Pain after Cardiac Surgery

A Prospective Cohort Study of 1-Year Incidence and Intensity

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**Background:** Persistent chest pain may originate from cardiac surgery. Conflicting results have been reported on the incidence of persistent poststernotomy pain with considerable discrepancies between the retrospective reports and the one prospective study conducted to assess this pain. Therefore, the authors conducted a follow-up survey for the first 12 months after cardiac surgery in 213 patients who had a sternotomy.

**Methods:** The authors performed a prospective inquiry of acute and chronic poststernotomy pain both before and after cardiac surgery. Two hundred thirteen coronary artery bypass patients received a questionnaire preoperatively, 4 days postoperatively, and 1, 3, 6, and 12 months postoperatively. All patients were asked about their expectations, their preferences, and the location and intensity of postoperative pain.

**Results:** The return rates for the postal questionnaires were 203 (95%) and 186 (87%) after 1 and 12 months, respectively. Patients experienced more pain postoperatively at rest than they had expected to preoperatively. At rest, the worst actual postoperative pain was 6 (0–10), and the worst expected pain as assessed preoperatively was 5 (0–10) (P = 0.013). The worst reported postoperative pain was severe (numeric rating scale score 7–10) in 49% at rest, in 78% during coughing, and in 62% of patients on movement. One year after the operation, 26 patients (14%) reported mild chronic poststernotomy pain at rest, 1 patient (1%) had moderate pain, and 3 patients (2%) had severe pain. Upon movement, persistent pain was more common: 45 patients (24%) had mild, 5 patients (3%) had moderate, and 7 patients (4%) had severe pain. Patients who experienced mild chronic postoperative pain also reported any chronic poststernotomy pain (numeric rating scale score 1–10) more frequently.

**Conclusions:** Although common, the incidence of persistent pain after sternotomy was lower than previously reported. Also, reassuringly, 1 year after surgery this pain was mostly mild in nature both at rest and on movement.

PAIN after surgery may persist well after wound healing has taken place, and in some patients, chronic pain ensues after the operation. After cardiac surgery, the reported incidence of chronic poststernotomy pain varies from 21 to 56% according to various studies. This large variability between studies seems to result from heterogeneity in both the definition of pain and the patient populations, as well as the retrospective nature of most of the investigations. To our knowledge, there is only one prospective study of chronic poststernotomy pain after cardiac surgery.

Persistent poststernotomy pain may correlate with the severity of pain during the first days after surgery. Prospective studies regarding the intensity of pain and quality of postoperative analgesia after cardiac surgery are scarce. In one study, postoperative pain was moderate, but unfortunately only the mean of the maximal pain values were reported. Likewise, little is known about patients’ attitudes and expectations regarding postoperative pain and recovery after cardiac surgery. However, these may be important issues contributing to patient’s satisfaction with their treatment.

To evaluate the incidence and intensity of pain, as well as the patient’s expectations and recovery after sternotomy, we designed this prospective follow-up study. We inquired about preoperative attitudes, expectations, and perception and the location and time course of acute postoperative and persistent poststernotomy pain in 213 patients undergoing coronary artery bypass grafting (CABG). The follow-up was up to 12 months after surgery.

We hypothesized that the incidence of persisting poststernotomy pain at 1 yr after surgery would be lower in a prospective survey compared with retrospective studies because regular follow-up enhances the reliability and return rate of the questionnaires.

**Materials and Methods**

This study was approved by the Institutional Review Board at the University of Kuopio, Kuopio, Finland, and conducted in accordance with the latest revision of the Declaration of Helsinki. All patients were informed and gave written consent. Patients scheduled to undergo primary elective CABG with cardiopulmonary bypass and who were younger than 70 yr were considered eligible for the study. All patients who were unable to express themselves verbally or who were unable to fill out the questionnaires were excluded. Reoperated patients were not excluded.

Two hundred thirty-one patients were given the pain questionnaire by one of the investigators (P.L.) 1 day before surgery was scheduled to obtain the preoperative
information. On the fourth postoperative day, while still hospitalized, patients completed the first postoperative questionnaire by themselves with guidance from a study nurse, if requested. Questionnaires were sent to patients via postal mail 1, 3, 6, and 12 months after the operation and were to be returned in a prepaid envelope. The patients who did not return postal questionnaires were contacted once by phone and asked whether they could still participate in the study or whether they wished to discontinue.

Pain was assessed with a numeric rating scale (NRS) at rest, during coughing, and on movement using an 11-point scale with 0 labeled as “no pain” and 10 as “worst pain imaginable.” Pain was classified as mild with a score of 1–3, moderate with scores of 4–6, and severe with scores of 7–10. Before the operation, the patients were asked how much pain they anticipated having after surgery. Before and after the operation, the patients were asked how much pain they were willing to accept without medication. After the operation, the actual pain levels were assessed. Patients were also instructed to report the presumed location of pain on a specific body picture preoperatively, and the actual location of pain postoperatively. Pain relief by medication and the overall satisfaction with analgesia were measured with the NRS score with a score of 0–3 indicating poor pain relief and dissatisfaction, 4–6 indicating moderate relief, and 7–10 indicating good pain relief and satisfaction with analgesia. The expected and actual adverse effects of pain medication before (presumed) and after surgery, respectively, were recorded.

All patients received a similar anesthesia protocol that is routinely used in our department. The anesthetic drug doses per protocol were 0.15–0.25 mg/kg diazepam, up to 20 mg cumulative dose, given as oral premedication. For induction of anesthesia, the patients received 1–2 mg/kg propofol, 7–10 μg/kg fentanyl, or alternatively 1.5–3.0 μg/kg sufentanil, 0.1 mg/kg midazolam, and 0.1 mg/kg pancuronium. Anesthesia was maintained with a continuous infusion of 2–4 mg · kg⁻¹ · h⁻¹ propofol until the end of surgery. Isoflurane supplementation was used at the discretion of the attending anesthesiologist. The postoperative analgesia regimen was 0.1 mg/kg intramuscularly administered oxycodone based on patient request. Acetaminophen (paracetamol) and acetaminophen–codeine tablets (500 mg acetaminophen–30 mg codeine) were used as adjunctive analgesics, but few patients received nonsteroidal antiinflammatory drugs. For pain treatment after discharge, all the study patients were given a prescription for tramadol, acetaminophen, or acetaminophen–codeine with a nonsteroidal antiinflammatory analgesic (ibuprofen or ketoprofen).

The operation consisted of a standard midline sternotomy, with harvesting of the saphenous vein and internal thoracic artery (ITA) as indicated. The ITA was harvested by using a retractor on one side of the sternum (usually the left) of all patients. Saphenous vein harvesting from the calf was accomplished using a standard open incision. Antegrade intermittent cold crystalloid cardioplegia was used, and patients were cooled to 34°C and then warmed to 36.5°C before decannulation. Cardiopulmonary bypass was conducted using membrane oxygenation. The sternotomy was closed with five or six sternal wires, and the skin incision was closed with intracutaneous stitches. Mediastinal and thoracic drains were passed through the rectus abdominis muscles just below the xiphoid area. Propofol sedation (2–4 mg · kg⁻¹ · h⁻¹) was continued in the postanesthesia care unit until the peripheral temperature exceeded 32°C, after which it was discontinued and weaning from the respirator was started.

Statistical Analysis

No formal sample size calculation was performed. We hypothesized that 200 analyzable patients would be an adequate number to obtain a good estimate of an average CABG patient with a reported incidence of persistent pain of 28%. Assuming that approximately 85% of the patients included would be available for analysis, 231 patients were included.

Because of the small number of patients with chronic pain, the associations of various risk factors with chronic pain were tested with Fisher exact test (categorical variables) and included sex, diabetes, smoking, New York Heart Association classification, postoperative complications, and operative variables.

Comparison of pain scores over time was performed using the Friedman test. Multiple comparisons of consecutive chronic poststernotomy pain scores were performed using the Wilcoxon signed-rank test. Comparison of assumed and actual pain location was performed with the McNemar test. A P value of less than 0.05 was considered statistically significant. Results are given as median (range) or number of patients (percentage of patients) where appropriate. All statistical analyses were performed with SPSS version 11.01 software (SPSS Inc., Chicago, IL).

Results

Two hundred thirty-one patients were included, but 18 were excluded for the following reasons: lost questionnaire (n = 12), operation cancelled (n = 2), and inability to complete the questionnaire because of postoperative complications or intensive care unit admission (n = 4). Hence, 213 patients (92%) who completed the first postoperative questionnaire on the fourth day after surgery were included in the analysis. The return rates for the postal questionnaires in these 213 patients after 1, 3, 6, and 12 months were 203 (95%), 187 (88%), 180 (85%), and 186 (87%), respectively. Three patients died
during the follow-up period, and other nonresponders withdrew their consent.

Patients were mostly male (83%), and 84% of all patients were overweight (body mass index > 25 kg/m²), including 34% who were considered obese (body mass index > 30 kg/m²). Patient characteristics are described in Table 1. There was no hospital mortality. Postoperative complications (cardiac arrhythmias not included) occurred in 35 patients (16%) (table 2). One patient was transferred postoperatively to the intensive care unit, and there were 2 readmissions to the intensive care unit due to respiratory insufficiency. Most patients (99%) spent 1 day in the postanesthesia care unit. Two patients needed 2 postoperative days and one patient needed 3 postoperative days in the postanesthesia care unit.

Preoperative Questionnaire (Attitudes and Expectations)

As assessed preoperatively, the intensity of postoperative pain the patients were willing and expected to experience is shown in Table 3. The pain the patients were willing to accept without medication after surgery was mild at rest and only slightly higher during coughing and on movement (table 4). Only 14 patients (7%) still experienced severe postoperative pain, whereas in 143 patients (67%) the pain was mild or moderate, and 56 patients (26%) were pain free at rest.

Table 1. Demographics, Operative Data, and Risk Factors

<table>
<thead>
<tr>
<th>Sex, male/female, n</th>
<th>176/37</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, yr</td>
<td>58 ± 7</td>
</tr>
<tr>
<td>Height, cm</td>
<td>171 ± 7</td>
</tr>
<tr>
<td>Weight, kg</td>
<td>84 ± 14</td>
</tr>
<tr>
<td>BMI, kg/m²</td>
<td>29 ± 4</td>
</tr>
<tr>
<td>NYHA I/II/III/IV/unknown, n</td>
<td>5/64/90/53/1</td>
</tr>
<tr>
<td>Coronary grafts, 2/3/4/5/6/7</td>
<td>13/67/74/37/20/2</td>
</tr>
<tr>
<td>Diabetics, none/type 1/type 2</td>
<td>167/4/42</td>
</tr>
<tr>
<td>Smoking, never/active/ex-smoker/unknown</td>
<td>89/48/63/13</td>
</tr>
</tbody>
</table>

Values are mean ± SD or number of patients.

BMI = body mass index; NYHA = New York Heart Association classification of severity of coronary heart disease.

The expected worst and average postoperative pain at rest, during coughing, and on movement was worse than the pain the patients were willing to accept without medication ($P < 0.001$) (table 3).

With regard to expected pain location as evaluated by the preoperative questionnaire, 167 patients (78%) expected to have postoperative pain in the chest, 60 patients (28%) in the leg, 35 patients (16%) in the back, and 24 patients (11%) in the shoulder.

Although the overall patient population hoped for a pain relief score of 9 (0–10) after taking the medication, only 45 patients (21%) hoped that the pain medication would eliminate all pain.

Postoperatively, 127 patients (60%) believed that pain medication did not have any adverse effects. Among the 86 patients (40%) who assumed any adverse effects from the medication, the most commonly expected adverse effects were confusion (7%), fatigue (7%), and abdominal pain (5%). Only 3% believed that the pain medication causes nausea, and only 2% thought that vomiting would occur.

Postoperative Questionnaire (Completed on the Fourth Postoperative Day)

On the postoperative day 4, the intensity of pain the patients were willing to accept without medication was mild and did not differ from the preoperative values at rest ($P = 0.087$), during coughing ($P = 0.27$), or on movement ($P = 0.17$) (data not shown).

The worst pain experienced within the first 4 postoperative days was moderate at rest, and severe during coughing and on movement (table 4).

Patients experienced more pain postoperatively at rest than they had expected to preoperatively. At rest, the worst actual postoperative pain was 6 (0–10), and the worst expected pain as assessed preoperatively was 5 (0–10) ($P = 0.013$). The worst actual pain during coughing and on movement did not differ from the preoperative assumption ($P = 0.14$ and 0.65, respectively). The worst postoperative pain was severe (NRS score 7–10) at rest in 49%, during coughing in 78%, and on movement in 62% of patients (fig. 1).

Postoperatively, 42 patients (20%) reported adverse events from the pain medication ($P = 0.522$ compared with expected). The most common actual adverse events were the same as those that were expected; 9 patients (4%) had nausea, 5 (2%) had abdominal pain, 5 (2%) had fatigue, and 4 (2%) had confusion.

Up to postoperative day 4, pain was relieved to mild at rest and on movement, and to moderate during coughing (table 4). Only 14 patients (7%) still experienced severe postoperative pain, whereas in 143 patients (67%) the pain was mild or moderate, and 56 patients (26%) were pain free at rest.
On postoperative day 4, 160 patients (75%) had chest, 40 (19%) had leg, 29 (14%) had shoulder, and 20 (9%) had back pain. There was no difference between the responses on the preoperative and postoperative questionnaires with regard to the number of patients having chest and shoulder pain ($P = 0.39$ and 0.51, respectively). The number of patients who had actual leg and back pain was smaller than the number who presumed they would have it preoperatively ($P = 0.022$ and 0.032, respectively). Twenty and 15 patients who thought they would have leg and back pain, respectively, did not report it postoperatively.

One hundred eighty-six patients (87%) thought that the pain medication administered to them provided good (NRS score $\geq 6$) pain relief, with only 7 patients (3%) disagreeing and who rated the efficacy as poor (NRS score $\leq 3$) after the operation.

Overall satisfaction with analgesia (before leaving hospital) was good (NRS score $\geq 6$) in 197 patients (92%), but 3 patients (1%) were unsatisfied (NRS score $\leq 3$) with the pain management.

Postoperative Questionnaire (Completed at 1, 3, 6, and 12 Months after Surgery)

After the first 4 weeks (1 month), the reported median pain values were mild at rest, during coughing, and on movement, although the individual variation remained substantial during the whole follow-up time (table 4). There was a significant decline in poststernotomy pain at rest and on movement up until 6 months postoperatively ($P < 0.001$), but there was no difference between pain scores reported at 6 and 12 months ($P = 0.68$).

At 1 month, 117 (58%) patients had chest pain, 40 (20%) had leg pain, and 28 (14%) had pain at both locations. At 1 yr, 73 (39%) patients had chest pain, 22 (12%) had leg pain, and 13 (7%) had pain at both locations.

The chest pain was described as burning in 12%, tender in 59%, and numbness in 30% of cases, and the leg pain was described as tender in 47% and numbness in 49% cases.

After hospital discharge, 91% of patients used analgesics; of those, 60% used opioid (tramadol or codeine for a median of 4 days) and 75% used nonopioid analgesics.

### Table 3. Preoperative Expected Intensity of Chest Pain after CABG at Rest, during Coughing, and on Movement on an 11-Point Numeric Rating Scale*

<table>
<thead>
<tr>
<th></th>
<th>At Rest</th>
<th>During Coughing</th>
<th>On Movement</th>
<th>$P$ Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain willing to accept without medication</td>
<td>3 (0–8)</td>
<td>4 (0–9)</td>
<td>4 (0–10)</td>
<td></td>
</tr>
<tr>
<td>Expected—worst</td>
<td>5 (0–10)</td>
<td>8 (0–10)</td>
<td>7 (0–10)</td>
<td>$&lt; 0.001$</td>
</tr>
<tr>
<td>Expected—average</td>
<td>4 (0–8)</td>
<td>6 (0–10)</td>
<td>6 (0–10)</td>
<td>$&lt; 0.001$</td>
</tr>
</tbody>
</table>

Values are median (range). $P$ values are differences between the scores of acute postoperative pain the patients were willing to accept without medication and those they expected to have at worst and on average (Wilcoxon signed-rank test).

*0 = no pain, 10 = worst pain.

CABG = coronary artery bypass grafting.

### Table 4. Intensity of Chest Pain after CABG at Rest, during Coughing, and on Movement on an 11-Point Numeric Rating Scale*

<table>
<thead>
<tr>
<th></th>
<th>At Rest</th>
<th>During Coughing</th>
<th>On Movement</th>
<th>$P$ Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average postoperative</td>
<td>5 (0–10)</td>
<td>7 (0–10)</td>
<td>6 (0–10)</td>
<td></td>
</tr>
<tr>
<td>Worst postoperative</td>
<td>6 (0–10)</td>
<td>8 (2–10)</td>
<td>7 (0–10)</td>
<td></td>
</tr>
<tr>
<td>Fourth postoperative day</td>
<td>2 (0–10)</td>
<td>5 (0–10)</td>
<td>3 (0–10)</td>
<td></td>
</tr>
<tr>
<td>1 Month</td>
<td>1 (0–8)</td>
<td>3 (0–10)</td>
<td>2 (0–9)</td>
<td>$&lt; 0.001$</td>
</tr>
<tr>
<td>3 Months</td>
<td>0 (0–8)</td>
<td>1 (0–8)</td>
<td>1 (0–8)</td>
<td>$&lt; 0.001$</td>
</tr>
<tr>
<td>6 Months</td>
<td>0 (0–8)</td>
<td>0 (0–8)</td>
<td>0 (0–8)</td>
<td>$&lt; 0.001$</td>
</tr>
<tr>
<td>12 Months</td>
<td>0 (0–8)</td>
<td>0 (0–7)</td>
<td>0 (0–8)</td>
<td>0.88</td>
</tr>
</tbody>
</table>

Values are median (range). $P$ values are differences between consecutive questionnaires of chronic postoperative pain at rest and on movement (Wilcoxon signed-rank test).

*0 = no pain, 10 = worst pain.

CABG = coronary artery bypass grafting.
have any chronic poststernotomy pain (NRS score 1–10) at rest 1 yr ($P = 0.042$) after the operation.

New York Heart Association classification ($P = 0.626$), diabetes ($P = 0.164$), sex ($P = 0.140$), smoking ($P = 0.525$), and postoperative complications ($P = 0.351$) were not associated with chronic pain after 1 yr.

Patients recalled the intensity of the worst postoperative pain as moderate even 12 months after surgery, although the recalled pain level was slightly but significantly less than the pain level measured on postoperative day 4, reported as 5 (0–10) and 6 (0–10) at rest, respectively ($P = 0.001$).

### Discussion

In this prospective follow-up study, persistent poststernotomy chest pain was common, with 30 patients (17%) reporting chest pain at rest and 57 patients (31%) reporting pain on movement 1 yr after cardiac bypass surgery. However, moderate and severe pain was infrequent, with only 4 patients (3%) reporting moderate to severe pain at rest and 12 patients (7%) reporting it on movement 1 yr after CABG surgery.

Our results agree with those from a previous prospective study where the incidence of persistent pain was 28% 12 months after cardiac surgery. In the previous study, the pain intensity, when it persisted, was mostly mild, with the visual analog scale score reported as 30 mm or less in 90% of patients at minimum and in 49% at maximum. Both prospective series, i.e., the previous one and the current one, found that persistent poststernotomy pain is common but seldom severe 1 yr after surgery.

In retrospective inquiries, the incidence or prevalence of poststernotomy chronic pain has been reported as 38–56%, which is two to three times higher than in the current prospective study. In disagreement with our results, the intensity of pain reported 12 months after surgery in the retrospective analyses was moderate or severe in 38–66% of patients compared with the corresponding figures of 3% and 7% at rest and on movement, respectively, found in the current study. There may be various reasons for this discrepancy. The most likely explanation for differences in the results are the differences in the timing of the questionnaires, the nature of the data collection (retrospective or prospective), heterogeneous patient populations, and the definition of the presence of chronic pain (prevalence or incidence). Furthermore, the patient cohort in the current study was younger than those included in the previous reports. Therefore, the decreased incidence and severity of persistent pain was unexpected, because previous results indicated that persistent pain after sternotomy is more common among younger (< 70 yr old) patients than in elderly patients. The younger age of...
our patient cohort may also explain the more intensive acute postoperative pain found in our study than in previous reports.5,11

The incidence of persisting severe chest pain of 2–4% 1 year after cardiac surgery was observed both in the current study and in the two previous ones.2,5 This incidence could be used when counseling and planning rehabilitation resources for pain clinics.

In the current survey, the return rate of the postal questionnaires was high, with at least 85% participation during the whole follow-up period. Also, the homogeneous patient population, prospective design, and the exact timing of each consecutive questionnaire improved the reliability of our study compared with previous ones. Patients were able to recall the postoperative pain they had experienced quite precisely, even 12 months after surgery. Therefore, we believe the results of the current study are soundly based, and not biased due to an inappropriate response rate or an inability to recall the pain experience.

The etiology of chronic pain after cardiac surgery is ambiguous. Although grafting of the ITA has been reported to increase the frequency of persistent discomfort,13 the overall incidence of chronic pain was lower in our study than that previously reported,2,5 even though the ITA was used in all our patients. Therefore, it seems unlikely that ITA dissection is the cause of chronic pain after cardiac surgery, which is in agreement with that suggested previously by Kalso et al.2

It has been stated that the severity of acute postoperative pain is a predictor for long-lasting pain.1 In agreement with this, the patients in the current study who had moderate or severe acute postoperative pain experienced more frequent chronic poststernotomy pain 1 yr after the operation. However, we were unable to identify a significant association between severe acute postoperative pain and chronic pain after sternotomy.

The inability to distinguish between different pain types was a limitation of the current study, i.e., somatic versus neuropathic pain, or visceral versus scar pain. We considered it impractical to include the differentiating questions necessary for this distinction in a large postal questionnaire. In self-reported pain studies, the distinction of poststernotomy pain from recurrent angina was found to be difficult. In the current study, all patients with moderate or severe pain at rest 1 yr after surgery were interviewed by telephone by one of the investigators (P.L.). Only one of the patients with severe pain was considered to have recurrent angina pectoris and was advised to seek a cardiology consultation. Also a limitation of our study is that we did not inquire about social consequences of persisting pain. However, every 10th patient reported that pain disturbed their sleep from 3 to 12 months postoperatively.

The amount of pain patients are willing to accept after surgery is not well described in the literature. In the current study, half of the patients reported that they were willing to accept only mild pain at rest, as well as during coughing, and on movement after the sternotomy. However, only 5% of patients expected to be pain free postoperatively, and only a minority hoped that the pain medication would provide complete pain relief. Some patients considered pain to be a beneficial alarm against movements that were too strenuous, or stated that they were willing to accept some pain because of their high pain tolerance.

The patients in our study expected that the pain medication would provide efficient postoperative pain relief. However, we did not offer sufficient pain relief with intramuscular opioid injections to our patients. Although the patients anticipated more intensive postoperative pain than they reported they were willing to accept, the intensity of acute postoperative pain was unexpectedly severe; in the current study, two thirds of the patients experienced moderate or severe postoperative pain at rest during the first few days. The intramuscular route is not optimal for acute pain management because drug absorption via this route is unpredictable. Most CABG patients are overweight (84% in the current study), and therefore, the depth of subcutaneous fat could be a significant factor. Because the blood flow to fat is minimal, drug absorption would have been minor if the intended intramuscular dose had been injected into fat. We suggest that more effective analgesic techniques such as intravenous patient-controlled analgesia opioids, local or regional analgesics, or multimodal techniques are warranted in the first few days postoperatively.14–16 Accordingly, we have recently tested propacetamol17 and 5-ketamine18 as adjuncts to patient-controlled analgesia opioid–based pain therapy after cardiac surgery, and that approach has been more successful.

The patients in the current study were surprisingly naive about the potential adverse effects of pain medications. Most patients believed that the pain medication would not cause any side effects. This fact has implications with regard to preoperative patient counseling regarding postoperative pain therapy. Potential adverse effects of analgesics, i.e., nausea and vomiting with opioids, should be discussed with the patient by the anesthesiologist in charge.

In conclusion, acute postoperative pain was severe in the majority of study patients after cardiac surgery. Most patients experienced moderate to severe pain that was more severe than they expected or were willing to tolerate. Also, persistent poststernotomy chest pain was common 1 yr after surgery, but reassuringly, it was more infrequent and less severe in this prospective study than has been reported in previous retrospective studies.
The authors thank Petri Toroi, R.N., Timo Tuovinen, R.N., and the nursing staff of the postanesthesia care unit and cardiac surgical ward of Kuopio University Hospital (Kuopio, Finland) for invaluable collaboration on this study.

References