


Detailing postoperative pain and opioid utilization after periacetabular osteotomy with automated mobile messaging

Christina Hajewski, Chris A. Anthony, Edward O. Rojas *, Robert Westermann and Michael Willey

Department of Orthopaedics and Rehabilitation, University of Iowa Hospitals and Clinics, 200 Hawkins Drive, 01008 JPP, Iowa City, IA 52242, USA.

*Correspondence to: E. Rojas. E-mail: edward-rojas@uiowa.edu

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ABSTRACT

In the setting of periacetabular osteotomy (PAO), this investigation sought to (i) describe patient-reported pain scores and opioid utilization in the first 6 weeks following surgery and (ii) evaluate the effectiveness of postoperative communication using a robotic mobile messaging platform. Subjects indicated for PAO were enrolled from a young adult hip clinic. For the first 2 weeks after surgery, subjects received daily mobile messages inquiring about pain level on a 0–10 scale and the number of opioid pain medication tablets they consumed in the previous 24 h. Messaging frequency decreased to 3 per week in Weeks 3–6. Pain scores, opioid utilization and response rates with our mobile messaging platform were quantified for the 6-week postoperative period. Twenty-nine subjects underwent PAO. Twenty-one had concurrent hip arthroscopy. Average daily pain scores decreased over the first four postoperative days. Average pain scores reported were 5.9 ± 1.9 , 4.1 ± 3.3 and 3.0 ± 3.5 on Day 1, Day 14 and Week 6, respectively. Reported opioid tablet utilization was 5.0 ± 3.2 , 2.2 ± 2.0 and 0.0 ± 0.0 on Days 1 and 14 and at 6 weeks. Response rate for participants completing the 6-week messaging protocol was 84.1%. Patient-reported pain scores decreased over the first two postoperative weeks following PAO before plateauing in weeks 3–6. Opioid pain medication utilization increased in the first postoperative week before gradually declining to no tabs consumed at 6 weeks after PAO. Automated mobile messaging is an effective method of perioperative communication for the collection of pain scores and opioid utilization in patients undergoing PAO.

INTRODUCTION

Hip dysplasia and femoroacetabular impingement alter normal hip mechanics causing pain, disability, and eventually osteoarthritis [1–4]. As our understanding of anatomy, joint mechanics, and the conditions that cause hip pain and degeneration evolves, new management strategies have been developed that aim to improve symptoms and potentially preserve the hip before the onset of osteoarthritis [2, 5, 6]. Periacetabular osteotomy (PAO) reorients the acetabulum and reduces the mechanical stress in the hip joint to improve pain and prevent osteoarthritis [5–7]. Optimal pain management is vital for patients undergoing PAO [7–9]. Use of opioid pain medications is common for postoperative pain management in orthopaedic surgery

patients, as demonstrated by orthopaedic surgeons ranking among the top prescribers of opioid medications [10]. In the face of the opioid epidemic in the United States, it has become increasingly important to better understand postoperative pain and attempt to define the appropriate amount of opioid pain medication for particular procedures. Studies investigating pain scores and opioid demand have been conducted for patients following anterior cruciate ligament reconstruction, arthroscopic knee surgery, orthopaedic hand procedures, orthopaedic trauma surgery, rotator cuff repair, and supracondylar humerus fractures [11–17]. These investigations found that opioid utilization decreases rapidly after surgery, spinal anesthetic reduces pain from anterior cruciate ligament reconstruction, and

there is no association between supracondylar humerus fracture severity and pain rating or opioid use [11–13, 17]. These types of investigations have not been conducted following PAO.

Understanding the most effective and efficient way to communicate with patients in the modern healthcare environment has become increasingly important [18]. Communication via mobile phone messaging has shown positive results in terms of response rate (RR) and patient acceptability in a variety of venues including concussion management, perioperative care, cancer treatment, and substance abuse [14, 19–21]. Additionally, previous investigations have validated the use of software-driven mobile phone messaging to assess postoperative pain, opioid utilization, and the delivery of patient-reported outcome measures outside of the hospital setting with excellent completion rates [11, 14, 22].

The natural history of postoperative pain and opioid utilization following PAO has not been quantified or defined in the literature. There is also no prior work that seeks to understand how patients who undergo a PAO will communicate with a mobile messaging robot in the perioperative period. This investigation aimed to (i) describe patient-reported pain scores and opioid utilization in the first 6 weeks following surgery and (ii) evaluate the effectiveness of postoperative communication in these patients using a robotic mobile messaging platform.

MATERIALS AND METHODS

This investigation was approved by our Institutional Review Board and deemed Health Insurance Portability and Accountability Act compliant. Potential subjects indicated and consented for PAO were approached in an orthopaedic young adult hip preservation clinic during their preoperative workup appointment. Patients with daily access to a mobile phone with mobile messaging capabilities and interested in participating underwent the informed consent process. Subjects enrolled in the study were not compensated for participating and did not receive a formal demonstration of the mobile phone software communication platform during the consent process.

Subjects were enrolled into the automated mobile phone messaging protocol via an online portal and at that time received an initial welcome message confirming their enrollment (Fig. 1). Preoperative Visual Analog Scale of Pain (VAS Pain) scores were also collected from all study participants at the time of enrollment and converted to a 0–10 scale to match the Numeric Rating Scale for Pain (NRS Pain) utilized in the texting protocol [23]. One week prior to undergoing PAO surgery, patients received mobile messages which provided preoperative physical

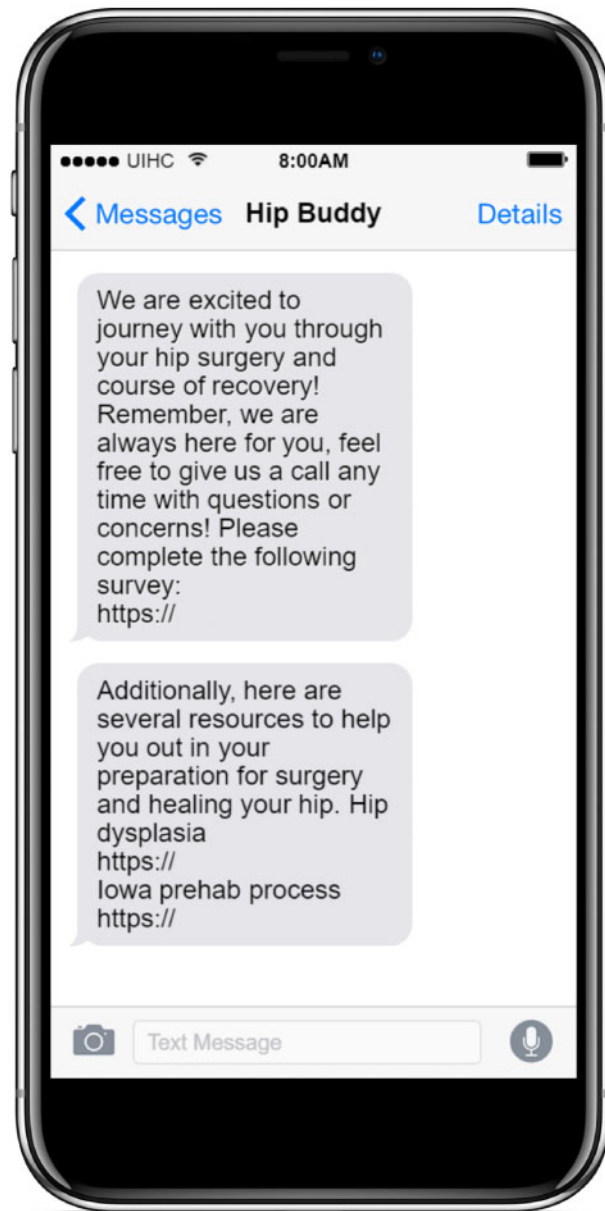


Fig. 1. Initial protocol welcome messages.

therapy information and patient instructions for the day prior to surgery (Supplementary Appendix SA). Following PAO, patients began receiving mobile messages on postoperative day (POD) 1 inquiring about their level of pain using the 0–10 (0 = no pain, 10 = worst pain imaginable) NRS Pain and about the amount of opioid pain medication tablets they consumed over the preceding 24 h [23]. There was no standardized perioperative analgesic protocol while patients were admitted and no patients received epidurals or regional anesthesia. At discharge, there was no standardized multimodal regimen, yet all patients did receive

nonsteroidal anti-inflammatory drugs as part of their discharge medications. These messages were sent to patients daily from POD1 to POD14, then three times a week during postoperative weeks 3–6. Postoperative weeks 3–6 were defined as follows: Week 3 consisted of POD 15–21, Week 4 was POD 22–28, Week 5 was POD 29–35, and Week 6 was POD 36–42. In addition to messages regarding pain and opioid demand, patients were provided with messages guiding them through the progression of their postsurgical physical therapy. A total of six physical therapy progression messages were sent to participants on POD1, POD4 and at 2, 6, 12, and 16 weeks after surgery.

Mean pain scores and opioid utilization reported by patients were calculated and evaluated. RR for the messaging protocol based on received messages was calculated. Reported postoperative NRS Pain scores were correlated to preoperative VAS Pain scores to determine the amount of days a subject required to return to or improve from their baseline pain score [23, 24]. Subject's electronic medical records were reviewed after study completion to verify the opioid pain medication and dosage per 24 h prescribed at discharge, the total amount of tablets dispensed, and any subsequent refills a subject received during the study period. This information was used to calculate the percent of opioid pain medication utilized by comparing patient-reported opioid tablet consumption with the number of tablets dispensed and the dosage prescribed for a 24-h period. Morphine milliequivalents (MME) consumed by patients throughout the study period using patient-reported opioid tablet consumption and the MME per tablet of their prescription. All statistical analysis and calculations were completed using Microsoft Excel (Redmond, WA, USA).

RESULTS

Thirty-two total patients were enrolled in this investigation, two patients had their operative plan changed after consent to exclude PAO, and one subject did not participate in any postoperative communication. All three subjects were excluded from the final study analysis. The final study population consisted of 29 subjects who underwent PAO and participated in the messaging protocol with at least 1 response in 6 weeks. Of this final cohort, 21 patients underwent concurrent hip arthroscopy, 25 were female, and 4 were male. The mean age for the final study population was 22.4 ± 7.6 years old. Participants on average discharged between POD3 and POD4, based on a calculated mean of $POD3.45 \pm 0.9$ days and range of POD2 to POD7.

Overall, daily patient-reported pain scores decreased over the first two postoperative weeks. Mean daily postoperative pain reported was 5.9 ± 1.9 , 4.7 ± 2.7 , and

4.1 ± 3.3 on POD1, POD7, and POD14 respectively (Table I). Mean pain scores out to 6 weeks were 2.0 ± 2.6 , 2.6 ± 2.6 , 2.8 ± 2.6 , and 3.0 ± 3.5 on PODs 20–21, 27–28, 34–35, and 41–42, respectively (Table II, Fig. 2). Likewise, the number of narcotic pain medication tabs consumed by patients overall declined in the first two postoperative weeks, peaking on POD8 at mean of 10.1 ± 6.8 tablets (Table I). Opioid pain medication demand was 2.5 ± 4.7 , 0.8 ± 1.6 , 0.8 ± 1.5 , and 0.0 ± 0.0 on Days 20–21, 27–28, 34–35, and 41–42 following PAO (Table II, Fig. 2). Overall RR to queries during the 6-week study period was 84.1%, with a 79.6% rate for the first 2 weeks when patients received daily messages, and 90.8% for Weeks 3–6 when receiving tri-weekly messages.

Preoperative VAS pain scores for participants averaged 5.7 ± 1.9 when converted to the 0–10 NRS Pain scale used in our messaging protocol. Subjects took an average of 5.2 ± 5.8 days to return to or improve from their preoperative pain score following PAO. A total of 52 opioid pain medication prescriptions were given to the study population during the 6-week study period (Table III). Prescriptions given to subjects at discharge averaged 77.3 ± 14.7 tablets dispensed, with a mean dosage of 11.4 ± 2.4 tablets per 24-h period. On average, subjects reported consuming $44.1\% \pm 42.3\%$ of their opioid pain medication over the entire 6-week study period. Mean opioid medication utilization during the first 2 weeks was $59.7\% \pm 44.7\%$ and $24.7\% \pm 45.0\%$ for Weeks 3–6 following surgery. The mean MME consumed by subjects was 465.5 ± 418.1 over the 6-week study period. Over the first 2 weeks, patients reported consuming 419.3 ± 377.6 MME on average, while in Weeks 3–6, they reported consuming 63.4 ± 87.9 MME, a difference of 355.9 MME.

DISCUSSION

PAO is increasingly offered for young adults with prearthritic hip dysplasia to improve pain and function [7, 25, 26]. In the midst of the opioid epidemic in the United States, it is essential to develop a reliable understanding regarding the amount of postoperative pain associated with a particular procedure, as well as the accompanying patient opioid medication requirements [6, 27, 28]. The present investigation reports the natural history of pain and opioid utilization in patients undergoing PAO. We find that patient-reported pain scores and opioid pain medication demand decreased substantially in the 6 weeks following PAO. Additionally, patients exhibited an overall high rate of communication with our automated mobile messaging platform for collection of pain scores and reporting of postoperative opioid utilization.

Table I. Daily mean pain and opioid utilization following PAO

Days after surgery	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Pain scores	6.9 ± 1.6	5.9 ± 1.9	5.6 ± 1.9	4.4 ± 2.1	4.3 ± 2.4	4.4 ± 2.0	5.0 ± 2.5	4.7 ± 2.7	4.3 ± 2.5	4.1 ± 2.9	4.2 ± 2.7	3.4 ± 2.7	3.9 ± 2.5	3.8 ± 2.8	4.1 ± 3.3
n	8	15	16	14	24	20	22	19	17	24	26	19	23	18	9
Opioid tabs	1.0 ± 1.7	5.0 ± 3.2	6.5 ± 3.2	8.7 ± 6.8	9.5 ± 5.9	7.2 ± 4.9	8.9 ± 7.5	8.1 ± 6.9	10.1 ± 6.8	6.6 ± 5.8	5.5 ± 5.1	3.7 ± 2.9	5.0 ± 5.2	4.5 ± 4.9	2.2 ± 2.0
n	5	10	8	11	16	16	20	17	16	23	23	17	21	17	8
Percent taken ^a	8.3% ± 12.9%	41.7% ± 25.6%	61.5% ± 32.4%	95.5% ± 82.4%	87.5% ± 64.9%	64.1% ± 39.9%	76.7% ± 60.1%	67.5% ± 55.8%	87.8% ± 54.8%	65.9% ± 60.7%	53.5% ± 47.2%	35.6% ± 27.4%	52.3% ± 63.4%	48.5% ± 50.3%	30.7% ± 34.0%
N	5	10	8	11	16	16	20	17	16	23	23	17	21	17	8

Values reported as mean ± standard deviation; n: number of responses from subjects on the day after surgery noted.
^aPercentages calculated utilizing total possible number of tablets per 24 h prescribed as the denominator.

Table II. Tri-weekly mean pain and opioid utilization following PAO

Days after surgery	15-17	18-19	20-21	22-24	25-26	27-28	29-31	32-33	34-35	36-38	39-40	41-42
Pain scores	2.9 ± 2.4	3.5 ± 2.7	2.0 ± 2.6	2.5 ± 2.4	2.3 ± 2.3	2.6 ± 2.6	2.5 ± 2.5	2.1 ± 2.3	2.8 ± 2.6	2.5 ± 2.6	2.7 ± 2.6	3.0 ± 3.5
n	22	19	6	19	19	16	24	8	20	23	17	6
Opioid tabs	2.6 ± 3.2	2.6 ± 4.4	2.5 ± 4.7	1.7 ± 2.7	1.1 ± 1.7	0.81 ± 1.6	0.9 ± 1.6	1.0 ± 1.2	0.8 ± 1.5	0.4 ± 1.1	0.7 ± 1.4	0.0 ± 0.0
n	21	17	6	18	18	16	24	8	20	23	17	6
Percent taken ^a	35.3% ± 56.4%	29.4% ± 40.5%	37.5% ± 72.9%	19.4% ± 29.5%	9.7% ± 15.0%	7.3% ± 12.8%	22.1% ± 49.1%	48.9% ± 97.2%	12.1% ± 22.7%	17.8% ± 61.9%	27.7% ± 93.5%	0% ± 0.0%
n	21	17	6	18	18	16	24	8	20	23	17	6

Values reported as mean ± standard deviation; n: number of responses from subjects on the day after surgery noted.
^aPercentages calculated utilizing total possible number of tablets per 24 h prescribed as the denominator.

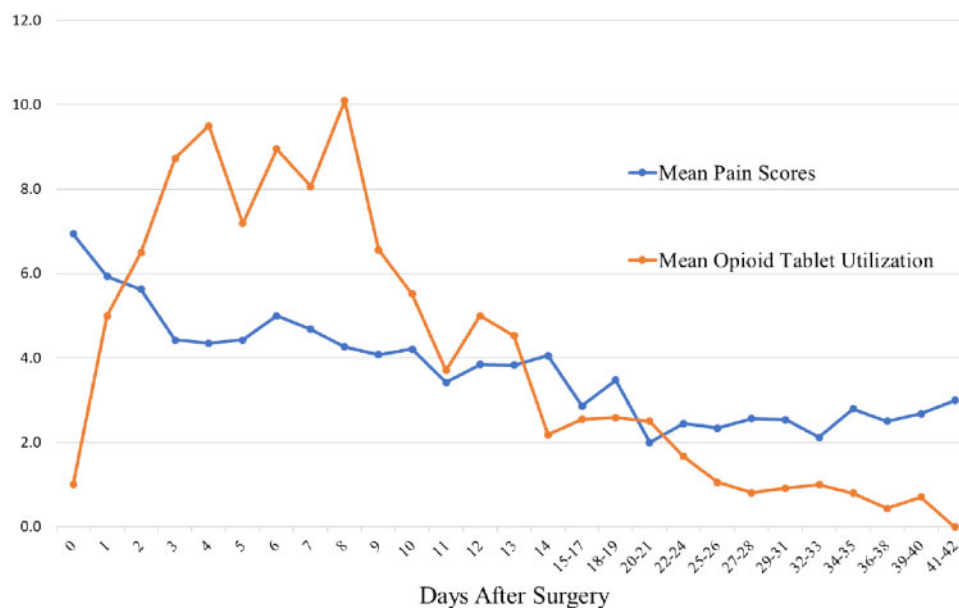


Fig. 2. Mean pain scores and opioid medication utilization after PAO.

Table III. Opioid pain medications prescribed to patients following PAO

Medication	Morphine milliequivalents per tablet	Frequency prescribed (n total = 52)
Hydrocodone-acetaminophen 5–325 mg	5	9
Hydromorphone 2 mg	8	12
Oxycodone 5 mg	7.5	6
Oxycodone-acetaminophen 5–325 mg	7.5	25

Previous studies have shown that pain scores and opioid consumption following various orthopaedic procedures declines rapidly within the first postoperative month [11, 14, 29]. Prospective studies looking at postoperative pain scores following ambulatory hand procedures showed daily improvements throughout a 1-week postoperative study period [15]. Orthopaedic trauma patients displayed similar results over a 2-week postoperative period [14]. Opioid pain medication demands in these patient populations also declined rapidly after surgery [14, 15]. These findings support the trends identified in retrospective database studies looking at postoperative opioid utilization in patients undergoing anterior cruciate ligament repair, rotator cuff

repair, and total hip arthroplasty [11, 12, 14, 15, 29]. There is a lack of knowledge regarding the natural history of pain and opioid demand following PAO.

Further understanding the course of pain after PAO helps surgeons set appropriate, evidence-based expectations for patients, as these have been identified as important predictors for functional outcomes and patient satisfaction in other orthopaedic procedures [30–32]. Additionally, understanding opioid demand after PAO helps define an appropriate amount of pain medication which could be utilized in future multimodal pain control regimens, such as those presented in other investigations [7]. In patients undergoing PAO, we report a steady decline in pain scores within the first two postoperative weeks (Table I). Pain scores stabilized after the first two postoperative weeks, fluctuating between a two and three on the NRS Pain (Fig. 2). Subjects needed an average of 5.2 ± 5.8 days after PAO to return to or improve upon their preoperative pain score. The percentage of opioid medication utilized during the first 2 weeks after surgery was 59.7%. The number of opioid tablets consumed by subjects increased initially following surgery, reaching a maximum average of 10.1 tablets consumed on POD8, before progressively decreasing out to 2 weeks postoperatively (Table I). Opioid utilization continues to decline in postoperative weeks 3–6, as patients only utilized 24.7% of their opioid pain medication, over 35% less than in the first 2 weeks, and ultimately reaching 0% at 6 weeks postoperatively (Table II).

Surgeons can utilize these findings when advising patients regarding the amount of pain they can expect following PAO. Additionally, these results may guide the prescription of opioid pain medication after PAO, as patient demand may be less than standard prescribing practices. Surgeons and future investigators can utilize this baseline data when designing interventional programs to decrease pain and opioid medication utilization after PAO.

Effective communication between healthcare teams and patients is essential for the delivery of high-quality healthcare [18]. Communicating with patients utilizing automated software mobile phone platforms has been successful across a variety of disease processes [20, 21, 33, 34]. Further, the interaction rates for utilizing automated mobile messaging platforms have been demonstrated to approach 90% in previous studies [14, 15]. We report that patients undergoing PAO exhibited an overall high interaction rate (84.1%) with our automated mobile phone messaging communication platform. Patients achieved the highest RRs in Weeks 3–6 of our protocol, which may signify that patients prefer less than daily communication with their providers after surgery. These findings support previous authors' conclusions that mobile communication tools have high acceptance among patients [35]. In patients undergoing PAO, we recommend the use of this technology for the purposes of data collection and perioperative communication.

Our study had several limitations. First, our patient population was small and limited to a single center. Second, there was limited diversity within our study population. Patients treated for hip dysplasia are typically young females who are familiar with communication through mobile messaging. Thus, the results of this study may not be translatable to other populations with less social support or familiarity with these technologies. Further, daily communication to collect pain scores and opioid utilization may draw more attention to these issues for patients, but this is inherent of any question posed to patients regardless of the platform for delivery. Finally, data collection in a few instances was affected by discordance between protocol start date and date of surgery. These cases occurred due to rescheduling of surgeries after a patient had been enrolled in the study, which identifies a point for future improvement of our methods. Studies seeking to adopt our methods should attempt to build a way for their communication platform to easily update participant changes like rescheduling to improve standardization of data capture.

CONCLUSIONS

Patient-reported pain scores decreased over the first 2-week postoperative period following PAO, before

plateauing in Weeks 3–6 following surgery. Opioid pain medication utilization increased in the first week following PAO before gradually declining to no tabs consumed 6 weeks after PAO. Automated mobile phone messaging software is an effective method of perioperative communication for collection of pain scores and opioid tablet consumption in patients undergoing PAO. This reported pain and opioid utilization data can be used to counsel patients on expectations for their postoperative course and better define opioid requirements for healthcare systems aiming to avoid over-prescription of opioid medication following surgery.

SUPPLEMENTARY DATA

Supplementary data are available at *Journal of Hip Preservation Surgery* online.

CONFLICT OF INTEREST STATEMENT

C.A. is a paid advisor for McKinsey & Company. R.W. has received educational support from Arthrex and Smith & Nephew. M.W. has received research support from Zimmer Biomet. All disclosures are outside of the submitted work.

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