseases that not incapacitating; IV, incapacitating systemic diseases that are a constant threat to life and V, moribund, not expected to survive without operation (Aitkenhead & Smith 1998). The NYHA classification system describes patients with cardiac diseases and their physical activity in categories ranging from: I, no limitation of normal activity; II, slight limitation of normal activity; III, marked limitation of ordinary activity; to IV, any physical activity brings on discomfort and symptoms occur at rest (Aitkenhead & Jones 1996). Systolic and diastolic blood pressure were measured pre-, peri- and postoperatively. Systolic and diastolic blood pressure was measured with the patient in the supine position, by auscultation, using the ordinary equipment on the wards. Perioperative blood pressure was measured every fifth minute, mainly in a non-invasive way, with the exception of patients treated with extracorporal circulation or undergoing major abdominal surgery. Blood loss and compensation given for this perioperatively were also recorded. The use of pressure-relieving devices and warming blankets was documented in the operating theatre. Data for the perioperative period were taken from the patients' records.

The patient's skin condition was assessed on admission, before moving to and from the operating table, daily during the first postoperative week, and thereafter weekly for a maximum of 12 weeks. Systolic and diastolic blood pressure was measured twice a day for 7 days postoperatively, and then once a week for 12 weeks or until discharge. Blood samples were collected for serum albumin analysis once a week.

Ethical considerations

The study was approved by the appropriate ethics committee. Patients were informed both orally and in writing about the study by a member of the scientific team and gave written consent.

Data analysis

The data were analysed as means and standard deviations. Data at interval and ratio levels were tested by Student's *t*-test and those at nominal and ordinal levels were tested by chi-square or Mann–Whitney *U*-tests when comparing pressure ulcer patients with non-pressure ulcer patients. The RAPS Scale is an ordinal scale, but for clarity the data are presented as mean and SD (Knapp 1990).

Hypotension during surgery was defined as a systolic blood pressure < 90 mmHg and the number of episodes was

calculated (Curatolo *et al.* 1996). The lowest value recorded during each half hour period was used for calculation of mean systolic blood pressure perioperatively. Substitution for missing blood pressure data postoperatively was made by calculating the mean blood pressure using the values noted immediately before and after the missing data. The analyses were also limited to the first 5 days postoperatively due to missing data.

Comparisons between more than two independent groups were made by one-way ANOVA and Scheffe's *post hoc* test. Comparisons between groups were performed using the Kruskall–Wallis test and the Bonferroni correction.

Univariate logistic regression analysis was used to determine factors associated with pressure ulcer development. Multiple logistic stepwise regression analysis was then used to elucidate significant risk factors from these associated factors. The dependent variable, pressure ulcer, was coded as 0 representing no pressure ulcers or 1 representing presence of pressure ulcers. In the regression analysis, the variable of friction and shear was excluded, as it was highly correlated (0·78) with mobility (Hosmer & Leweshow 1989, Lindgren *et al.* 2002).

Results

Two hundred and eighty-six patients were included in the study, of whom 129 were women and 157 were men. The mean age was 67·1 ± 13·1 years, and the women were significantly older than the men at 68·8 ± 13·7 and 65·5 ± 12·5 years, respectively ($P < 0·05$). Preoperatively, women had significantly lower scores on the total RAPS Scale as compared with men, as well as significantly lower scores for the variables of general physical condition, activity, mobility, food intake, and friction and shear (Table 1). Women had significantly lower BMIs than men ($P < 0·001$). However, there were no significant differences according to ASA or NYHA classification and gender.

Forty-one (14·3%) patients developed a total of 57 pressure ulcers, and nine (15·8%) developed more than one pressure ulcer. Twenty-nine (22·5%) of the women developed pressure ulcers, as did 12 (7·6%) of the men ($P < 0·001$). Thirty-nine (68·4%) pressure ulcers were rated as grade I, 14 (24·6%) were grade II, and four (7%) were grade III (Table 2). Eight ulcers (14·5%) progressed during the observation period. These included seven grade I ulcers: five to grade II, one to a grade III, and one to grade IV; one pressure ulcer grade III progressed to grade IV. Thirty ulcers (52·6%) healed during the observation period, and one patient with a grade II ulcer died. The most common locations for the pressure ulcers were the sacrum (29·8%), heels (19·3%) and ischial tuberosities (14%).

Preoperative data

Patients who developed pressure ulcers were significantly older (72·6 ± 13·8 years) than non-pressure ulcer patients (66·1 ± 12·8 years) ($P < 0·01$). Pressure ulcer patients also weighted less ($P < 0·001$), had lower BMIs ($P < 0·05$) and lower serum albumin ($P < 0·05$) than non-pressure ulcer patients (Table 3). Preoperative patients who developed pressure ulcers scored significantly lower on the total RAPS Scale ($P < 0·01$), as well as scoring significantly lower on some of the variables included in the scale (Table 4) as compared with non-pressure ulcer patients. Those who developed pressure ulcers had suffered fractures ($P < 0·01$), and were prescribed antibiotics ($P < 0·05$) to a greater

Table 1 Preoperative mean Risk Assessment Pressure Sore (RAPS) Scale score and scores for separate variables in the scale (mean and SD)

Variable	Men ($n = 157$)	Women ($n = 129$)	P value	Missing values men/women
Mean RAPS score	37·93 ± 2·12	37·29 ± 2·39	< 0·05	11/17
General physical condition	3·87 ± 0·41	3·76 ± 0·51	< 0·05	0/2
Activity	3·91 ± 0·47	3·77 ± 0·69	< 0·05	0/2
Mobility	3·87 ± 0·38	3·64 ± 0·61	< 0·001	1/2
Moisture	3·99 ± 0·11	3·98 ± 0·15	ns	1/2
Food intake	3·83 ± 0·56	3·68 ± 0·68	< 0·05	0/3
Fluid intake	3·94 ± 0·29	3·87 ± 0·41	ns	1/2
Sensory perception	3·92 ± 0·28	3·90 ± 0·35	ns	1/2
Friction and shear	2·92 ± 0·30	2·78 ± 0·45	< 0·01	1/3
Body temperature	3·92 ± 0·38	3·92 ± 0·35	ns	3/6
Serum albumin	3·81 ± 0·54	3·78 ± 0·56	ns	6/11

RAPS total score comparison using Student's *t*-test and remaining comparisons using Mann–Whitney *U*-test.
ns, not significant.

Table 2 Pressure ulcers staging and location, first appearance

Location	No. of sores (%)	Grade I	Grade II	Grade III	Grade IV
Head	1 (1·8)	1			
Back/shoulder	3 (5·3)	3			
Arm	2 (3·5)	2			
Hip	3 (5·3)	1	2		
Sacrum	17 (29·8)	11	4	2	
Ischial tuberosity	8 (14·0)	5	1	2	
Leg	1 (1·8)	1			
Heel	11 (19·3)	10	1		
Foot/malleoli	4 ((7·0)	4			
Not reported	7 (12·3)	1	6		
Total	57 (100)	39	14	4	

Table 3 Patients' characteristics preoperatively (mean and SD)

Characteristics	Pressure ulcer(s) ($n = 41$)	No pressure ulcer(s) ($n = 245$)	*P* value	Missing values pressure ulcer(s)/ no pressure ulcer(s)
Male/female	12/29	145/100	< 0·001	–
Age	72·6 ± 13·8	66·1 ± 12·8	< 0·01	–
Weight	68·4 ± 15·8	78·8 ± 17·3	< 0·001	4/8
Body mass index	24·1 ± 4·6	26·6 ± 5·3	< 0·05	7/15
Serum albumin	37·9 ± 5·5	39·9 ± 4·3	< 0·05	7/21
Systolic blood pressure	149·8 ± 22·3	150·1 ± 23·8	ns	1/15
Diastolic blood pressure	79·6 ± 12·1	82·9 ± 11·4	ns	1/17
Mean arterial blood pressure	110·1 ± 55·5	105·3 ± 13·5	ns	1/17

Gender comparison using Chi-square test and remaining comparisons using Student's *t*-test.
ns, not significant.

Table 4 Preoperative mean Risk Assessment Pressure Sore (RAPS) Scale score and scores for separate variables in the scale (mean and SD)

Variable	Pressure ulcer(s) ($n = 41$)	No pressure ulcer(s) ($n = 245$)	*P* value	Missing values, pressure ulcer(s)/ no pressure ulcer(s)
Mean RAPS score	36·5 ± 3·0	37·8 ± 2·1	< 0·01	7/20
General physical condition	3·76 ± 0·44	3·83 ± 0·46	ns	0/2
Activity	3·59 ± 0·95	3·89 ± 0·49	< 0·01	0/2
Mobility	3·44 ± 0·74	3·82 ± 0·44	< 0·001	0/3
Moisture	3·95 ± 0·22	3·99 ± 0·11	ns	0/3
Food intake	3·46 ± 0·81	3·82 ± 0·57	< 0·001	0/3
Fluid intake	3·83 ± 0·50	3·92 ± 0·32	ns	1/2
Sensory perception	3·93 ± 0·26	3·90 ± 0·32	ns	0/3
Friction and shear	2·67 ± 0·53	2·88 ± 0·35	< 0·01	1/3
Body temperature	3·90 ± 0·38	3·92 ± 0·37	ns	1/8
Serum albumin	3·64 ± 0·68	3·82 ± 0·52	< 0·05	5/12

RAPS total score comparison using Student's *t*-test and remaining comparisons using Mann–Whitney *U*-test.
ns, not significant.

extent than non-pressure ulcer patients. Those assessed at ASA or NYHA level two or more ($n = 199$) developed pressure ulcers to a greater extent than patients classified as level one ($n = 57$) ($P < 0·05$).

Factors associated with pressure ulcer development among patients undergoing surgery, as identified in the univariate regression analysis preoperatively, were RAPS total score, physical activity, mobility, food intake, and friction and shear. Further associated variables were female gender, age, ASA or NYHA staus, weight, BMI and serum albumin.

Risk factors for pressure ulcer development among surgical patients as identified in the multiple stepwise logistic

Table 5 Preoperative risk factors for pressure ulcer development among surgical patients as identified by multiple logistic regression analysis

Risk factor	Odds ratio	95% confidence interval	*P* value
Female gender	0·27	0·11–0·68	0·003
ASA or NYHA	2·30	1·21–4·38	0·011
Food intake	0·53	0·31–0·91	0·022

ASA, American Society of Anaesthesiologists classification; NYHA, New York Heart Association classification.

regression analysis were female gender, ASA or NYHA status, and food-intake (Table 5).

Perioperative data

Out of 279 patients, 124 (44·4%) had epidural/spinal analgesia, 99 (35·5%) had general anaesthesia and 56 (20·1%) a combination of epidural/spinal analgesia and general anaesthesia. There were 27 (21·8%) patients who developed pressure ulcers among those who had epidural/spinal analgesia, 5 (5%) among those who had general anaesthesia and, 7 (12·3%) among patients who had epidural/spinal analgesia combined with general anaesthesia. Significantly more patients having epidural/spinal analgesia developed pressure ulcers than did patients having general anaesthesia ($P < 0·01$). Patients who had epidural/spinal analgesia were older ($P < 0·001$), and suffered from musculoskeletal diseases ($P < 0·001$) and fractures ($P < 0·001$) to a greater extent than those receiving general anaesthesia.

Perioperatively, there were no significant differences in the number of hypotensive episodes, mean systolic blood pressure, time spent on the operating table, blood loss, compensation for blood loss or not, or amount of external warming and pressure-relieving pads used between patients who developed pressure ulcers and those who did not.

Postoperative data

Postoperatively, patients who developed pressure ulcers scored lower on the RAPS total score ($P < 0·01$), as well as for every variable included in the scale except for fluid intake and body temperature (Table 6).

Discussion

Few studies have attempted to investigate factors associated with pressure ulcer development among surgical patients. Stotts (1999) concluded, after performing a review of studies from 1960 onwards, that the development of pressure ulcers has been studied to a limited extent only among mixed groups of surgical patients.

In our study, the incidence of pressure ulcers was 14·3%, which corresponds with earlier studies with mixed surgical samples, thus confirming that patients undergoing surgical treatment are a vulnerable group (Kemp *et al.* 1990, Hoshowsky & Schramm 1994). Patients suffering from hip fractures represent a group needing specific attention, as their incidence of pressure ulcers has been reported to be as high as 42% and 55% (Unosson *et al.* 1995, Gunningberg *et al.* 2000).

A predominance of grade I pressure ulcers was found, i.e. non-blanchable erythema (68·4%). These ulcers tend to heal when relieved of pressure. However, as many as seven grade I

Table 6 Postoperative mean Risk Assessment Pressure Sore (RAPS) Scale score and scores for separate variables in the scale (mean and SD)

Variable	Pressure ulcer(s) ($n = 41$)	No pressure ulcer(s) ($n = 245$)	*P* value	Missing values, pressure ulcer(s)/ no pressure ulcer(s)
Mean RAPS score	32·08 ± 6·16	35·82 ± 2·81	< 0·01	16/92
General physical condition	3·34 ± 0·88	3·71 ± 0·57	< 0·01	0/1
Activity	3·37 ± 1·09	3·82 ± 0·59	< 0·001	0/2
Mobility	3·20 ± 0·84	3·70 ± 0·57	< 0·001	0/2
Moisture	3·75 ± 0·54	3·94 ± 0·27	< 0·01	1/6
Food intake	3·15 ± 1·01	3·65 ± 0·74	< 0·001	0/1
Fluid intake	3·73 ± 0·67	3·82 ± 0·46	ns	0/0
Sensory perception	3·73 ± 0·59	3·92 ± 0·33	< 0·01	0/5
Friction and shear	2·46 ± 0·71	2·86 ± 0·39	< 0·001	0/3
Body temperature	3·62 ± 0·74	3·81 ± 0·52	ns	1/7
Serum albumin	2·15 ± 0·77	2·79 ± 0·81	< 0·001	14/80

RAPS total score comparison using Student's *t*-test and remaining comparisons using Mann–Whitney *U*-test.
ns, not significant.

and one grade III ulcer worsened during the observation period. These ulcers were probably not relieved of pressure or this was not possible. As almost half of the pressure ulcers remained when the observation period was over, it was not possible to gain a total picture of their progress.

Women in this study developed pressure ulcers to a greater extent than men and were also statistically significantly older; they had statistically significantly lower admission scores on the total RAPS Scale, as well as statistically significantly lower scores for variables such as general physical condition, activity, mobility, food intake, and friction and shear. Female gender also emerged as a risk factor for pressure ulcer development in the multiple logistic regression analyses. Female gender itself might not be the real risk; instead, it might be the overall poorer condition, immobility and older age among women that makes them more vulnerable.

Preoperatively, as well as postoperatively, patients who developed pressure ulcer scored statistically significantly lower on the total RAPS Scale. They also scored statistically significantly lower for variables indicating restricted mobility and possible nutritional problems. This highlights the importance of identifying patients at risk preoperatively in order to initiate preventive measures, and the importance of repeating the risk assessment postoperatively. Using multiple stepwise logistic regression analyses, ASA or NYHA status emerged as a strong risk factor for pressure ulcer development in this study. These results match those of Scott *et al.* (2001), who found the ASA classification system to be a possible indicator of postoperative risk of developing pressure ulcers. Patients with ASA or NYHA scores of two or more preoperatively developed pressure ulcers to a greater extent than those with lower scores. ASA or NYHA score may be a possible indicator for the preventive measures to be performed perioperatively. Thus, risk assessment of patients undergoing surgery could be a three-step process. First, preoperative assessment with the RAPS Scale could determine the risk of pressure ulcer development, and as a baseline for later postoperative assessments. Secondly, in patients in whom preoperative risk scores did not indicate the need for special preventive interventions, the ASA or NYHA scoring systems could be used to evaluate any additional risk perioperatively. The RAPS Scale could, finally, be used for predicting pressure ulcer occurrence in the postoperative period.

One further significant risk factor that emerged from the multiple stepwise logistic regression analysis was food intake, which is related to nutritional status. Patients who are unable to provide for their nutritional needs may be at risk of malnutrition, and a good nutritional status is easier to keep than to regain (Ek *et al.* 1991). It has been found that extra nutritional support may decrease pressure ulcer development and improve the wound healing process among older patients (Kemp *et al.* 1990). An area of interest for further study could be the effect of extra nutritional support as a preventive intervention for patients undergoing surgery.

Low blood pressure or hypotensive episodes did not emerge as risk factors in this study. This may be related to some uncertainty in the measurements, as blood pressure pre- and postoperatively was measured by different people, using the ordinary equipment on the different wards. Blood pressure has been a significant risk factor in previous studies. However, this study was not designed to investigate the importance of blood pressure (Ek *et al.* 1991). It is also possible that the control of blood pressure and the correction of hypotension perioperatively was satisfactory and did not affect the development of pressure ulcers.

None of the perioperative variables measured emerged as statistically significant risk factors for pressure ulcer development. This may be related to adequate preventive measures performed perioperatively. On the contrary, it may be related to other variables affecting pressure ulcer development but not measured in this study.

More patients who had epidural/spinal analgesia developed pressure ulcers than those who had general anaesthesia. This may be explained by their greater age and the fact that they were suffering from diseases affecting their mobility to a greater extent than patients having general anaesthesia, leading to prolonged periods of immobilization. Ouchterlony *et al.* (1995) found that patients administered regional analgesia had a longer recovery period during the immediate postoperative period than patients having general anaesthesia. The period of recovery was also strongly correlated to age (Ouchterlony *et al.* 1995). These may be contributing factors for pressure ulcer development in the postoperative period, as the duration of pressure may be prolonged. Therefore, the importance of helping these patients to change position must be emphasized. These findings indicate that, in the population studied, every seventh patient and every third woman undergoing surgical treatment runs the risk of developing pressures ulcers during the postoperative period. Factors of importance in this process may be female gender, ASA or NYHA status, and food intake.

Conclusion

We recommend that particular attention, with regard to the risk of pressure ulcer development, be paid to patients undergoing surgery who have low ASA or NYHA scores, low food intake and/or are women.

What is already known about this topic

- Patients undergoing surgery may be at high risk of developing pressure ulcers.
- The incidence among patients undergoing cardiac surgery and those with hip fracture are high.
- Time on the operating table, extracorporeal circulation and age may be predictors for pressure ulcer development.
- Few studies have investigated the relationship between undergoing surgery and the risk factors for pressure ulcer development.

What this paper adds

- Every seventh patient and every third woman undergoing surgical treatment runs the risk of developing pressure ulcers.
- Preoperatively, as well as postoperatively, patients who developed pressure ulcers scored statistically significantly lower on the Risk Assessment Pressure Sore Scale.
- Patients having epidural/spinal analgesia tend to develop pressure ulcers to a greater extent than those having general anaesthesia.
- Significant risk factors for developing pressure ulcers may be female gender, poor physical state and low food intake.

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Author contributions

ML, MU and ACE were responsible for the study conception and design, data analysis and for obtaining funding. ML and AMK collected the data and provided administrative support. ML drafted the manuscript. MU and ACE supervised the study. ML, MU, AMK and ACE performed critical revisions.

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