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A comparison of local intraarticular anesthesia versus general anesthesia for ambulatory arthroscopic knee surgery

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Abstract

Various anesthetic techniques including local, regional, and general anesthesia have been utilized for ambulatory arthroscopic knee surgery. The choice of anesthetic technique for this surgical procedure can have a significant impact on postoperative recovery, side effects, and patient satisfaction. The objective of this randomized, prospective study is to evaluate the efficacy of utilizing either intraarticular (IA) local anesthesia or general anesthesia (GA) for patients undergoing outpatient arthroscopic knee surgery. Patients assigned to the local anesthesia group were administered an IA injection of 30 mL of bupivacaine 0.25% approximately 20–30 min before surgery. Intraoperative sedation was provided with the administration of propofol. Patients assigned to the GA group were administered propofol and fentanyl for induction and maintained with sevoflurane combined with nitrous oxide in oxygen by laryngeal mask airway. The surgeon injected 30 mL of bupivacaine 0.25% through the arthroscope at the completion of the surgical procedure. This study demonstrates that IA anesthesia provides for improved pain relief, decreased postoperative opioid use, postoperative nausea and vomiting (PONV), time spent in the recovery room, and improved patient satisfaction with similar operating conditions comparable to general anesthesia in patients undergoing outpatient arthroscopic knee surgery. Although both groups received a similar dose of IA bupivacaine, administering the local anesthetic prior to surgery resulted in more effective analgesia. We currently believe that intraarticular local anesthesia fulfills all the criteria for the optimal anesthetic technique for outpatient arthroscopic knee surgery.

Keywords: Knee arthroscopy; Intraarticular; Ambulatory surgery; Local anesthesia; Outcomes

1. Introduction

The optimal anesthetic technique for ambulatory arthroscopic knee surgery should be technically simple to administer, have minimal side effects, provide for rapid onset with a high success rate, allow for a timely discharge, be inexpensive, and provide postoperative analgesia [1–3]. General anesthesia (GA) may be associated with a higher incidence of side effects and unanticipated hospital admissions after outpatient surgery [4]. Regional anesthesia may be more preferable for ambulatory surgical patients because of the potential for improved postoperative analgesia, faster recovery times, and decreased incidence of side effects [4–6]. A variety of regional anesthetic techniques have been described for outpatient arthroscopic knee surgery. Peripheral regional techniques have included instillation of intraarticular (IA) local anesthetics [2,3,7–23], combined psoas compartment and sciatic nerve blocks [24], and femoral three-in-one nerve blocks [2,14,25]. Central neuraxial nerve blocks have included spinal, epidural, and combined spinal–epidural anesthetic techniques [1,22,26–28]. Due to concerns about possible back pain, spinal headache, transient radicular irritation, and prolonged hospital discharge, we no longer perform spinal or epidural anesthesia for outpatient knee arthroscopy. Although femoral three-in-one nerve blocks may provide ad-

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equate anesthesia, they take considerable time to perform, have a high failure rate, and many anesthesiologists are not familiar or comfortable performing them [29]. Furthermore, the use of a femoral three-in-one block was shown to be no more efficacious than the IA administration of local anesthesia following outpatient knee arthroscopy [2]. At our institution, arthroscopic knee surgery has been successfully performed with IA local anesthesia (LA) for over a decade. For those patients refusing an IA local anesthetic block, we currently offer the option of general anesthesia. This study was designed to prospectively evaluate general and IA local anesthesia in patients scheduled for outpatient knee arthroscopy by comparing postoperative pain, incidence of side effects, surgical operating conditions, discharge times, and patient satisfaction.

2. Materials and methods

Following approval by our local Institutional Review Board, written informed consent was obtained from 104 patients scheduled to undergo elective diagnostic or operative arthroscopic surgery of the knee by a single surgeon (JS). By the use of a computer-generated table of random numbers, patients were allocated to receive either GA or IA local anesthesia.

All patients were premedicated with intravenous (IV) midazolam 0.035 mg kg^{-1}. A standard three-portal arthroscopic technique was used for surgery. Before incision, 10–15 mL of 1.0% lidocaine was used to infiltrate the skin, subcutaneous tissue, and capsule at the portal sites (3–5 mL in each of the three portals) in both study groups. A tourniquet was not used for any of the surgical procedures.

Patients assigned to the local anesthesia group were administered an IA injection of bupivacaine by one of two anesthesiologists (SSR or SBG) in the preoperative holding room approximately 20–30 min before surgery. After a sterile preparation was performed, an 18-gauge needle was used to inject 30 mL of bupivacaine 0.25% with 1:200,000 epinephrine through the superolateral portion of the knee. Presence of anesthetic solution within the knee joint was confirmed by one of several methods. If an effusion was present, it was aspirated, ensuring correct IA placement of the needle. If no effusion was present, free flow of local anesthetic was sought by palpating the flow of fluid along the medial gutter. If resistance was felt, the injection was identified as going into the fat pad or IA soft tissues, and the needle was redirected. After IA injection, the knee was flexed three or four times to achieve an even distribution of the local anesthetic. Intraoperatively, intravenous sedation was titrated throughout the procedure in accordance to the patients' wishes and comfort. Some patients preferred to be awake enough to watch the video monitor, whereas others preferred to be more sedated. Propofol was administered in a bolus dose of 20 mg immediately prior to insertion of the trochar and then as an IV infusion at a rate of 10–100 μg kg^{-1} min^{-1}. Opioids were not a component of the intraoperative sedation. During the surgical procedure, patients were asked to rate their pain on an 11-point verbal rating scale (VRS) pain score, with 0 corresponding to no pain and 10 the worst imaginable pain. Intraoperative assessment of pain was performed every 10 min or when the patient experienced a painful event. If the intraoperative VRS was ≥3, 5 mL of lidocaine 1.0% was injected through the arthroscope. If the pain persisted, IV fentanyl 25 μg could be titrated to a total dose of 2 μg/kg. If pain persisted despite these measures, patients were converted to general anesthesia.

Patients assigned to the GA group were administered IV propofol 2 mg/kg and fentanyl 1.5 μg/kg for induction. General anesthesia was maintained with 0.5–2% sevoflurane (end-tidal concentration) combined with 60% nitrous oxide in oxygen by laryngeal mask airway. The surgeon injected 30 mL of 0.25% bupivacaine with 1:200,000 epinephrine through the arthroscope at the completion of the surgical procedure.

After surgery, patients were admitted to the Phase I postanesthesia care unit (PACU). Patients were transferred to the Phase II ambulatory surgical unit (ASU), after achieving a modified Aldrete score [30] of 10. If patients achieved a modified Aldrete score of 10 before leaving the operating room, they were admitted directly to the Phase II ASU. Patients were discharged home from the ASU after achieving a postanesthetic discharge scoring system (PADSS) [31] score ≥9. While in the PACU, patients received incremental doses of fentanyl 25 μg IV every 5 min for a VRS ≥3. Side effects including postoperative nausea and vomiting (PONV) were recorded. Odansetron 4 mg IV was administered for nausea lasting longer than 5 min, on patient request, or when vomiting occurred. All assessments (pain, time to oral intake, nausea, vomiting, Aldrete, and PADSS scores) were recorded by an independent nurse-observer (HM) blinded to the analgesic treatment group.

At the completion of surgery, the primary surgeon (JS) was asked to assess surgical operating conditions on a five-point scale (1: excellent, 2: very good, 3: good, 4: moderate, 5: unacceptable). Postoperative pain scores, both at rest and with movement, were assessed using an 11-point VRS at 30 min, 60 min, and 24 h after surgery. Pain scores with movement were recorded immediately after the patient actively flexed the operative knee to 90°.

Patients were instructed to take 1–2 acetaminophen 325 mg/oxycodone 5 mg tablets, every 3 h as needed for a VRS ≥ 3 while at home. Patients were contacted by telephone 24 h after surgery by the same blinded investigator (HM), and were asked about their pain score, time to first analgesic use, 24-h total use of analgesic tablets, incidence of nausea and vomiting, and to estimate their overall satisfaction with the entire perioperative experience on a five-point scale (1: very satisfied, 2: satisfied, 3: somewhat satisfied, 4: unsatisfied, 5: very unsatisfied). Analgesic duration was defined as the time

from completion of surgery until the first postoperative use of fentanyl or acetaminophen/oxycodone.

2.1. Statistical analysis

Demographic data and times (duration of procedure, time to discharge, time to oral intake, and analgesic duration) were assessed by analysis of the variance. Pain scores, patient satisfaction, surgical operating conditions, amount of postoperative analgesics, and odansetron use were analyzed by the Kruskal–Wallis test. The incidence of nausea and vomiting were evaluated by contingency analysis and the chi-square test. If a significant result was obtained, the Mann–Whitney *U*-test was performed to determine between which groups there was significance; a Bonferroni adjustment was made for multiple comparisons. Significance was determined at the $P < 0.05$ level.

3. Results

Of the 104 patients accepting randomization, four were excluded from analysis (one required open arthrotomy, one required overnight admission because of IA bleeding, and two for protocol violations). There were no significant differences among the two study groups with respect to age, sex, weight, duration of surgery, or surgical procedures (Table 1). There were no differences in the surgeon rating of intraoperative surgical conditions (Table 2) between the two groups. No patient in the IA local anesthesia group required intraoperative fentanyl or conversion to general anesthesia. Fourteen patients (28%) in the IA local anesthesia group required an additional IA injection of local anesthetic because of an intraoperative VRS pain score ≥3. Pain scores in the immediate postoperative period were significantly lower, both at rest and with movement in the IA group (Table 2). There were no differences in pain scores 24 h after surgery. Significantly, more patients required the administration of fentanyl in the PACU or acetaminophen/oxycodone use in the 24 h following surgery (Table 2). Patients in the GA group had a higher incidence of PONV, antiemetic use, and longer time to first oral intake compared to the IA group (Table 2). All patients in the IA local anesthesia group achieved a modified Aldrete score of 10 after leaving the operating room and were admitted directly to the ASU (Table 2). These patients spent less time in both the ASU and were discharged from the hospital sooner than patients receiving GA (Table 2). Analgesic duration in the IA local anesthesia group was significantly longer compared to patients in the GA group (Table 2). More patients in the IA group reported higher satisfaction scores with their entire perioperative care compared to the GA group (Table 2).

Table 1
Patient demographics and surgical data

	IA local anesthesia	General anesthesia
Number	50	50
Gender (M/F)	29/21	33/17
Age (year)	41 ± 12	44 ± 16
Weight (kg)	79 ± 15	81 ± 16
Type of surgery (*n*)		
Partial medial meniscectomy	19	16
Partial lateral meniscectomy	6	5
Chondroplasties	5	7
Loose body removal	5	6
Diagnostic arthroscopy	4	2
Lateral release	3	4
Medial meniscal repair	3	5
Lateral meniscal tear	2	3
Synovectomy	2	2
Plica excision	1	0
Duration of surgery (min)	21 ± 7	24 ± 6
Propofol use (mg)	58.8 ± 20.1	170.3 ± 69.8*
Fentanyl (μg)	0 ± 0	127.5 ± 52.3*

Data are presented as mean ± S.D.; *n*, number in each group.
* $P < 0.001$.

Table 2
Surgical outcomes

	IA local anesthesia	General anesthesia	*P*-value
Number	50	50	
Intraoperative VRS[a]	2 (0–4)	0 (0)	<0.05
Postoperative VRS[a]			
30 min (rest)	1 (0–2)	3 (2–5)	<0.05
30 min (movement)	2 (1–4)	4 (3–8)	<0.05
60 min (rest)	1 (0–2)	3 (2–6)	<0.05
60 min (movement)	2 (1–4)	5 (3–9)	<0.05
24 h (rest)	2 (1–3)	2 (1–4)	NS
24 h (movement)	3 (2–5)	3 (2–6)	NS
PACU fentanyl use (μg)[b]	0 ± 0	25.5 ± 36.2	<0.001
24 h Percocet use (tabs)[b]	4.6 ± 1.2	6.1 ± 1.1	<0.05
Nausea[c]	1 (2)	19 (38)	<0.01
Vomiting[c]	0 (0)	8 (16)	<0.05
Odansetron use[c]	0 (0)	10 (20)	<0.05
Time to oral intake (min)[b]	9.2 ± 2.1	59.1 ± 12.6	<0.01
Phase I PACU stay (min)[b]	0 ± 0	48.7 ± 11.3	<0.001
Phase II ASU stay (min)[b]	58.1 ± 12.2	138.5 ± 24.1	<0.01
Actual discharge time (min)[b]	112 ± 22	198 ± 36	<0.01
Analgesic duration (min)[b]	310 ± 42	64 ± 12	<0.001
Surgical conditions[c,d]			NS
Excellent	41 (82)	45 (90)	
Very good	7 (14)	5 (10)	
Good	2 (4)	0 (0)	
Patient satisfaction[c,e]			<0.05
Very satisfied	35 (70)	16 (32)	<0.01
Satisfied	12 (24)	15 (30)	NS
Somewhat satisfied	3 (6)	19 (38)	<0.01

[a] Data are presented as median (range).
[b] Data are presented as mean ± S.D.
[c] Values are numbers and percentages [*n* (%)]; IA, intraarticular; PACU, postanesthesia care unit; ASU, ambulatory surgical unit.
[d] Graded from 1 (excellent) to 5 (unacceptable).
[e] Graded from 1 (very satisfied) to 5 (very unsatisfied).

4. Discussion

Arthroscopy of the knee joint is one of the most commonly performed orthopedic surgical procedures performed in the United States. In an attempt to decrease cost, an increasing number of these procedures have been performed over the past decade on an outpatient basis. The choice of anesthetic technique for outpatient arthroscopy can have a significant impact on postoperative recovery, side effects, and patient satisfaction. Local anesthetic techniques fulfill many of the requirements for the ideal ambulatory anesthetic technique [32]. Although IA local anesthesia is a more cost-effective technique [19–21], many institutions continue to utilize general, spinal, or epidural anesthesia for arthroscopic knee surgery. Some physicians have expressed concerns about adequacy of surgical conditions for operative arthroscopy or certain patient populations [14,22,33]. Our present study revealed that a wide variety of knee procedures could be successfully performed utilizing local anesthesia with sedation. We found this to be a safe, practical, and reliable technique that resulted in high patient satisfaction. Operative surgical conditions were rated very good to excellent in the majority of patients and similar to those patients receiving general anesthesia. The majority of patients in the local anesthesia group reported either no or mild (VAS ≤ 3) intraoperative pain.

In contrast to our findings, Swedish surgeons assessed "technical difficulties" and patients' pain as "more intense" with the use of local anesthesia compared to spinal or general anesthesia for arthroscopic knee surgery [22]. The reasons for the improved surgical conditions observed in our study may be several-fold. Firstly, it has been observed that the "success of local anesthesia/sedation techniques is also dependent upon the skills of the surgeon" [5]. Some orthopedic surgeons believe that there is a larger "learning curve" [18] and that a greater degree of expertise with more "meticulous attention to technical details" [16] is required when local anesthesia is used. Excessive varus and valgus manipulation of the knee under local anesthesia should be avoided since this can produce significant intraoperative pain [34]. In contrast to our surgeon (JS), the Swedish surgeons [22] had varying experience from the resident to consulting level. Secondly, the two prospective studies [14,22] that revealed better surgical conditions under general anesthesia, failed to administer intraoperative sedatives for those patients assigned to receive local anesthesia. The use of sedation with local anesthesia has been shown to improve both patient satisfaction and arthroscopic operating conditions (reduces anxiety and muscle spasm) compared to local anesthesia alone [16]. Although intraoperative sedation is beneficial, we are in agreement with other investigators [16,17,19] that the patient should not be oversedated. Our study utilized minimal intraoperative doses of propofol (< 60 mg) for the duration of the surgical procedure. This provided for optimal surgical conditions while still allowing patients the opportunity to view the video monitor. We have found that allowing patients to view their surgery is beneficial in facilitating the explanation and understanding of their pathology. In addition, since functional performance of the knee is not altered after IA anesthesia [34], the retained ability of the patient to voluntary move his or her knee during the procedure allows for dynamic evaluation of the knee and patellofemoral joints [20].

Another factor, which may affect surgical conditions, is the injection technique utilized for the IA administration of local anesthetics for arthroscopic knee surgery. We have observed that a minimum IA volume of 20–30 mL of bupivacaine injected at least 20 min before surgery is necessary to produce adequate surgical conditions. This wait is necessary to insure that the local anesthetic is well absorbed by the synovium and capsule and will not be leached out by the irrigating fluids later. Further, the knee is then flexed three or four times to achieve an even distribution of the local anesthetic as described by other investigators [11]. Alternatively, others recommend ambulating the patient with assistance to the operating room table to allow for adequate distribution of the local anesthetic prior to surgery [11,18,21]. In addition, providing for a supplemental injection of IA local anesthetic during the operative period may provide for additional comfort [9,11,23]. We found that 14 (28%) of patients in the local anesthesia group required an additional IA injection of local anesthetic to improve intraoperative analgesia and avoid the use of either intraoperative opioids or general anesthesia. Similarly, Eriksson et al. [11] reported that 22% of patients undergoing arthroscopic knee surgery required an additional IA injection of local anesthesia and none required conversion to general anesthesia.

IA anesthesia also provided for enhanced perioperative analgesia while obviating the need for intraoperative administration of opioids or general anesthesia. Utilizing a non-opioid analgesic technique for ambulatory surgical procedures may be associated with an improvement in outcomes and patient satisfaction [35]. The use of large doses of opioids during ambulatory surgery can be associated with an increased incidence of postoperative complications (e.g., PONV, ileus, pruritus, urinary retention, sedation, and respiratory depression), which in turn, contribute to a prolonged stay in the same-day surgery facility or to unanticipated hospital admissions [35]. Further, the intraoperative use of large bolus doses or continuous infusions of short-acting opioid analgesics may actually increase postoperative pain as a result of their rapid elimination and the development of acute tolerance and hyperalgesia [36–38].

We believe the use of IA local anesthesia for arthroscopic knee surgery provides for the ideal non-opioid analgesic technique. This technique provided for enhanced postoperative analgesia, decreased PONV and recovery times, and higher patient satisfaction when compared to general anesthesia. None of the patients in the IA group required either parenteral or oral opioids in the PACU compared to 100% of patients in the GA group. Although both groups received a similar dose of IA bupivacaine, the timing of local anesthetic administration may have contributed to the difference in analgesic

efficacy. Patients in the IA group were administered bupivacaine 20–30 min before surgery, whereas those in the GA group received an IA injection at the conclusion of the arthroscopic procedure. The enhanced analgesic effect in the IA group may be related to a preemptive analgesic effect of IA bupivacaine [39]. We have previously demonstrated that IA bupivacaine is a more effective analgesic when administered prior to rather than at the conclusion of arthroscopic knee surgery [40]. Alternatively, the IA administration of bupivacaine at the conclusion of arthroscopic knee surgery may have not provided sufficient analgesia until well after the patients were admitted to the PACU. It has been demonstrated that the optimal analgesic effect derived from bupivacaine is not observed until at least 20 min after its IA injection [39].

In addition to an improved analgesic effect, patients in the IA group demonstrated a significantly lower incidence of PONV. This decreased incidence of PONV may been due to the reduction in postoperative pain or perioperative use of opioids, both of which are known to be independent risk factors for PONV [41]. The improved perioperative analgesia and decreased PONV may have contributed to the earlier discharge times and improved satisfaction scores observed in the IA group. Inadequate pain management and PONV are two of the most common reasons for delayed discharge, unanticipated admission, and hospital readmission following ambulatory surgery [4]. Further, increased PONV has been associated with significantly decreased patient satisfaction following surgery [42].

In conclusion, IA anesthesia provides for improved pain relief, decreased postoperative opioid use, PONV, time spent in the recovery room, and improved patient satisfaction with similar operating conditions comparable to general anesthesia in patients undergoing outpatient arthroscopic knee surgery. Although both groups received a similar dose of IA bupivacaine, administering the local anesthetic prior to surgery resulted in more effective analgesia. We currently believe that intraarticular local anesthesia fulfills all the criteria for the optimal anesthetic technique for outpatient arthroscopic knee surgery.

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