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Observational study

Females report higher postoperative pain scores than males after ankle surgery

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HIGHLIGHTS

- Severe postoperative pain is reported to be a predictor of persistent pain.
- We therefore studied pain after ankle fracture operations in the postanaesthetic care unit (PACU).
- We focused on possible predictors of at least moderate pain, i.e. ≥4 on a 0–10 Verbal Numeric Rating Scale (vNRS).
- Being female was a statistically significant predictor of pain ≥4/10 in the PACU after ankle operations.
- These were not predictors: age, weight, smoking, time to operation, types of fracture, anaesthesia, operation, or tourniquet inflation.

GRAPHICAL ABSTRACT

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ABSTRACT

Objectives: The majority of patients experience moderate-to-intense pain following ankle surgery. Early, adequate treatment of postoperative pain is desirable for optimal pain relief, which in turn may facilitate optimal pulmonary function, normal respiration pattern, rehabilitation and prevention of a chronic pain condition. In this retrospective study, we aimed to identify possible predictors of moderate-to-intense postoperative pain while in the Post Anaesthesia Care Unit (PACU) in patients operated for ankle fractures.
Materials and methods: Social demographics and clinical characteristics from admission throughout the stay in the PACU were collected from the hospital patient record system in retrospect. Pain was assessed using a Visual Analogue Scale (VAS) or a verbal Numeric Rating Scale (vNRS). A VAS/vNRS score 4–6 was classified as moderate and 7–10 as intense pain. Other factors which were investigated were time from ankle fracture to surgery, anaesthetic procedure, pre-, per- and postoperative medical treatment, radiological classification, complexity of fracture, operative technique, and time using tourniquet procedure.

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Abbreviations: PACU, post anaesthesia care unit; ASA, American Society of Anaesthesiologists; VAS, Visual Analogue Scale; vNRS, verbal Numeric Rating Scale.
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Results: Data from 336 patients who underwent surgery to repair an ankle fracture between January 2009 and December 2010 were analysed. None of the following variables had a statistically significant effect on pain; age, weight, smoking, timeframe from fracture to operation, type of anaesthesia, opioids given peroperatively, complexity of the fracture, operation technique or tourniquet inflation procedure. Female sex predicted moderate-to-intense postoperative pain in the PACU with odds ratio 2.31 (95% confidence interval 1.39–3.86), $P = 0.001$. As far as we know, this is the first study to show a sex difference in reporting pain in the first hours after surgery for ankle fracture.
Conclusion: Female patients operated for ankle fracture report higher pain-intensity-score than male patients while in the PACU.
Implications: Our findings suggest that treatment strategies to prevent high peaks of pain should particularly target women operated for an ankle fracture.

1. Introduction

In Norway, 4500 ankle fractures are reported per year, which translates to an incidence of roughly 100 ankle fractures for every 100,000 people [1]. Ankle fractures are painful. Generally, inadequate postoperative pain treatment may affect pulmonary function negatively, developing into atelectasis or pulmonary infections and prolong recovery [2]. Intense, uncontrolled postoperative pain may also lead to persistent pain [3,4]. Being female, low educational level, report of frequent illness or chronic illness was found to be predictors of chronic pain in a Norwegian cohort [5]. A systematic review involving 23,037 patients reported that preoperative pain, anxiety, younger age, and surgery type (orthopaedic, thoracic, and abdominal surgery) were important predictors for intensity of postoperative pain [6]. None of the included studies examined ankle fractures in particular. Sex and pain were the foci of a literature review on clinical and postoperative pain in experimental studies of ankle fractures [7]. There was strong evidence to support that females experienced more pain than males in clinical pain situations, as well as in postoperative and procedural pain situations. The distinction between the sexes was more evident around and after puberty. The review examined a great variety of studies, some of which also included orthopaedic patients. They concluded that men and women perceive pain differently. However, none of the studies included ankle-operated patients. With a literature search of relevant publications in MEDLINE (Ovid), Cochrane Library, Web of Science, and Excerpta Medica Database (EMBASE) only four studies exist on postoperative pain in patients with ankle fractures short time after surgery. Two prospective and one retrospective study measured the effect of pneumatic tourniquets on postoperative pain. The first study with a small number of patients ($n - 32$) [8], the second included 138 patients [9]. The third, involved 603 patients and investigated tourniquet procedure and postoperative opioid consumption in addition to peak pain score and time in the post anaesthesia care unit (PACU) [10]. The fourth, retrospectively examined the association of gender and body mass index (BMI) with postoperative pain scores [11]. To complement these analyses, the current study aimed to examine potential predictors of moderate-to-intense postoperative pain following ankle operations.

2. Methods

2.1. Design and setting

The current study was conducted retrospectively, utilising an observational, cross-sectional design to identify factors that affect ankle-operated patients' perceived peak pain in the PACU. The data were collected between January 2009 and December 2010 in a tertiary university hospital on the west coast of Norway. The project was classified as quality improvement by the Institutional Review Board (Ref: 2010/2596). Hence, following Norwegian standard, the ethics procedures was approved by the Data protection Officer (2011/69) and **patient information** was not needed.

2.2. Patients

Patients included were ≥18 years old; had an isolated ankle fracture; and had an American Society of Anaesthesiologists (ASA) physical status classification score of 1, 2, or 3 [12]. Hospital operating scheduling software (Orbit 4, Evry) identified 412 patients eligible for inclusion. Exclusion criteria were reoperation, tibial pilon fracture, crus fracture, or whether concomitant, non-ankle injuries also needed treatment. After performing accurate radiological classification we excluded 76 patients (Fig. 1).

2.3. Measurements

2.3.1. Pain

Self-reported pain was recorded while the patient was in the PACU. We used a Visual Analogue Scale (VAS) or verbal Numeric

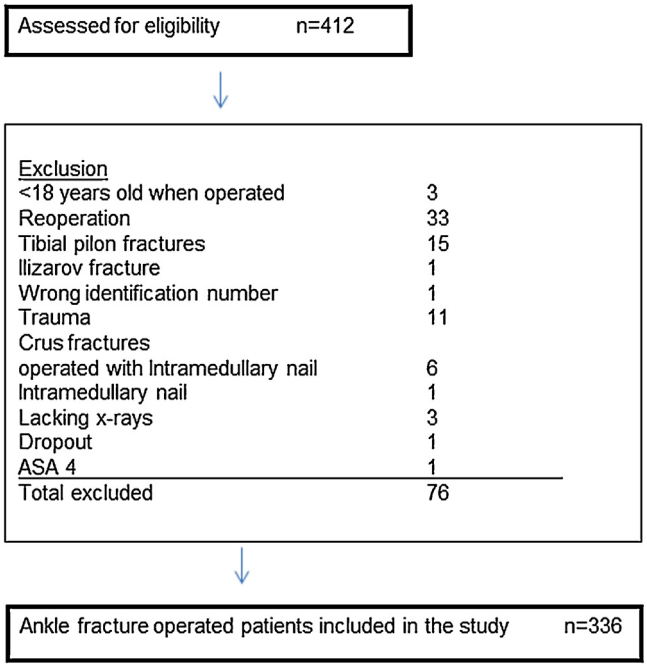

Fig. 1. Flowchart.

Rating Scale (vNRS) for pain assessment. The VAS scoring scale is a straight horizontal, 100-mm-long line, in which the ends of the line denote the positive and negative extremes of the observed phenomenon [13]. Patients in this PACU are instructed to indicate their pain level on a100-mm line on a ruler with a movable line to indicate their pain score. With the vNRS, patients are asked to rate their pain on an 11-point scale of 0 ('No pain at all') to 10 ('Worst imaginable pain'). VAS and vNRS are both valid and reliable instruments for assessing postoperative pain [14–16]. The vNRS are the preferred instrument over VAS in this PACU. The nurse reports the pain scores in the postoperative registration records. Pain was regarded as acceptable if VAS/vNRS were rated 3 or below. In accordance with local protocol, patients were offered medications, typically intravenous (IV) opioids, if scores were moderate (4–6) or intense (7 or higher), in accordance with international published guidelines [17,18]. The protocol, used at the time when the study was performed, instructed the nurses to report on patient pain at least once during the PACU stay. The pain was also recorded before transfer to the ward, i.e. at least two times per patient. The patients' peak VAS/vNRS score during the total stay in the PACU constituted the data analysed in this study.

2.3.2. Radiology classification

Ankle fractures were classified according to the anatomical classification system of Danis (1949) and Weber (1972), as cited by Donken and colleagues [19]. This system uses radiographical findings to classify fibular fractures as follows: Weber A, below the syndesmosis; Weber B, at the syndesmosis; and Weber C, above the syndesmosis. Isolated medial (tibia) fractures were identified and included as a group but were not radiologically specified in more detail.

2.3.3. Tourniquet procedure

Tourniquet inflation is a standard procedure in orthopaedic surgery. It is used to stop blood flow, and thereby facilitate good visibility of the surgical field. However, tourniquet use reduces the time available to perform surgery [20] and may increase risk of complications [21–26]. There are two main types of tourniquets used: the Esmarch bandage and the pneumatic tourniquet [27]. When collecting data for the present study, we applied the standard pneumatic procedure for the Zimmer ATS 500 or 1200 tourniquet system [28]: Pneumatic pressures were maintained between 250 and 300 mmHg, with a low profile cuff placed on the thigh. Local protocols recommended that, in general, the procedure should not exceed 90 min, with an absolute maximum of 120 min.

2.3.4. Clinical characteristics

With a literature search of relevant publications, we found no available validated questionnaires to identify possible factors that could influence the patients' perceived pain for ankle fractures. We therefore constructed a data abstraction sheet based on local expert opinion (nurses, anaesthesiologists, and orthopaedists) in the PACU, operating theatre, and orthopaedic ward.

2.4. Pain management

Following local guidelines at the time of the study, the optimal choice for anaesthetic method was spinal blockade for ankle operations. Other methods were general anaesthesia/total intravenous anaesthesia, popliteal blockade, or combinations of these. In the PACU, nurses administered medications as directed by the anaesthesiologists. Standard treatment was paracetamol (1000 mg every 6 h), morphine or ketobemidone (2–5 mg i.v., if VAS/vNRS $\geq$4). NSAIDS were individually given when prescribed by an orthopaedic surgeon.

2.5. Data collection

All nurses in the PACU were trained to monitor pain using VAS/vNRS scores to guide pain treatment. Data were collected by two nurse specialists and one of the authors (M.V.O.) and validated by the first author (A.S). Radiologic screening was performed by A.S. and validated by the second author, an orthopaedic surgeon (Y.K). The data was retrieved from ambulance records, admission reports, operation description, anaesthesia records, and scanned postoperative registrations.

2.6. Data management and statistical analysis

All statistical analyses were carried out using R version 3.2.2 (The R Foundation for Statistical Computing, www.r-project.org) and SPSS version 22 (SPSS Inc., Chicago, IL, USA) for windows. All tests were two-sided, and *P* values less than 0.05 were considered statistically significant. First, we analysed potential predictors of pain using VAS/vNRS scores according to the native continuous scale of the instruments. For future reference, we also presented the data as means with the F test using analysis of variance (ANOVA).

Second, we analysed potential predictors of pain using dichotomised VAS/vNRS scores. Scores of 0–3 were assigned to a no-to-minor pain category, and scores of 4–10 were assigned to a moderate-to-intense pain category. This was done for two purposes. The first reason was that it allowed us to contrast the established clinical cut-off point of acceptable pain (3 or lower) and non-acceptable pain (4 or higher). A second benefit of dichotomisation was that it allowed us to include into new analysis patients who originally had missing VAS/vNRS data. Of the 336 patients included in the study, 112 were not registered with a VAS/vNRS score. For these patients, we imputed missing VAS/vNRS categories using the following reasoning: If the patients received no opioids during their postoperative stay, we presumed that VAS/vNRS scores were likely in the category of 0–3. In a complimentary way, if the patient did receive opioids, we presumed that VAS/vNRS were in the category of 4–10. Our presumptions were based on the established pain protocol of the PACU, where a VAS/vNRS score of 3 is regarded to be 'acceptable' pain, not requiring opioids. For higher pain scores, patients are offered opioids.

All patient variables were considered as possible predictors of VAS/vNRS and the relationships were examined using logistic regression models. For each patient variable we calculated both crude and adjusted odds ratio (ORs) with 95% confidence intervals (CIs). The adjusted ORs were estimated from multivariate logistic regression models by incorporating additional patient variables (i.e., adjustment variables) that could potentially affect the effect of the index variable on the outcome. In this study, these adjustment variables were the same for all studied patient variables and were selected among all variables on the basis of a *P*-value less than 0.25 in univariate logistic regression analysis.

3. Results

3.1. Patient characteristics

Demographic and clinical characteristics of the 336 patients in our study are presented in Table 1. Median age was 52 years (range, 18–93 years). Females represented 53.6% of the population. The average tourniquet time was 65 min. Mean length of PACU stay was approximately 7 h, ranging from 1.5 to 56 h.

3.2. Pain and pain management peroperatively and in the PACU

During their stay in the PACU sixty-seven percent of patients had VAS/vNRS results. Data imputation probably increased the

Table 1
Characteristics of the total population and subsample with complete pain scores.

	Total sample (n = 336)		Sub sample (n = 224)	
	n	%	n	%
All	336	100.0	224	100.0
Sex				
Male	156	46.4	104	46.4
Female	180	53.6	120	53.6
Age				
18–50	163	48.5	113	50.5
51–93	173	51.5	111	49.5
Smoking[a]				
Yes	102	30.4	66	29.5
No	187	55.7	129	57.6
Weight, kg[b]				
46–70	64	19.1	41	18.3
71–85	91	27.1	67	29.9
86–100	60	17.9	43	19.2
101–150	21	6.2	16	7.1
Time to operation, h[c]				
0–7	91	27.1	66	29.5
8–24	56	16.7	40	17.9
Over 24	189	56.2	118	52.7
Anaesthesia				
Central/peripheral blockade (epidural, spinal,poplithea)	308	91.7	207	92.4
TIVA/GA	16	4.8	10	4.5
Central/peripheral blockade and TIVA/GA	12	3.6	7	3.1
Peroperative pain treatment[d]				
Opioid given	246	73.2	169	75.5
Opioid not given	90	26.8	55	24.6
Type fracture				
Single malleoli fracture	187	55.7	123	54.9
Multiple malleoli fracture	149	44.3	101	45.1
Syndesmosis damage				
No	238	70.8	161	71.9
Yes	98	29.2	63	28.1
Luxation				
No	235	69.9	160	71.4
Yes	65	19.3	40	17.9
Subluxation	36	10.7	24	10.7
Radiology classification				
Weber B	226	67.3	154	68.8
Weber C	90	26.8	57	25.4
Other[e]	20	6.0	13	5.8
Operation technique				
Plate and screws	197	58.6	137	61.2
Screws	36	10.7	23	10.3
Syndesmosis screws	16	4.8	9	4.0
External fixation	13	3.9	6	2.7
Plate and screws and syndesmosis screws	65	19.3	42	18.8
Screws and syndesmosis screws	9	2.7	7	3.1
Tourniquet inflation, min				
0–59	149	44.3	97	43.3
60–119	167	49.7	113	50.5
>120	17	5.1	12	5.4

TIVA, Total intravenous anaesthesia; GA, general anaesthesia.
[a] No smoking data for 47 patients.
[b] No weight data for 100 patients.
[c] Time from accident to operation.
[d] Fentanyl (n = 96); alfentanil (n = 149); remifentanil (n = 2).
[e] Weber A – 2 patients, Not classified using the Weber system because of an isolated tibial fracture – 18 patients.

statistical power of our analysis for some predictors, but it did not provide other results compared with those from a model without imputation using complete VAS/vNRS data (n = 224; data not shown). Table 2 shows the social demographics and clinical distribution for the subgroup with pain scores. Both median and mean pain scores are based on the continuous VAS/vNRS 0–10. Fig. 2 illustrates the distribution of pain. Forty-three patients reported no pain, of those, the majority were males (62.8%). Because the overall distribution of VAS/vNRS was skewed with many zeroes (Fig. 2), data were presented as medians and compared across groups by using the non-parametric Kruskal–Wallis test. The median time spent in the PACU for the no-pain group was 255 min (range: 125–555 min), for those reporting pain; 420 min (range: 95–3350 min). For the pain group, the average pain score was 4.7 (±S.E. 0.19). Peroperatively seventy-three percent of the patients received opioids. The complexity of relieving pain for this group of patients got transparent studying pain management in PACU. Postoperative pain management varied greatly, from none at all (n = 48) to 28 different combinations or orders of pain management. To illustrate: during the entire PACU stay, one combination could be a single drug like paracetamol; another, paracetamol and morphine; a third, morphine and paracetamol; a fourth, a combination

Table 2
Social demographics, clinical characteristics and VAS/vNRS registered for various patient- and per-operative characteristics of patients with ankle fractures ($n = 224$).

	Median VAS/vNRS	25th percentile	75th percentile	P[a]	Mean VAS/vNRS	SE	P[b]
All	5.0	3.0	7.0		4.7	0.19	
Sex				0.003			0.002
Male	4.5	0.0	6.0		4.0	0.29	
Female	5.0	4.8	7.0		5.2	0.25	
Age				0.37			0.38
18–50	5.0	3.0	7.0		4.5	0.27	
51–93	5.0	3.0	7.0		4.8	0.28	
Smoking[c]				0.54			0.42
Yes	5.0	0.0	6.0		4.4	0.38	
No	5.0	3.0	7.0		4.8	0.25	
Weight, kg[d]				0.63			0.70
46–70	5.0	2.0	6.0		4.2	0.40	
71–85	5.0	3.0	7.0		4.8	0.36	
86–100	5.0	1.5	7.0		4.5	0.47	
101–150	5.0	3.0	7.0		4.9	0.74	
Time to operation, h[e]				0.53			0.42
0–7	5.0	3.0	6.8		4.9	0.31	
8–24	5.0	3.5	8.0		4.9	0.46	
Over 24	5.0	1.2	6.8		4.4	0.28	
Anaesthesia				0.029			0.068
Central/peripheral blockade (epidural, spinal,poplithea)	5.0	3.0	6.0		4.5	0.20	
TIVA/GA	8.0	7.0	8.8		6.6	1.14	
Central/peripheral blockade and TIVA/GA	5.0	4.0	7.0		5.4	0.78	
Peroperative pain treatment[f]				0.46			0.39
Opioid given	5.0	3.0	7.0		4.6	0.23	
Opioid not given	5.0	4.0	6.5		4.9	0.35	
Type fracture				0.004			0.003
Single malleoli fracture	5.0	1.5	6.0		4.1	0.26	
Multiple malleoli fracture	5.0	4.0	7.0		5.3	0.28	
Syndesmosis damage				0.63			0.73
No	5.0	3.0	7.0		4.6	0.23	
Yes	5.0	3.0	7.0		4.8	0.34	
Luxation				0.16			0.15
No	5.0	2.0	7.0		4.4	0.23	
Yes	5.0	4.5	7.0		5.0	0.42	
Subluxation	6.0	5.0	7.2		5.6	0.54	
Radiology classification				0.072			0.082
Weber B	5.0	3.0	7.0		4.7	0.24	
Weber C	5.0	4.0	7.0		4.8	0.34	
Other[g]	4.0	0.0	5.0		2.9	0.74	
Operation technique				0.013			0.032
Plate and screws	5.0	3.0	7.0		4.9	0.26	
Screws	4.0	0.5	4.5		3.0	0.45	
Syndesmosis screws	6.0	0.0	6.0		4.2	1.06	
External fixation	5.5	4.2	6.8		5.0	0.93	
Plate and screws and syndesmosis screws	6.0	3.0	7.0		5.1	0.40	
Screws and syndesmosis screws	4.0	0.0	5.0		3.0	1.11	
Tourniquet inflation, min				0.28			0.47
0–59	5.0	3.0	6.0		4.4	0.28	
60–119	5.0	3.0	7.0		4.8	0.29	
>120	5.0	4.8	6.0		5.1	0.66	

VAS, visual analogue scale; vNRS, verbal numeric rating scale; SE, Standard error of the mean; TIVA, Total intravenous anaesthesia; GA, general anaesthesia.
[a] P value by Kruskal–Wallis test.
[b] P value by ANOVA.
[c] No smoking data for 47 patients.
[d] No weight data for 100 patients.
[e] Time from accident to operation.
[f] Fentanyl ($n = 96$); alfentanil ($n = 149$); remifentanil ($n = 2$).
[g] Weber A – 2 patients, Not classified using the Weber system because of an isolated tibial fracture – 18 patients.

of seven drugs to reduce pain or pain-related behaviour (e.g., morphine, ketobemidon, ketorolac, clonidine, ketamine, diazepam, and midazolam).

3.3. Radiological classification and complexity of ankle fractures

The majority (67%) of the fractures were classified as Weber B fractures. A total of twenty patients were left out of the analysis presented in Table 3. These were 2 Weber A, and 18 classified as an isolated medial (tibia) fracture. Of interest we examined the association between VAS/vNRS ≥ 4 and type of ankle fracture, distinguishing between a single from a multiple (bi- and tri-malleoli) fracture combined with additional damage. Statistical tests disclosed significance within the different groups except subluxation influence on a single or a multiple fracture. However, when testing for interaction between a single and a multiple fracture combined with or without syndesmosis damage, there were no significance (interaction term, $P = 0.74$). The type of ankle

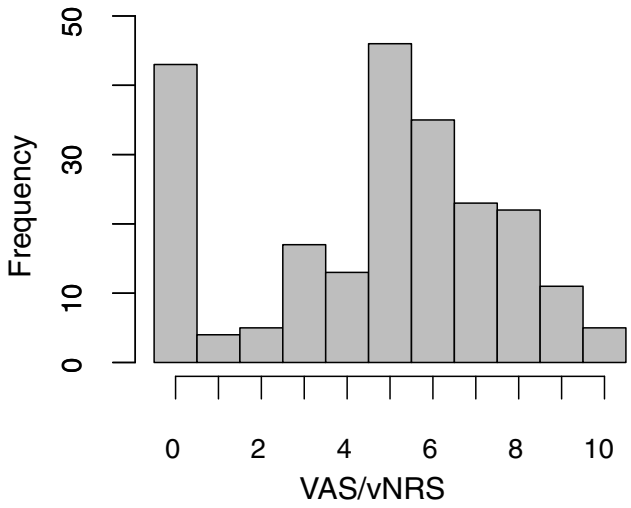

Fig. 2. Distribution of pain scores.

fracture, with or without luxation and subluxation, also was not significant (interaction term, $P = 0.31$). After adjustments there was no statistical significance.

3.4. Tourniquet inflation

Tourniquet inflation procedure was used in nearly all patients (92%) (Table 1). Twenty three patients were operated without. Of these, 14 were external fixations, leaving 9 using other operation techniques. Three patients were reported to use tourniquet inflation, but no data on duration were disclosed leaving three as missing. Tourniquet procedure was not statistical significant.

3.5. Prediction of patients experiencing medium-to-intense postoperative pain in the PACU

Female sex and multiple fractures of the malleolus were predictors of a VAS/vNRS score ≥4. Patient and ankle operation characteristics, stratified according to VAS/vNRS categories, are presented in Table 3. The *P* values obtained from the parametric and non-parametric tests were essentially the same. The results indicate that females were about three times more likely to experience a VAS/vNRS score ≥4 than men (odds ratio (OR) 2.85 [95% confidence interval (CI), 1.79–4.60]). Patients with multiple fractures of the malleolus had double the risk for reporting VAS/vNRS scores ≥4 compared to those with a single fracture (OR 2.32, [95% CI, 1.44–3.78]). When adjusting for possible confounding factors, we found that only one factor statistically predicted medium or intense pain: female sex (OR 2.31, [95% CI, 1.39–3.86]).

4. Discussion

In this study, we identified predictors of moderate-to-intense postoperative pain while in the PACU in patients operated on for ankle fractures. We examined a variety of demographic and clinical variables as possible predictors of self-reported pain, including age, sex, smoking, weight, time from ankle fracture to surgery, anaesthetic procedure, pre- per- and postoperative medical treatment, complexity of fracture, operative technique and tourniquet inflation. This is one of the very few studies to focus on this particular patient group and their self-reported pain score. The majority (67%) of the patients' experienced moderate or intense pain during their stay in the PACU. We found that female sex was a strong predictor of moderate-to-intense pain after an ankle fracture operation.

4.1. The female sex

The International Association for the study of Pain (IASP) highlighted pain in women for a year (2007/2008) in order to increase awareness about this significant problem [29]. Females in our study were over two times more likely to report a VAS/vNRS score of ≥4 than men. Being female has also been reported to be a predictor of chronic pain [30], and acute pain, however, these studies involved patients with a mixture of different surgical procedures [31–34]. More recently, a systematic review in PAIN on sex's influence on pain perception revealed similarities and differences in terms of different experimental pain modalities in healthy volunteers in a laboratory setting. Racine and colleagues clearly demonstrated that females tolerate less pressure and thermal pain than their male counterparts [35]. More vaguely, however, there were indications that females and males had comparable pain sensitivity for cold and ischemic pain. This review study could not reach a firm conclusion about differences between the sexes and their perception of pain, in general, from a laboratory setting design. A clinical randomised controlled trial (RCT with placebo controls) examined perceived pain intensity in women and men after a knee arthroscopic procedure [32]. One-third of patients did not report any pain. For the group reporting at least moderate pain, women were at significantly greater risk than men for experiencing postoperative pain within the first 2 h after arrival in the PACU. In general, however, the evidence regarding sex and pain is mixed.

One systematic review included studies conducted in the clinical field [6]. Several factors were identified to be predictors of postoperative pain, but being female was not one of them. Another review of both studies conducted in the clinic and experimental studies [7] found, however, that women report higher pain scores than men for the most common forms of pain, and they are more sensitive to experimental pain (except for ischemic pain) than men. Interestingly, trends in their analysis suggested that females experience more pain than men postoperatively.

We identified four studies on ankle operated patients perception of pain with measurements in the PACU, and they conclude in different ways. One found that males and age over thirty years experienced more pain after a pneumatic tourniquet procedure [8]. A second found significantly more pain in patients having a tourniquet procedure performed during the ankle operation [9]. A third concluded that tourniquet procedure increased opioid consumptions, increased postoperative peak pain with longer tourniquet time, and prolonged stay in the PACU compared to non-tourniquet usage [10]. The fourth and last study found no significant pain differences between obesity and gender in ankle operated patients [11]. However, they found that pain decreased with increased age. Interestingly, included participants received individually tailored iv Morphine dosages. But, they were not able to include the post-operative Morphine received as patient controlled analgesia because the information was unavailable to the study group. So their results of no association of gender and body mass index's influence on postoperative pain scores may be due to differences in opioid consumptions. Our results contrast the published literature on this particular group with identification of females being the only predictor of moderate to intense pain in the PACU. A recent study of lumbar disc herniation patients [34] found a strong correlation between being female and possessing genotype A118G of the μ-opioid receptor, and pain intensity one year after surgery/conservative treatment. Explanations for possible differences between the sexes suggest that differences in biological factors such as hormonal factors, skin thickness, and neurobiological variables, and gender variances psychologically and socially account for different perceptions of experimental pain between females and males [7,36].

Table 3
Predictors of VAS/vNRS score by patient- and operation characteristics of patients with ankle fracture ($n = 336$).

	VAS/vNRS ≥4									
	No		Yes		Crude analysis[a]			Adjusted analysis[b]		
	n	%	*n*	%	OR	95% CI	*P*	OR	95% CI	*P*
All	110	100	226	100						
Sex							<0.001			0.001
Male	70	63.6	86	38.1	1			1		
Female	40	36.4	140	61.9	2.85	1.79, 4.60		2.31	1.39, 3.86	
Age							0.076			0.77
18–50	61	55.5	102	45.1	1			1		
51–93	49	44.5	124	54.9	1.51	0.96, 2.40		1.08	0.65, 1.77	
Smoking[c]							0.89			0.73
Yes	33	30.0	69	30.5	1			1		
No	59	53.6	128	56.6	1.04	0.62, 1.73		0.91	0.52, 1.58	
Weight, kg[d]							0.31			0.89
46–70	16	14.5	48	21.2	1			1		
71–85	30	27.3	61	27.0	0.68	0.33, 1.37		1.24	0.55, 2.84	
86–100	23	20.9	37	16.4	0.54	0.25, 1.15		1.11	0.45, 2.79	
101–150	9	8.2	12	5.3	0.44	0.16, 2.17		0.85	0.27, 2.80	
Time to operation, h[e]							0.16			0.47
0–7	23	20.9	68	30.1	1			1		
8–24	18	16.4	38	16.8	0.71	0.34, 1.50		0.80	0.37, 1.72	
Over 24	69	62.7	120	53.1	0.59	0.33, 1.02		0.69	0.38, 1.25	
Anaesthesia							0.36			0.35
Central/peripheral blockade (epidural, spinal,poplithea)	104	94.5	204	90.3	1			1		
TIVA/GA	3	2.7	13	5.8	2.21	0.69, 9.79		2.45	0.74, 11.2	
Central/peripheral blockade and TIVA/GA	3	2.7	9	4.0	1.53	0.45, 7.00		0.93	0.24, 4.51	
Peroperative pain treatment[f]							0.36			0.50
Opioid given	84	76.4	162	71.7	1			1		
Opioid not given	26	23.6	64	28.3	1.28	0.76, 2.19		1.20	0.70, 2.11	
Type fracture							<0.001			0.14
Single malleoli fracture	76	69.1	111	49.1	1			1		
Multiple malleoli fracture	34	30.9	115	50.9	2.32	1.44, 3.78		1.55	0.86, 2.83	
Syndesmosis damage							0.32			0.95
No	74	67.3	164	72.6	1			1		
Yes	36	32.7	62	27.4	0.78	0.48, 1.28		0.98	0.57, 1.71	
Luxation							0.80			0.53
No	79	71.8	156	69.0	1			1		
Yes	19	17.3	46	20.4	1.23	0.68, 2.27		0.67	0.33, 1.38	
Subluxation	12	10.9	24	10.6	1.01	0.49, 2.19		0.81	0.37, 1.83	
Radiology classification							0.75			0.84
Weber B	74	67.3	152	67.3	1			1		
Weber C	28	25.5	62	27.4	1.08	0.64, 1.84		1.17	0.67, 2.08	
Other[g]	8	7.3	12	5.3	0.73	0.29, 1.94		1.17	0.44, 3.25	
Operation technique							0.52			0.97
Plate and screws	58	52.7	139	61.5	1			1		
Screws	16	14.5	20	8.8	0.52	0.25, 1.09		0.81	0.36, 1.85	
Syndesmosis screws	5	4.5	11	4.9	0.92	0.32, 3.02		0.86	0.25, 3.23	
External fixation	6	5.5	7	3.1	0.49	0.16, 1.57		0.80	0.24, 2.75	
Plate and screws and syndesmosis screws	22	20.0	43	19.0	0.82	0.45, 1.50		1.03	0.53, 2.06	
Screws and syndesmosis screws	3	2.7	6	2.7	0.83	0.21, 4.06		1.52	0.36, 7.76	
Tourniquet inflation, min							0.13			0.83
0–59	56	50.9	93	41.2	1			1		
60–119	50	45.5	117	51.8	1.41	0.88, 2.26		1.09	0.64, 1.83	
>120	3	2.7	14	6.2	2.81	0.87, 12.6		1.50	0.42, 7.13	

VAS, visual analogue scale; vNRS, verbal numeric rating scale; OR, Odds Ratio; CI, Confidence Interval; TIVA, Total intravenous anaesthesia; GA, general anaesthesia.
[a] By logistic regression model.
[b] Adjusted for Sex, Age, Time to operation, Type fracture, and Tourniquet inflation.
[c] No smoking data for 47 patients.
[d] No weight data for 100 patients.
[e] Time from accident to operation.
[f] Fentanyl ($n = 96$); alfentanil ($n = 149$); remifentanil ($n = 2$).
[g] Weber A – 2 patients, Not classified using the Weber system because of an isolated tibial fracture – 18 patients.

4.2. Complexity of the fracture

The complexity of the fracture was regarded as greater for patients who also had syndesmosis damage, subluxation, or full luxation. We found no statistically significant association between complexity of fracture and moderate or intense pain when examining the interaction of fracture complexity. Studies comprising larger samples of patients with similar fracture complexities are needed in order to make more robust conclusions about a lack of association.

4.3. Strengths and limitations

This study included 336 patients and is one of the largest study samples of its kind. However, pain was not scored for all the patients. One hundred and twelve patients had a missing pain score.

This is a limitation, because validity of the pain scoring for the total group of 336 may be weakened. However, testing predicting factors for the group of 224 who have a pain score, the conclusion remains the same. Future studies should pay particular attention to provision of training and monitoring and to using pain scale instruments. This study was done retrospectively, aiming to identify predictors of moderate and intense pain. This design limited our observations to patients receiving standard care. Incomplete patient records is indeed a known challenge in retrospective studies [37,38].

5. Conclusion

Most patients receiving surgical operations for ankle fractures experience moderate to intense postoperative pain in the PACU. We found a clear sex difference in postoperative pain. Female patients operated for ankle fracture report higher pain-intensity-score than male patients while in the PACU.

Implication of the study

Our findings promote that treatment strategies to prevent high peaks of pain should particularly target women after ankle fracture surgery.

Conflict of interest

No conflict of interest.

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