Mini-CAT Presentation: PCA vs Non-PCA in Postoperative Hip Replacement Patients

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Clinical Scenario:
Your orthopedist supervising physician has asked you to help out with the research on a presentation she is to give next week on patient controlled analgesia (PCA) in adult post-op total hip replacement patients. She needs to know how effective PCA is compared to PRN (as needed) IM pain medication.

Patient Controlled Analgesia (PCA) Pain Pump

Clinical Question:

In adult post–op total hip replacement patients, how does patient-controlled analgesia (PCA) compare with PRN IM pain medication in improving postoperative pain control and patient satisfaction?

PICO Search Terms

Patient/Population	Intervention	Comparison	Outcome
Total hip replacement	Patient controlled analgesia	PRN analgesia	Pain control
Post operative patients	PCA	As needed analgesia	Pain management
Post op patient		IM pain medication	Patient satisfaction
		Intramuscular analgesia	Post op recovery

Summary of Search Strategy

Terms used:

- Post operative patient AND patient controlled analgesia
- Total hip replacement AND pain control
- Post op patient AND pain management

Databases searched:

- PubMed:
  - Search criteria gave 1,763 results, after filters were applied, results were narrowed down to 552.
  - We skimmed through the first 30-40 articles and 5 articles were chosen from this database.
- Trip Database:
  - Search criteria gave 331 results, results were narrowed down to 115 after filters were applied.
  - The articles from Trip Database were not specifically applicable to our clinical question.

Articles Used: PubMed- 5 articles

Appraised Articles

1. Intravenous patient-controlled analgesia vs nurse administered oral oxycodone after total knee arthroplasty: a retrospective cohort study. (Lahtinen et al., 2020)
2. The Effectiveness of Patient-Controlled Analgesia in Orthopedic Joint Replacements: A Systematic Review (Altamimi et al., 2025)
3. Patient controlled opioid analgesia versus non-patient controlled opioid analgesia for postoperative pain (McNicol, Ewan et al., 2015)
4. Patient-Controlled Epidural Analgesia or Multimodal Pain Regimen with Periarticular Injection After Total Hip Arthroplasty (Jules-Elysee et al. 2015)
5. Pain therapy following joint replacement. A randomized study of patient-controlled analgesia versus conventional pain therapy. (Forest et al., 1999)

Intravenous Patient-Controlled Analgesia vs Nurse Administered Oral Oxycodone After Total Knee Arthroplasty: A Retrospective Cohort Study

Criteria:

- Patients were 75 years old or younger
- ASA Physical Status I–III
- No preoperative use of strong opioids
- Exclusion criteria: renal insufficiency, liver failure, bilateral TKA, or use of an epidural catheter or femoral nerve block in post-operative pain management

Methods:

- Retrospective cohort study including 164 total subjects
- Setting: HUS Helsinki University Hospital
- Patient cohort: Adults who underwent Total Knee Arthroplasty (TKA) for osteoarthrosis between 2016–2017
- Subjects divided into two groups:
    - 82 patients received oxycodone via intravenous PCA devices (Intervention group)
    - 82 patients received oral pain medication administered by nurses (Control group)

Procedures:

- Primary outcome measured: **total opioid consumption during the first 24 hours after surgery**, calculated as IV morphine-equivalent doses
- Secondary outcomes included: use of **anti-emetic medication, Length of Stay (LOS), and evaluation of opioid-related adverse event reports**

Intravenous Patient-Controlled Analgesia vs Nurse Administered Oral Oxycodone After Total Knee Arthroplasty: A Retrospective Cohort Study

Results

1. **Opioid Consumption (Primary Outcome):**
   The median opioid consumption during the first 24 post-operative hours was statistically similar between the two groups. Median dose was 41.1 mg (IQR: 29.5–69.1 mg) in the PCA group and 40.5 mg (IQR: 32.4–48.6 mg) in the control group (p=0.35).
2. **Opioid Variation:**
   The interquartile range of opioid doses was significantly wider in the PCA group compared to the control group (p=0.005). This wider variation may indicate that some control group patients did not receive sufficient pain medication, or some PCA patients took unnecessarily large doses.
3. **Antiemetic Use:**
   The use of anti-emetic medication was similar in both groups (p=0.86), suggesting that PCA did not increase nausea or vomiting.
4. **Length of Stay (LOS):**
   The median LOS was statistically significantly shorter in the PCA group (2 days; IQR: 2–3 days) compared to the control group (3 days; IQR: 2–3 days) (p=0.02).

Intravenous Patient-Controlled Analgesia vs Nurse Administered Oral Oxycodone After Total Knee Arthroplasty: A Retrospective Cohort Study

Limitations of this study:

1. **Selection Bias:** This was the most important limitation due to the lack of randomization.
2. **Intervention Group Status:** Patients in the PCA group were recruited from another randomized trial, which may have resulted in a more standardized treatment regimen than the retrospectively selected control group.
3. **Blinding:** Neither participants nor caregivers were blinded.
4. **Missing Variables:** Pain intensity, nausea severity, and patient satisfaction could not be measured
5. **Adverse Events:** The sample size was not sufficient to confirm rare opioid-related adverse events.

The Effectiveness of Patient-Controlled Analgesia in Orthopedic Joint Replacement: A Systematic Review

Study Overview:

- Systematic Review of RCTS- 11 studies with a total of 1,396 participants
- Patients 19-96 y/o undergoing orthopedic joint replacement (hip and knee)
- Multiple international clinical trials across the USA, Japan, China, UK, South Korea, Italy, Czech Republic

Methods:

- Identified RCTs evaluating PCA vs non-PCA analgesia
- Groups:
  - PCA-based analgesia groups (unspecified IV PCA, IV morphine, IV fentanyl + droperidol, IV oxycodone, and sublingual sufentanil)
  - Non-PCA based analgesia (IM opioid injections as needed, oral prolonged-release oxycodone-naloxone, continuous femoral nerve block, single-shot nerve blocks, IV acetaminophen, continuous epidural analgesia, multimodal
- Inclusion Criteria: RCTs using PSA for postoperative pain that reported outcomes including pain control, opioid use, satisfaction, or hospital stay
- Exclusion Criteria: Non-RCTs, RCTs not involving joint replacement, RCTs not using PCA, non-pharmacological intervention only studies, and those published in a language other than English

The Effectiveness of Patient-Controlled Analgesia in Orthopedic Joint Replacement: A Systematic Review

Primary Outcomes:

- Pain control/pain intensity- measured by visual analogue scale (VAS) or Numeric Rating Scale (NRS) at at 0-24 hours, 25-48 hours and 49-72 hours
- Opioid consumption (total postoperative dose used)

Secondary Outcomes:

- Opioid consumption
- Patient satisfaction
- Length of hospital stay time to mobilization
- Side effects/adverse events related to analgesia (respiratory depression, sedation, nausea, vomiting)

The Effectiveness of Patient-Controlled Analgesia in Orthopedic Joint Replacement: A Systematic Review

Results

1. PCA provides effective pain control after orthopedic joint replacement, with most studies reporting lower pain scores at rest and during mobilization compared to non-PCA methods.
2. Opioid consumption was often lower or more efficiently managed with PCA, although some studies reported similar total opioid use compared to other analgesic methods.
3. Patient satisfaction was generally higher in PCA groups, reflecting greater control over pain management.
4. Side effects (nausea, vomiting, sedation) were reported across all groups, but PCA was generally well tolerated; differences were not consistently significant.
5. Hospital stay and mobilization time showed minimal differences between PCA and non-PCA groups, suggesting that analgesic method did not strongly impact recovery duration

The Effectiveness of Patient-Controlled Analgesia in Orthopedic Joint Replacement: A Systematic Review

Limitations

- Heterogeneity of studies: included various types of joint replacements, not just total hip replacement, and various types of non-PCA treatments, not just IM
- Variation in outcomes measured: pain was measured using different scales (VAS, NRS) at different points in time (immediately after surgery vs a few hours after vs 24-48 hours after) making direct comparison challenging
- Sample Size: Some RCTs used a limited number of patients which reduced statistical power
- Performance Bias: unable to blind participants as patients control the delivery of analgesia in PCA and nurses/clinicians are aware of who is getting PCA vs non-PCA analgesia
- Selection Bias: There were differences in the inclusion/exclusion criteria across the RCTs with some excluding older adults or patients with comorbidities

Patient Controlled Opioid Analgesia Versus Non-patient Controlled Opioid Analgesia For Postoperative Pain: A Systematic Review

Criteria: Adult post-op surgical patients (≥ 18 years old) in variety of surgical settings (orthopedic, abdominal, cardiothoracic, etc) receiving systemic opioid analgesia.

- Randomized to either PCA opioid therapy or nurse administered PRN IM, IV, SC or oral opioids
- Exclusion criteria: chronic opioid users, chronic pain diagnoses, pediatric patients, non-postop pain conditions

Methods: Systematic review of randomized control trials (RCTs)

- 49 RCTs met including criteria
- 1,725 in PCA groups (intervention) and 1,687 in non-PCA groups (control) = 3,412 total participants
- Trials were conducted in hospital inpatient post-op settings across multiple countries worldwide
- Major outcome categories:
    - Pain intensity using Visual Analog Scale (VAS), opioid consumption measured as IV morphine equivalents, patient satisfaction measured through self-reported scores, adverse effects, and length of hospital stay

Patient Controlled Opioid Analgesia Versus Non-patient Controlled Opioid Analgesia For Postoperative Pain: A Systematic Review

Results

Pain intensity:

- 0-24, 24-48 and 49-72 hours: PCA users had lower pain scores than non-PCA users on a 100-point VAS

Opioid consumption:

- PCA patients consumed more opioids overall
  - about 7 mg more morphine equivalent in the first 24 hours
  - about 5 mg more morphine equivalent in hours 25-48

Patient satisfaction:

- PCA patients reported higher satisfaction scores
  - effect size was moderate: standardized mean difference of about 0.5

Adverse effects:

- The only significant difference was that PCA patients had slightly higher rates of pruritis (15%) than non-PCA patients (8%)

Length of hospital stay:

- No difference in length of stay between the two groups

Patient Controlled Opioid Analgesia Versus Non-patient Controlled Opioid Analgesia For Postoperative Pain: A Systematic Review

Limitations:

Performance/Detection/Selection Bias:

- Most of the trials could not blind patients or clinicians to PCA vs non-PCA
- Some studies did not show how randomization was done

High heterogeneity across studies:

- Studies differed in types of surgery (cardiothoracic, orthopedic, abdominal, gynecological, urologic), doses & routes of opioids (IM, IV, SC, oral) and PCA settings
- Reduces confidence in precision of results

Variability in non-PCA groups:

- Control groups received IM, SC, IV and oral PRN opioids, which are not equivalent treatments, making comparisons uneven

Pain Therapy Following Joint Replacement. A Randomized Study of Patient-Controlled Analgesia versus Conventional Pain Therapy

Criteria:

- Adults undergoing a elective total hip arthroplasty or total knee arthroplasty under general anesthesia
- Excluded if postoperative confusion, preexisting high-dose opioid therapy, or inability to use the PCA device

Methods:

- Prospective randomized controlled trial including 38 total subjects
- Setting: Orthopaedic Clinic, RWTH Aachen University Hospital
- Patient cohort: Adults who underwent Total Knee Arthroplasty or Total hip arthroplasty
- Subjects divided into two groups:
    - 19 patients received intravenous PCA devices (Intervention group)
    - 19 patients received intramuscular tramadol (Control group)

Outcomes Measured:

- Primary outcome: Postoperative pain intensity measured by visual analogue scale over 60 hours
- Secondary outcomes: Total opioid consumption (piritramid-equivalent), incidence of opioid side effects, and patient satisfaction with pain management.

Pain Therapy Following Joint Replacement. A Randomized Study of Patient-Controlled Analgesia versus Conventional Pain Therapy

Results

- **Side-effect rates (e.g. nausea, respiratory depression):**
  - Similar between groups
- **Opioid consumption:**
  - The PCA group used substantially more opioids
    - On average twice the equivalent dose as the conventional pain therapy group.
- **Mean visual analog scale pain scores between patient controlled analgesia and conventional pain therapy groups:**
  - No significant difference
- **Patient satisfaction:**
  - Higher with PCA, despite similar pain scores.
  - Most patients in both groups remained above their preoperative pain tolerance thresholds

Pain Therapy Following Joint Replacement. A Randomized Study of Patient-Controlled Analgesia versus Conventional Pain Therapy

Limitations

- Small sample size limits statistical power.
- Ten percent of enrolled patients were excluded, which could have caused attrition bias.
- The study was single-center and unblinded, with subjective pain and satisfaction measures.
- All patients were on general anaesthesia and treated postoperatively in an ICU setting, which may limit generalizability.
- The finding that both groups had visual analog scale scores above pain thresholds suggests overall suboptimal analgesia in both arms.
- No long-term outcomes were assessed.

Pain Therapy Following Joint Replacement. A Randomized Study of Patient-Controlled Analgesia versus Conventional Pain Therapy

Criteria:

- Patients with a diagnosis of osteoarthritis of the hip scheduled for a primary unilateral total hip arthroplasty (THA)
- ASA Physical Status I–III
- Exclusion: allergy to study meds, ASA IV, hepatic/renal failure, chronic opioid use >3 months

Methods:

- Prospective randomized, double-blind, placebo-controlled trial including 90 total subjects (41 in PAI group & 43 in PCEA group)
- Setting: Unspecified university-affiliated orthopedic teaching hospital
- Patient cohort: Adults 50-80 years old
- Subjects divided into two groups:
    - PCEA group who received patient-controlled epidural analgesia with bupivacaine 0.06% + hydromorphone (Intervention group)
    - PAI/multimodal group received a peri-articular injection of: bupivacaine, epinephrine, morphine, methylprednisolone, and cefazolin oxycodone 10 mg + a multimodal systemic regimen of acetaminophen, ketorolac (later transitioned to meloxicam), and PRN oxycodone + they also received an epidural pump with normal saline to preserve blinding (Control group)

Pain Therapy Following Joint Replacement. A Randomized Study of Patient-Controlled Analgesia versus Conventional Pain Therapy

Outcomes Measured:

- Primary outcomes: time to readiness for discharge (indicated by ability to tolerate PO, stable vitals, catheter removed, pain NRS <4 independent of parenteral narcotics for a 4 hour period, minimal nausea etc.)
- Secondary outcomes: length of stay, pain scores, total opioid consumption, opioid-related side effects, quality of recovery, patient satisfaction with pain management etc.

Results:

- Pain Intensity: PCEA administration did not result in lower pain at rest overall, however lower pain was observed with ambulation
- Rescue analgesic use: The PAI group needed more opioids than the PCEA group in the first 48 hours
- Regain of function: There was no difference found in terms of regain of function/readiness for discharge/length of stay. For example, the PCEA group averaged 2.3 days until readiness vs. the 2.4 days observed in the PAI group.
- Side effects: PCEA resulted in more side effects such as N/V, pruritus, dizziness, and headache.
- Patient satisfaction & Conclusion: There was no observable difference in patient satisfaction amongst both groups.

Pain Therapy Following Joint Replacement. A Randomized Study of Patient-Controlled Analgesia versus Conventional Pain Therapy

Limitations:

- PCA route: this study used epidural PCA as opposed to IV/oral which are more common routes of PCA, this potentially limits generalizability to other studies involving PCA.
- Functional task assessment: the study did not evaluate pain during tasks like climbing stairs and sit to stand which are important aspects of THA recovery.
- Confounders: with the multimodal regimen methylprednisolone was used which is known to reduce nausea and inflammation thus providing a notable advantage in the relief of pain.

Summary of Mini-CAT Grid

1. **Lahtinen et al., 2020**
   - Patients using PCA had similar total opioid consumption in the first 24 hours, but with **greater variability** (some took higher amounts while others required less medication)
   - Patients using PCA had a shorter hospital stays, suggesting a potential benefit in postoperative recovery efficiency
2. **Altamimi et al., 2025**
   - PCA provides effective pain control; most studies reporting lower pain scores at rest and during mobilization
   - Opioid consumption was often lower/more efficiently managed with PCA, although some studies reported similar total opioid use
   - Patient satisfaction was generally higher in PCA groups, reflecting greater control over pain management
   - Analgesic method did not strongly impact recovery duration or side effects
3. **McNicol et al., 2015**
   - Patients using PCA reported lower pain intensity and higher satisfaction
   - Patients using PCA used more opioids and had slightly higher rates of pruritis; no difference in hospital stay
4. **Jules-Elysee et al., 2015**
   - Patients on PAI were found to have higher pain scores and greater opioid consumption when compared with PCEA users.
   - The PCEA group however had more instances of adverse side effects
   - PCEA resulted in better pain reduction during ambulation but at rest the results were comparable.
   - No significant difference was found in relation to readiness for discharge/length of stay.
5. **Forst et al., 1999**
   - No significant difference in postoperative pain scores, although PCA users consumed roughly twice as much opioids
   - Patient satisfaction was significantly higher in the PCA group despite most patients in both groups experiencing pain above their preoperatively determined pain thresholds.

Clinical Bottom Line

Pain Control:
- PCA generally provides effective pain relief, often lower pain scores at rest and during mobilization
- PCEA may reduce pain better during ambulation

Opioid Use:
- Total opioid consumption is variable
- PCA may lead to higher or similar opioid use depending on the study

Patient Satisfaction:
- PCA consistently results in higher patient satisfaction due to perceived control over pain management

Recovery & Length of Stay:
- Minimal impact on hospital stay or readiness for discharge
- Some evidence suggests slightly shorter stays with PCA

Side Effects:
- PCA may increase opioid-related side effects (e.g., pruritis)
- PCEA can have more adverse events but similar overall tolerability.

References

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