Original article

Chronic pain 1 year after foot surgery: Epidemiology and associated factors

F. Remérand\textsuperscript{a,}*, H.B. Godfroid\textsuperscript{a}, J. Brilhaut\textsuperscript{b}, R. Vourch\textsuperscript{a}, J. Druon\textsuperscript{b}, M. Laffon\textsuperscript{c}, J. Fusciardi\textsuperscript{c}

\textsuperscript{a} Pôle Anesthésie Réanimation SAMU, SAR2, Hôpital Trousseau, CHRU de Tours, 37044 Tours Cedex 9, France
\textsuperscript{b} Service de chirurgie Orthopédique et Traumatologique, Université François-Rabelais, CHRU de Tours, Tours, France
\textsuperscript{c} Pôle Anesthésie Réanimation SAMU, Université François-Rabelais, CHRU de Tours, Tours, France

A R T I C L E   I N F O

Article history:
Accepted 17 July 2014

Keywords:
Chronic postoperative pain
Foot and ankle surgery
Acute postoperative pain
Neuropathic pain

A B S T R A C T

Background: Most studies of chronic postoperative pain focussed on major surgical procedures. Chronic postoperative pain occurred in 10% to 50% of patients and exhibited neuropathic features in 5% to 68% of cases. The objectives of this prospective single-centre study were to determine the rates of occurrence and associated factors of any chronic pain and of neuropathic chronic pain 1 year after orthopaedic surgery on the foot.

Methods: We included consecutive patients who underwent scheduled orthopaedic surgery on the foot or ankle at a university hospital centre between 2009 and 2011. All patients received a multimodal analgesia regimen that usually combined a continuous popliteal sciatic nerve block, paracetamol, and ketoprofen, with additional ketamine if deemed appropriate. A telephone interview was conducted 1 year after the surgical procedure. The main outcome measures were moderate-to-severe pain (numerical rating scale score $>$ 3/10) 1 year after surgery at rest and during walking, and presence of neuropathic pain (defined using the DN2 score). Multivariate analysis was performed to look for associations of various perioperative clinical variables with pain.

Results: One year after surgery, 55 of 260 (21%) patients reported moderate-to-severe pain at rest, 111 (43%) moderate-to-severe pain during walking, and 9 (3%) neuropathic pain. By multivariate analysis, factors independently associated with moderate-to-severe pain at rest and/or during walking 1 year after surgery were moderate-to-severe pain during the first postoperative night ($p=0.048$) and/or day ($p=0.043$) and revision surgery ($p=0.001$).

Discussion: The rate of occurrence of moderate-to-severe pain 1 year after orthopaedic foot surgery is similar to that seen after major surgical procedures, whereas neuropathic pain seems rare. Orthopaedic surgery on the ankle or hindfoot is not more likely to be followed by chronic pain compared to surgery for hallux valgus or toe abnormalities. There is some evidence that earlier surgery might be beneficial.

Level of evidence: IV, prospective observational longitudinal cohort study.

© 2014 Published by Elsevier Masson SAS.

1. Introduction

In 20% of patients referred to specialised centres for chronic pain, surgery is the main aetiological factor. Chronic postsurgical pain (CPSP) is defined as postoperative pain occurring in the absence of an identifiable cause (local complication) and persisting for more than 2 months (the time needed for normal healing to occur) [1]. Most studies of CPSP focussed on major procedures (e.g., thoracotomy and mastectomy) and showed rates of occurrence ranging from 10% to 50% [2,3], with neuropathic features in two-thirds of cases [4]. CPSP often occurs in patients with a history of chronic preoperative pain. Thus, in clinical practice, patients with pain before surgery often continue to report pain after surgery.

In orthopaedic practice, surgery is performed to relieve pain. This fact complicates the assessment of pain persisting after surgery. For instance, 1 year after carpal tunnel surgery, 36% of patients reported pain in the wrist and/or hand on the operated side; pain different from the preoperative pain was reported by 22% of patients and pain similar to the preoperative pain by 12% of patients [5]. In studies of total hip or knee arthroplasty, 28% and 35% of patients, respectively, reported persistent pain 1 year

http://dx.doi.org/10.1016/j.otsr.2014.07.012
1877-0568/© 2014 Published by Elsevier Masson SAS.
after the procedure [6,7]. In another study, 27% and 44% of patients complained of pain 3 to 4 years after total hip or knee arthroplasty, respectively, [8] and the pain exhibited neuropathic features in 1% and 6% of patients, respectively [8]. The amount of perioperative data collected in these studies was usually limited, most notably regarding the analgesia regimen. This point is important since specific postoperative analgesic regimens have been proven to decrease the frequency of chronic pain after total hip arthroplasty [9] or of neuropathic pain after total knee arthroplasty [10]. No published data are available on the rate of occurrence of chronic and/or neuropathic pain after orthopaedic surgical procedures on the foot. Studies of these procedures usually focussed on functional scores to describe outcomes [11–13].

Here, our objectives were to determine the rate of occurrence and associated factors of chronic pain and neuropathic pain 1 year after orthopaedic surgery on the foot.

2. Methods

2.1. Inclusion criteria

We conducted a prospective observational study of patients managed at a single university centre between October 2009 and August 2011. The study did not lead to any changes in standard care and ethics committee approval was consequently not required by French legislation. We nevertheless obtained oral informed consent from all patients during the telephone interview 1 year after surgery.

We included patients who met the two following criteria: surgery involving the hallux and/or lesser toes (phalanges and/or metatarsals), Lisfranc joint, Chopart joint, or ankle; and postoperative analgesia regimen comprising a popliteal perineural catheter or long-duration popliteal nerve block (with ropivacaine). Non-inclusion criteria were surgery that did not involve the bones of the foot and surgery involving the bones of a single lesser toe. Exclusion criteria were harvesting of an iliac bone graft, other concomitant surgical procedure, trauma within the past 15 days, sepsis, patient unable to self-evaluate pain intensity on a simple numerical rating scale (NRS, from 0, no pain; to 10, worst pain imaginable), severely impaired sensory function, and refusal to participate in the study.

2.2. Anaesthesia and analgesia

The anaesthesia and analgesia techniques were chosen during the pre-anaesthesia visit based on the patient’s medical history and wishes. Regional anaesthesia was suggested as the first-line method if the surgeon predicted that the procedure would last less than 90 minutes. Pre-medications included 0.25 to 0.5 mg of alprazolam. In the operating room, the patient’s vital signs were monitored non-invasively.

Continuous regional analgesia was offered routinely and consisted in a continuous popliteal sciatic nerve block. The nerve was identified by stimulation [14] or, starting in October 2010, by ultrasonography with insertion of the needle within the ultrasound field (4–13 MHz 12L-SC probe, Venue 40 ultrasound machine, General Electric Healthcare, Vélizy, France). The needle was then used to inject 20 mL of 0.475% ropivacaine or 2% mepivacaine/0.75% ropivacaine. A non-stimulating catheter (Plexolong 20G, Pajunk, Geisingen, Germany) was introduced 3–5 cm beyond the needle tip then secured to the skin using adhesive tape.

General anaesthesia was induced intravenously (sufentanil 0.2–0.3 μg/kg, propofol 2–3 mg/kg, atracurium 0.5 mg/kg, and ketamine 0.5 mg/kg) then maintained by inhalation of sevoflurane and nitrous oxide.

Regional anaesthesia consisted of femoral and popliteal nerve blocks (20 mL of 2% mepivacaine/0.75% ropivacaine for each block). If deemed necessary by the anaesthesiologist, intravenous sedation could be administered (midazolam 1 mg and sufentanil 5 μg).

All anaesthetic and analgesic procedures were either performed or directly supervised by 1 of 8 anaesthesiologists/intensivists with more than 4 years of experience with orthopaedic surgery.

2.3. Surgical management

The lower-limb veins were emptied and a pneumatic tourniquet was placed at the thigh and inflated to 300 mmHg. At the end of the surgical procedure, a suction drain was usually left in place. All surgical procedures were performed or directly supervised by a senior surgeon.

2.4. Postoperative care

In the post-anaesthesia care unit, intravenous morphine titration was performed in patients with moderate-to-severe pain (defined as a NRS score >3/10). Continuous regional analgesia comprised 0.2% ropivacaine (5 mL/h) via an electronic pump (AmbITM, Sorenson Medical, Salt Lake City, UT, USA) or an elastomomic pump (Infusor LVSTM 300 mL, Baxter, Deerfield, IL, USA). The pumps were weighed and checked at regular intervals [14]. The catheter was clamped on the morning of the second day then removed 6 hours later in the absence of moderate-to-severe pain.

The systemic postoperative analgesia regimen consisted of paracetamol (4 g/d), ketoprofen for 48 h (200–300 mg/d) in the absence of contra-indications (creatinine clearance <30 mL/min, history of gastro-duodenal ulcer, allergy, or asthma induced by non-steroidal anti-inflammatory drugs). The use of ketamine (2 μg/kg/min for 24 h, maximum 250 mg/d) was at the discretion of the anaesthesiologist [15].

Morphine was prescribed as the rescue analgesic and administered either via a patient-controlled intravenous pump (1 mg bolus, refractory period of 7 minutes, maximum dosage 20 mg over 4 h, no continuous administration) or via the oral or subcutaneous route on demand.

At discharge, each patient was given a prescription of paracetamol and an appointment for follow-up radiographs and a surgeon visit 45 days later. At our institution, none of the surgical procedures included in the study were performed on an outpatient basis.

2.5. Collection of clinical perioperative data

The characteristics of the patient, anaesthesia, surgical procedure, and perioperative analgesia were entered in the patient’s anaesthesia record and electronic medical record, as well as by our institution’s electronic prescription software (Actipidos Nursepad 4.2.7, Medicares, Pessac, France).

2.6. Questionnaire used to evaluate chronic pain 1 year after surgery

Each patient was asked to participate in a telephone interview 1 year (±3 months) after the surgical procedure. The interview involved completing the questionnaire shown in Appendix 1. Patients who failed to answer three telephone calls were classified as lost to follow-up. The questionnaire included a self-evaluation of pain intensity using an NRS, identification of the location of the pain in the operated foot at rest and during walking, determination of the DN2 score for neuropathic pain features [16], an assessment of the impact of the pain (use of analgesics, difficulties with footwear, need for walking aids, and global interference with daily life), and identification of postoperative complications.
Patients with a clear recollection of their preoperative pain were asked to complete the same questionnaire for the 2 weeks before surgery and to assess the duration of the preoperative pain.

### 2.7. Statistical analysis

The three main outcome measures were moderate-to-severe pain at rest, moderate-to-severe pain during walking, and neuropathic pain (DN2 score ≥ 3, Appendix 2). These outcome measures were assessed 1 year after surgery.

Quantitative variables were described as mean ± SD and qualitative variables as number (%). Age and NRS pain scores were converted into qualitative variables (≥ vs. < 50 years of age and presence vs. absence of moderate-to-severe pain).

A univariate analysis was performed using the two-sided Fisher’s test to compare qualitative variables. Variables yielding \( P \) values < 0.15 by univariate analysis and available to clinicians in the immediate preoperative and postoperative periods were entered into a multivariate model. Statistical analyses were performed using PASW Statistics 18 software (SPSS Inc., Chicago, IL, USA). Values of \( P < 0.05 \) by multivariate analysis were considered significant.

### 3. Results

#### 3.1. Study population

During the study period, 436 patients underwent foot surgery at our institution, including 382 who met our inclusion criteria. Organisational reasons prevented us from calling 85 of these patients, 1 year after surgery. Of the 297 remaining patients, 37 were lost to follow-up and none declined study participation. Thus, 260 (88%) of the 297 patients called for the 1-year interview were included in our analysis. Among them, 252 clearly recollected their preoperative pain.

#### 3.2. Patient characteristics

Mean age of the 260 patients was 58 ± 14 years and mean body mass index was 26 ± 5 kg/m². There were 185 (71%) women.

Preoperatively, 165 (65%) patients had pain at rest and 233 (93%) during walking. The pain was moderate-to-severe at rest in 116 (46%) patients and during walking in 218 (87%) patients. The mean NRS score was 3.8 ± 3.4 at rest and 6.6 ± 2.7 during walking. Preoperative neuropathic pain was reported by 12 (5%) patients.

The complications listed below were reported by 70 (30%) patients:

- complex regional pain syndrome type I (\( n = 16 \)), with a fatigue fracture in 1 patient;
- infection/abscess (\( n = 12 \)), requiring revision surgery in the operating room in 2 patients and outpatient drainage of an abscess in 1 patient (who subsequently experienced complex regional pain syndrome type I);
- skin complications (wound dehiscence or necrosis) (\( n = 7 \));
- haematoma (\( n = 8 \)) successfully managed without revision surgery;
- neurological complications (\( n = 5 \)), including surgically managed neuroma in 1 patient and sciatic neuropathy related to regional anaesthesia;
- mechanical complications (\( n = 16 \)) consisting of non-union, discomfort related to the material, material breakage, tendinitis, fatigue fracture, and early recurrence of the symptoms or deformities;
- other mild complications (\( n = 17 \)) consisting of delayed awakening, postoperative nausea and/or vomiting, persistent oedema, keloid scar, skin reaction to povidone-iodine, and scar perceived as bothersome.

#### 3.3. Rate of occurrence of pain at rest and during walking 1 year after surgery

After 1 year, 95 (37%) patients reported pain at rest and 164 (63%) during walking (Figs. 1 and 2). Moderate-to-severe pain was present at rest in 55 (21%) patients and during walking in 111 (43%) patients. Neuropathic pain was reported by 9 (3%) patients.

The mean NRS scores were 1.7 ± 2.6 (range, 0–9) for pain at rest and 3.0 ± 3.0 (range, 0–10) for pain during walking. Compared to...
the preoperative pain scores, the pain scores 1 year postoperatively were lower by 2.2–4.2 at rest and by 3.6–3.7 during walking.

3.4. Impact of moderate-to-severe chronic postoperative pain (CPOP) at rest and during walking

Moderate-to-severe CPOP at rest was significantly associated with higher proportions of patients using analgesics (65% vs. 23%, \(P<0.001\)) and step 2 analgesics (27% vs. 7%, \(P<0.001\)), discomfort during everyday activities (85% vs. 35%, \(P<0.001\)), difficulties with footwear (82% vs. 41%, \(P<0.001\)), and need for a walking aid (22% vs. 8%, \(P=0.004\)).

Moderate-to-severe CPOP during walking was significantly associated with the same five factors: higher proportions of patients using analgesics (57% vs. 13%, \(P<0.001\)), step 2 analgesics (23% vs. 3%, \(P<0.001\)), discomfort during everyday activities (80% vs. 17%, \(P<0.001\)), difficulties with footwear (74% vs. 32%, \(P<0.001\)), and need for a walking aid (18% vs. 5%, \(P<0.001\)). In addition, moderate-to-severe CPOP during walking was significantly associated with neuropathic pain (7% vs. 0%, \(P=0.006\)).

3.5. Factors associated with moderate-to-severe chronic postoperative pain (CPOP) 1 year after surgery

By univariate analysis, 10 factors were significantly associated with moderate-to-severe CPOP at rest after 1 year (Table 1). Collinearity was found between preoperative use of analgesics and preoperative use of step 2 analgesics, as well as between highest NRS pain score > 3 during the first postoperative night (8 pm–8 am) and highest NRS pain score > 3 during the first postoperative day (8 am–8 am); in both cases, only the variable yielding the lowest \(P\) value was entered into the multivariate model. In the multivariate model including the perioperative variables (i.e., excluding postoperative complications and complex regional pain syndrome type I), the only factor significantly associated with moderate-to-severe CPOP at rest after 1 year was moderate-to-severe pain (highest NRS pain score > 3) on the first postoperative day (8 am–8 am): odds ratio (OR), 2.0; 95% confidence interval (95%CI), 1.1–3.7; \(P=0.043\). By univariate analysis, 12 factors were significantly associated with moderate-to-severe CPOP during walking after 1 year (Table 2). Collinearity was found between the same two pairs of variables as for CPOP at rest, and only the variables yielding the lowest \(P\) values were entered into the multivariate model (preoperative use of analgesics and highest NRS pain score > 3 during the first postoperative night [8 pm–8 am]). By multivariate analysis including eight perioperative variables (3, 5, 7, 11, 12, 14, 15, and 20 in Table 2), only two variables were significantly associated with moderate-to-severe CPOP during walking, namely, moderate-to-severe pain during the first postoperative night (OR, 2.6; 95%CI, 1.4–4.8; \(P=0.048\)) and revision surgery or surgery after a trauma in the distant past (OR, 3.7; 95%CI, 2.1–6.3; \(P=0.001\)).

4. Discussion

One year after foot surgery, CPOP is common but neuropathic pain is rare. Several hypotheses can be put forward to explain the occurrence of CPOP and to suggest avenues for effective prevention. In our prospective study, 21% of 260 patients reported CPOP at rest and 43% during walking 1 year after foot surgery. These rates of occurrence are similar to those reported after surgical procedures believed to be more aggressive, such as thoracotomy, mastectomy, and arthroplasty [1–3,6,7]. In contrast, the 3% occurrence rate (9/260) of neuropathic CPOP 1 year after surgery is substantially lower than after more aggressive surgical procedures [4]. This rate may have been underestimated by our definition of neuropathic pain based only on the first two questions in the DN4 score, without questions 3 and 4, which require physical examination of the patient [16]. However, the two-question self-report version and the full four–question version have demonstrated closely similar sensitivity (78% vs. 83%) [16]. In contrast to most studies of CPOP, our study involved a detailed description of the intra-operative and postoperative analgesia modalities. Inadequate analgesia would be expected to increase the rate of occurrence of CPOP after 1 year. However, the multimodal analgesic regimen used in our patients was slightly more intensive than currently recommended for foot surgery [9]. Most patients (87%) received regional analgesia [17–20], as recommended since 2003 [1]. Compared to morphine-based analgesia, regional

Table 1

<table>
<thead>
<tr>
<th>Variables</th>
<th>M/S pain at rest after 1 year n = 55</th>
<th>No M/S pain at rest after 1 year n = 205</th>
<th>(P) value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female gender</td>
<td>42 (76)</td>
<td>143 (70)</td>
<td>0.4</td>
</tr>
<tr>
<td>BMI &gt; 30 kg/m²</td>
<td>7 (13)</td>
<td>40 (21)</td>
<td>0.242</td>
</tr>
<tr>
<td>Age &lt; 50 years</td>
<td>18 (33)</td>
<td>41 (20)</td>
<td>0.069</td>
</tr>
<tr>
<td>Preoperative use of analgesics</td>
<td>12 (24)</td>
<td>23 (13)</td>
<td>0.123</td>
</tr>
<tr>
<td>Preoperative use of step 2 analgesics</td>
<td>11 (20)</td>
<td>32 (16)</td>
<td>0.541</td>
</tr>
<tr>
<td>Preoperative need for help with footwear</td>
<td>46 (88)</td>
<td>164 (82)</td>
<td>0.839</td>
</tr>
<tr>
<td>Corticosteroid therapy</td>
<td>4 (7)</td>
<td>14 (7)</td>
<td>1</td>
</tr>
<tr>
<td>Preoperative neuropathy</td>
<td>1 (2)</td>
<td>9 (4)</td>
<td>1</td>
</tr>
<tr>
<td>Inflammatory joint disease</td>
<td>6 (11)</td>
<td>24 (12)</td>
<td>1</td>
</tr>
<tr>
<td>Revision surgery and/or remote trauma</td>
<td>23 (42)</td>
<td>56 (27)</td>
<td>0.047</td>
</tr>
<tr>
<td>Surgery not on hallux and/or lesser toes</td>
<td>28 (51)</td>
<td>67 (33)</td>
<td>0.018</td>
</tr>
<tr>
<td>Preoperative M/S pain at rest</td>
<td>20 (37)</td>
<td>96 (48)</td>
<td>0.166</td>
</tr>
<tr>
<td>Preoperative M/S pain during walking</td>
<td>4 (7)</td>
<td>29 (15)</td>
<td>0.181</td>
</tr>
<tr>
<td>General anaesthesia</td>
<td>47 (89)</td>
<td>151 (74)</td>
<td>0.027</td>
</tr>
<tr>
<td>Analgesia via a popliteal catheter</td>
<td>50 (91)</td>
<td>175 (85)</td>
<td>0.375</td>
</tr>
<tr>
<td>Ketoprofen H0–H24</td>
<td>48 (87)</td>
<td>173 (84)</td>
<td>0.676</td>
</tr>
<tr>
<td>Ketamine IV pump H0–H24</td>
<td>27 (50)</td>
<td>76 (37)</td>
<td>0.088</td>
</tr>
<tr>
<td>PCA morphine H0–H24</td>
<td>41 (75)</td>
<td>37 (18)</td>
<td>0.251</td>
</tr>
<tr>
<td>Highest NRS score D0 8 pm–8 am &gt; 3</td>
<td>18 (33)</td>
<td>37 (19)</td>
<td>0.04</td>
</tr>
<tr>
<td>Highest NRS score D1 8 pm–8 am &gt; 3</td>
<td>24 (44)</td>
<td>56 (29)</td>
<td>0.032</td>
</tr>
<tr>
<td>Postoperative complications</td>
<td>22 (40)</td>
<td>55 (27)</td>
<td>0.068</td>
</tr>
<tr>
<td>CRPS type I</td>
<td>14 (7)</td>
<td>1 (2)</td>
<td>0.206</td>
</tr>
</tbody>
</table>

M/S: moderate-to-severe; BMI: body mass index; H: hour; IV: intravenous; PCA: patient-controlled analgesia; NRS: numerical rating scale; D: day; CRPS: complex regional pain syndrome. *P values associated with Fisher’s exact test. The variables in bold type were entered into the multivariate model. **With or without regional analgesia via a popliteal perineural catheter.

Table 2  
Factors associated with moderate-to-severe pain (M/S pain) during walking 1 year after orthopaedic surgery on the foot or ankle.

<table>
<thead>
<tr>
<th>Variables</th>
<th>M/S pain during walking after 1 year</th>
<th>M/S pain during walking after 1 year</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (%)</td>
<td>n (%)</td>
<td></td>
</tr>
<tr>
<td>Female gender</td>
<td>78 (70)</td>
<td>107 (72)</td>
<td>0.78</td>
</tr>
<tr>
<td>BMI &gt; 30 kg/m²</td>
<td>16 (15)</td>
<td>31 (22)</td>
<td>0.193</td>
</tr>
<tr>
<td>Age &lt; 50 years</td>
<td>32 (29)</td>
<td>27 (18)</td>
<td>0.053</td>
</tr>
<tr>
<td>Corticosteroid therapy</td>
<td>5 (5)</td>
<td>13 (9)</td>
<td>0.23</td>
</tr>
<tr>
<td>Preoperative use of analgesics</td>
<td>62 (63)</td>
<td>62 (49)</td>
<td>0.042</td>
</tr>
<tr>
<td>Preoperative use of step 2 analgesics</td>
<td>21 (22)</td>
<td>14 (11)</td>
<td>0.041</td>
</tr>
<tr>
<td>Preoperative use of a walking aid</td>
<td>26 (24)</td>
<td>17 (12)</td>
<td>0.011</td>
</tr>
<tr>
<td>Preoperative need for help with footwear</td>
<td>86 (81)</td>
<td>122 (84)</td>
<td>0.636</td>
</tr>
<tr>
<td>Neuropathy</td>
<td>4 (4)</td>
<td>6 (4)</td>
<td>0.952</td>
</tr>
<tr>
<td>Inflammatory disease</td>
<td>13 (12)</td>
<td>17 (11)</td>
<td>1</td>
</tr>
<tr>
<td>Revision surgery and/or remote trauma</td>
<td>51 (46)</td>
<td>28 (19)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Surgery not on hallux and/or lesser toes</td>
<td>49 (44)</td>
<td>46 (31)</td>
<td>0.037</td>
</tr>
<tr>
<td>Preoperative M/S pain at rest</td>
<td>46 (43)</td>
<td>70 (48)</td>
<td>0.523</td>
</tr>
<tr>
<td>Preoperative M/S pain during walking</td>
<td>7 (7)</td>
<td>26 (18)</td>
<td>0.008</td>
</tr>
<tr>
<td>General anaesthesia</td>
<td>91 (83)</td>
<td>107 (72)</td>
<td>0.036</td>
</tr>
<tr>
<td>Analgesia via a popliteal catheter</td>
<td>98 (88)</td>
<td>127 (85)</td>
<td>0.582</td>
</tr>
<tr>
<td>Ketoprofen H0–H24</td>
<td>92 (83)</td>
<td>20 (13)</td>
<td>0.483</td>
</tr>
<tr>
<td>Ketamine IV pump H0–H24</td>
<td>46 (42)</td>
<td>57 (38)</td>
<td>0.608</td>
</tr>
<tr>
<td>PCA morphine H0–H24</td>
<td>26 (23)</td>
<td>25 (17)</td>
<td>0.208</td>
</tr>
<tr>
<td>Highest NRS score D0 8 pm–8 am &gt; 3</td>
<td>34 (31)</td>
<td>21 (15)</td>
<td>0.002</td>
</tr>
<tr>
<td>Highest NRS score D1 8 am–8 pm &gt; 3</td>
<td>44 (41)</td>
<td>36 (25)</td>
<td>0.014</td>
</tr>
<tr>
<td>Postoperative complications</td>
<td>45 (41)</td>
<td>32 (21)</td>
<td>0.001</td>
</tr>
<tr>
<td>CRPS type I</td>
<td>13 (9)</td>
<td>2 (2)</td>
<td>0.028</td>
</tr>
</tbody>
</table>

M/S: moderate-to-severe; BMI: body mass index; H: hour; IV: intravenous; PCA: patient-controlled analgesia; NRS: numerical rating scale; D: day; CRPS: complex regional pain syndrome.  
* P values associated with Fisher’s exact test. The variables in bold type were entered into the multivariate model.  
* With or without regional analgesia via a popliteal perineural catheter.

Analgesia improves pain relief [21,22] and allows earlier rehabilitation therapy [23]. The proportion of patients who received regional analgesia in our study was substantially higher than in a nationwide study conducted in France [24]. The systemic multimodal analgesia regimen comprised ketoprofen and paracetamol, often with ketamine. At present, ketamine is recommended only after more aggressive surgical procedures [25]. Despite our intense analgesia regimen, 19% to 44% of patients experienced moderate-to-severe pain within 48 hours after surgery (Tables 1 and 2), suggesting a need for increased attention to implementation of the multimodal analgesia regimen.

Several lines of evidence suggest that pain after orthopaedic foot surgery may differ from typical CPOP [1]. The very high frequency of postoperative pain in our study (65% at rest and 93% during walking), intensive multimodal analgesia regimen, and very low frequency of postoperative neuropathic pain (3%) do not support a causal link between the surgical procedure and the pain reported 1 year later. In most patients, persistence of the preoperative pain is a more likely hypothesis. A high frequency of persistent pain may indicate that surgery was performed at an excessively advanced stage of the disease process [26].

Complex regional pain syndrome type I and surgical complications were not entered into our multivariate model. We chose to focus on variables accessible to clinicians during the perioperative period, that is, assessable before or within 48 hours after the surgical procedure. By multivariate analysis, only two such variables were significantly associated with CPOP. One of these variables was moderate-to-severe pain within 48 hours after surgery. Acute postoperative pain is a well-established risk factor for CPOP [1]. Importantly, in our study, the time of occurrence of moderate-to-severe pain (first postoperative night vs. first postoperative day, Tables 1 and 2) had little influence on the association with CPOP after 1 year. This finding suggests that the analgesic regimen should be administered for a sufficiently long period after surgery and not only during the first few hours. The other variable was prior surgery or trauma of the foot. Taken alone, this finding might suggest a role for sensitisation to pain during the initial insult. However, the low frequency of neuropathic pain makes this explanation unlikely.

A more plausible hypothesis is that prior surgery or trauma is a marker for greater severity of the bone and joint lesions, particularly when previous surgery was required. This hypothesis is consistent with the possibility that surgery was performed at an excessively advanced stage of lesion progression.

An interesting finding from our study is that ketamine administration within the first 24 hours after surgery was not associated with a decreased frequency of moderate-to-severe CPOP after 1 year. This finding is unexpected, since ketamine has been proven effective in relieving acute and chronic pain after total hip arthroplasty [9]. In our study, two reasons preclude definitive conclusions regarding the absence of a beneficial effect of ketamine in relieving pain. First, ketamine therapy was probably reserved for those patients considered at high risk for acute and chronic postoperative pain. Second, a ketamine bolus is administered almost routinely at anaesthesia induction in our department, whereas only the administration of ketamine as a continuous infusion was recorded for our study.

Another negative finding from our study deserves to be highlighted: the frequency of CPOP after 1 year was not lower in the subgroup of patients whose surgical procedure was confined to the hallux or lesser toes. Proximal foot surgery, defined as surgery at sites located between the Lisfranc joint and the ankle, is generally held to be more complex and motivated by more advanced stages of deformities or disease processes (inflammatory disease, post-traumatic osteoarthritis) [20,27] compared to surgery on the hallux or lesser toes. Until future studies of this point become available, our findings suggest a similar risk of CPOP after 1 year in all patients undergoing foot surgery (other than surgery on a single lesser toe). Therefore, the same analgesic regimen should be used in all these patients. This approach raises challenges with adapting the analgesic regimen to outpatient care (most notably, continuous ketamine therapy).

### 5. Conclusion

One year after foot surgery, the rate of occurrence of moderate-to-severe CPOP was similar to that seen after more aggressive procedures, despite an analgesic regimen complying with the best standard of care. This rate was not influenced by the site of surgery (ankle, hindfoot, or hallux/lesser toes). Neuropathic pain was very rare. Several lines of evidence suggest that earlier surgery may be beneficial.
Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

Funding source: Pôle Anesthésie Réanimation SAMU, Hôpital Trousseau, CHRU de Tours, Tours, France

Appendix 1. Questionnaire used for the telephone interview 1 year after orthopaedic surgery on the foot

1. Can you score your pain at rest in the operated foot?
   0 = no pain at all
   10 = worst possible pain
   score: ........................................ /10

2. Can you say where your pain at rest is located in the operated foot?
   ankle, heel, sole, top of the foot, inside of the foot, outside of the foot, big toe (first ray), second toe/ray, third toe/ray, fourth toe/ray, fifth toe/ray

3. Can you score your pain during walking in the operated foot?
   0 = no pain at all
   10 = worst possible pain
   score: ........................................ /10

4. Can you say where your pain during walking is located in the operated foot?
   ankle, heel, sole, top of the foot, inside of the foot, outside of the foot, big toe (first ray), second toe/ray, third toe/ray, fourth toe/ray, fifth toe/ray

5. Does your pain have any of the features listed below?
   burning, painful cold, electric shocks

6. Is the pain associated with one or more of the following symptoms in the same area?
   tingling, pins and needles, numbness, itching

7. Does your pain interfere with your everyday life?
   no, somewhat, to a large extent

8. What analgesics do you take for your foot pain and, on average, how much do you take each day?
   Yes No
   Specify the amount per day
   □ paracetamol ........................................
   □ dextropropoxyphene + paracetamol ........................................
   □ paracetamol + codeine ........................................
   □ tramadol or similar ........................................
   □ NSAID: name........................................
   □ other: name........................................

9. To walk, do you use
   no aid, help from another person, one crutch, two crutches, a walker; or are you unable to walk (confined to an armchair)

10. Do you have difficulty putting on your shoe on the operated side?
    no difficulty, some difficulty (but ‘normal’ footwear), major difficulties (custom-made footwear)

11. Did you experience any complications after the operation?
    infection, wound dehiscence, haematoma, complex regional pain syndrome, other: please specify

12. Did you experience any complications after the anaesthesia? (please specify)
    prolonged anaesthesia, prolonged paralysis, painful sequelae, other: please specify

13. Do you remember the pain you had before the operation?
    yes, no
    IF YES
    14. Can you score your pain at rest in the operated foot?
        0 = no pain at all
        10 = worst possible pain
        score: ........................................ /10
    15. Can you say where your pain at rest was located in the operated foot?
        ankle, heel, sole, top of the foot, inside of the foot, outside of the foot, big toe (first ray), second toe/ray, third toe/ray, fourth toe/ray, fifth toe/ray
    16. Can you score your pain during walking in the operated foot?
        0 = no pain at all
        10 = worst possible pain
        score: ........................................ /10
    17. Can you say where your pain during walking was located in the operated foot?
        ankle, heel, sole, top of the foot, inside of the foot, outside of the foot, big toe (first ray), second toe/ray, third toe/ray, fourth toe/ray, fifth toe/ray
    18. Did your pain have any of the features listed below?
        burning, painful cold, electric shocks
    19. Was the pain associated with one or more of the following symptoms in the same area?
        tingling, pins and needles, numbness, itching
    20. What analgesics did you take for your foot pain and, on average, how much did you take each day?
        Yes No
        Specify the amount per day
        □ paracetamol ........................................
        □ dextropropoxyphene + paracetamol ........................................
        □ paracetamol + codeine ........................................
        □ tramadol or similar ........................................
        □ NSAID: name........................................
        □ other: name........................................
    21. To walk, did you use
        no aid, help from another person, one crutch, two crutches, a walker; or are you unable to walk (confined to an armchair)
    22. Did you have difficulty putting on your shoe on the side where you subsequently had the operation?
        no difficulty, some difficulty (but ‘normal’ footwear), major difficulties (custom-made footwear)
    23. When did you have pain in the foot on the side where you subsequently had the operation?
        At rest: ........................................ during walking: ........................................

Appendix 2. Determination of the DN2 score (or seven-item DN4 score)

The DN2 score is based on the responses to the following two questions.

1. Does the pain have one or more of the following characteristics?
   burning, painful cold, electric shocks

2. Is the pain associated with one or more of the following symptoms in the same area?
   tingling, pins and needles, numbness, itching

The DN2 score is the number of symptoms present among the seven above-listed symptoms. Neuropathic pain is defined as a DN2 score equal to or greater than 3, i.e., as the presence of at least three of the seven above-listed symptoms [16].

[16]
References