CONTINUOUS L2 PARAVERTEBRAL BLOCK FOR POSTOPERATIVE ANALGESIA AFTER DIRECT ANTERIOR TOTAL HIP ARTHROPLASTY: A CASE SERIES

Alberto E. Ardon[1], Ryan R. Reed[2], Robert L. McClain[2], Arun Kalava[2], Justin Lee[2], John Redmond[3] and Roy A. Greengrass[2]

Abstract

Objective: The purpose of this case series was to assess the potential use of a continuous paravertebral block (PVB) at the L2 nerve root level as a part of a multimodal regimen in patients undergoing direct anterior total hip arthroplasty (DA-THA).

Design: 20-patient case series.

Setting: tertiary care hospital.

Subjects: patients undergoing DA-THA.

Methods: We retrospectively analyzed 20 patients undergoing DA-THA who had a continuous L2 PVB until postoperative day 2. Hip flexor strength, pain scores, opioid use, and length of stay were assessed post operatively.

Results: 11 of 20 patients had motor weakness to gravity postoperatively. However, mean basic mobility score on postoperative day (POD) 1 was 18.4 ± 2.4. Mean maximum pain on POD0 was 5.4 ± 3.0. On POD1, mean dynamic and maximum pain scores were 3.5 ± 2.5 and 3.5 ± 2.8, respectively. Mean intravenous morphine use was 22.5mg ± 13.4 and 16.5mg ± 11.4 on POD0 and POD1, respectively. Mean discharge day was 2.1 ± 0.5.

Conclusions: While over half of the patients in our case series had some hip weakness postoperatively, participation in physical therapy was not hindered. An L2 PVB catheter, combined with a multimodal postoperative pain control regimen, may provide analgesia after anterior-approach THA without inhibiting recovery.

Keywords: paravertebral block, hip arthroplasty, paravertebral catheter.

1 MD, MPH, Department of Anesthesiology, University of Florida, 655 West 8th St, Jacksonville, FL 32209.
2 MD, MBBS, Department of Anesthesiology, Mayo Clinic, 4500 San Pablo Road, Jacksonville, FL 32224.
3 MD, Department of Orthopedic Surgery, Mayo Clinic, 4500 San Pablo Road, Jacksonville, FL 32224.
Corresponding Author: Alberto E. Ardon MD, MPH, Assistant Professor, University of Florida-Jacksonville, 2nd Floor, Clinical Center, Department of Anesthesiology, 655 West 8th Street, C72, Jacksonville.
E-mail: a.ardon@gmail.com; alberto.ardon@jax.ufl.edu

Introduction

Recent studies suggest that direct anterior (DA) total hip arthroplasty (THA) may offer early functional recovery and decreased length of hospital stay compared to traditional lateral approach surgery[1]. Lumbar plexus block has been an accepted technique for analgesia in patients undergoing hip arthroplasty[2-4]. However, blockade of the lumbar plexus leads to significant quadriceps weakness, which may affect participation in physical therapy and, while controversial, has been suggested as a possible contributor to patient falls[5]. In a 2008 case report by Lee et al.[6], the use of paravertebral block (PVB) by single injections at the levels of L1 and L2 was described as an effective method of postoperative analgesia in two cases of hip arthroscopy, with limited motor weakness. In one previous case series at our institution, single shot T12-L2 paravertebral blockade was found to be a useful postoperative analgesic technique for DA-THA without significant motor weakness[7]. Another study by Wardhan and colleagues examined the use of an L2 PVB catheter among minimally invasive hip arthroplasty patients and found the technique comparable to continuous lumbar plexus blockade, with equivalent motor weakness[8].

The purpose of this case series was to assess the potential use of a continuous paravertebral block at the L2 nerve root level in patients undergoing DA-THA as part of a multimodal analgesic regimen, with an aim to minimize any detriment to mobility.

Methods

This was a retrospective chart review where-in, after institutional review board approval, all patients who underwent an elective DA-THA at our institute from March 18 2015 to May 1, 2015 who received an L2 PVB block were reviewed. The use of paravertebral blockade for DA-THA is routinely used by the senior author at our institution, based on clinical outcomes previously investigated[7]. Of the initial 25 patients identified, 5 patients were excluded from the study: 2 patients had L2 PVB catheters removed early so that anticoagulation therapy could be started, 2 patients did not have the functionality of their block checked preoperatively, and one patient lacked sensory deficit after initial catheter bolus and the decision was made to proceed with surgery without further attempt at regional analgesia.

Preoperative Assessment/Regional Analgesic Techniques

Baseline static and dynamic pain scores as reported by the patient, as well as use of opioids at home for pain were recorded in the preoperative bay. After establishment of intravenous access, administration of supplemental oxygen, and application of American Society of Anesthesiologists standard monitors, the patients were placed in a sitting position. After a pre-procedure timeout, intravenous sedation using fentanyl citrate (50-250 mcg) and/or midazolam (2-5 mg) was administered at the discretion of the attending anesthesiologist. The second lumbar spinous process was identified using ultrasound, and the needle entry site was marked 2.5 cm lateral to the superior aspect of the L2 spinous process. The area was prepared and draped in a sterile fashion, and 1% lidocaine was infiltrated subcutaneously at the point of needle entry. A sterile18-gauge 10cm insulated nerve-stimulating Tuohy needle (Contiplex. B Braun, Melsungen, DE) was introduced perpendicularly to the skin until the transverse process was encountered. The needle was then redirected in a caudad direction and advanced inferior to the corresponding transverse process approximately 1-2cm until an inguinal or femoral motor response was elicited at 0.5mA using a peripheral nerve stimulator (Stimuplex HNS12. B Braun. Melsungen, DE). At this point a 20-gauge soft tip catheter was inserted to a depth of 4 cm beyond the needle tip. A bolus of 10 mL 0.5% ropivacaine was then injected via the catheter into the paravertebral space. The catheter was secured with an adhesive Dermabond™ (Ethicon, San Larenzo, Puerto Rico),Steri-strips™ (3M, St Paul, MN, USA) and a transparent occlusive dressing (Tegaderm™ 3M, St Paul, MN, USA). Vital signs were recorded every 5 minutes until the patient was taken to the operating room. Adequacy of the block was checked 15 minutes after injection of local anesthetic by testing for loss of temperature sensation by comparing bilateral dermatomes from T12 through

L4 using an ice filled bag. All blocks were done by the regional anesthesiology fellow or the attending anesthesiologist.

Intraoperative Anesthesia Management

Per our usual anesthetic management for arthroplasties, all patients had spinal anesthesia at L3-4 with isobaric bupivacaine 0.5% 2.5 ml (12.5mg). Intraoperative sedation was accomplished with propofol and/or midazolam, at the discretion of the anesthesiologist in the operating room.

Postoperative Assessment

In the postanesthesia care unit, a paravertebral infusion of 0.3% ropivacaine was started at 6 mL/hour. Additional pain relief was available via patient-controlled 6-mL boluses of 0.3% ropivacaine via catheter pump given no more than hourly, as well as nurse-administered opioids given as needed. In accordance with our standard multimodal system of analgesia after THA, patients were also scheduled to receive acetaminophen 1000mg po q6 hours, celecoxib 200mg po q12 hours, and dexamethasone 6mg IV on the morning of postoperative day 1. All patients were followed and assessed daily by our acute pain service; sensory deficit to ice in the L2 distribution, pain scores, and motor function were assessed during these visits. Motor strength was assessed using the Oxford scale during these visits. Paravertebral catheters were removed at 05:30 on the second morning after surgery (POD2).

Primary outcomes of this study were 1) lower extremity mobility scores, and 2) mean postoperative static, dynamic, and maximum pain scores. Mobility scores were obtained from the medical record as recorded by physical therapists during their daily visits using the Activity Measure for Post-Acute Care Basic Mobility Score (BMS). Static and dynamic pain scores during recovery were recorded during the acute pain service visits. Static pain scores were inquired while the patient was supine in bed; dynamic pain scores were asked during performance of motor strength assessment. Maximum pain scores were derived from review of patient charts. Other outcomes included mean opioid use (in milligrams of intravenous morphine equivalents), day of discharge, and discharge destination. In an effort to standardize postoperative analgesic use and pain score data collection, the following definitions were used for this study: postoperative day 0 (POD 0) is the time from end of surgery to 24 hours thereafter; POD 1 is 24-48 hours after end of surgery or until the PVB catheter was removed, whichever occurred first. No data for any variable was collected after patients had their paravertebral catheter removed.

Means and standard deviations for numerical data were calculated using Microsoft Excel (Microsoft, Redmond WA). As this is a case series rather than a case/control study, no comparative statistics were performed

Results

Patient characteristics are presented in Table 1. Only 5 of the 20 patients required an assistive device for ambulation on presentation to the preoperative bay secondary to hip pain; no patients reported preoperative baseline lower extremity weakness. All patients received postoperative acetaminophen, celecoxib, and dexamethasone. 10 patients were using opioids as analgesics prior to surgery.

Immediately after placement and dosing of the paravertebral catheters, all patients had ipsilateral sensory deficit to cold in L1, L2 or L3 distribution. 9 patients had no motor weakness to Oxford testing; 11 of the 20 patients (55%) had 2/5 or 3/5 hip flexor or quadriceps strength. The morning after surgery, mean motor strength was 3.5 ± 2.5 of the 20 patients (85%) had at least 3/5 hip flexion strength. 2 patients had 2/5 strength; one patient had no numerical value assessed. On postoperative day 1, basic mobility scores ranged from 15 to 24, with a mean BMS of 18.4 ± 2.3 (Table 2). No patient had sufficient weakness to prevent ambulation or participation in physical therapy on POD1.

Postoperative pain scores are also shown in Table 2. Mean maximum pain on POD0 was 5.4 ± 3.0. On POD1, mean static and dynamic pain scores were 1.2 ± 1.6 and 3.5 ± 2.5, respectively.

Table 1
Patient characteristics

Pt ID	Age	ASA	Sex	Operative Side	Consistent preoperative opioid, if any	Baseline static pain	Baseline dynamic pain
1	70	2	F	Right	No	0	6
2	66	3	M	Left	No	0	5
3	66	2	F	Right	Yes	5	9
4	62	2	M	Right	No	0	5
5	68	3	M	Right	No	1	10
6	75	3	F	Right	Yes	2.5	9.5
7	65	2	F	Left	No	1.5	4
8	61	2	F	Right	No	0	6
9	65	2	F	Right	No	4	9.5
10	71	2	F	Right	Yes	0	7
11	63	2	M	Left	No	0	2
12	56	2	M	Right	Yes	0	7
13	61	2	F	Right	Yes	0	10
14	53	2	F	Left	Yes	0.5	7
15	68	2	F	Left	Yes	0.5	4.5
16	61	3	F	Right	No	3	7
17	61	2	F	Left	Yes	0	5.5
18	70	3	F	Right	Yes	2	9
19	65	2	M	Right	Yes	2	3
20	70	2	F	Right	No	0	5
Mean ± SD	64.8 ± 5.3					1.1 ± 1.5	6.6 ± 2.4

As shown in Table 3, mean opioid use during POD0 was 22.5 mg ± 13.3, with decreased usage of 16.5mg ± 11.4 on POD1 (Figs. 2 and 3).

Regarding discharge, 17 patients (85%) were discharged on or before POD2; the remaining 3 patients were discharged on POD3. Mean discharge day was 2.1 ± 0.5. All but one patient were discharged home.

All patients had functioning paravertebral catheters (as assessed by sensory deficit in L2 distribution) until scheduled removal time; no patients required postoperative boluses to re-establish sensory blockade.

Discussion

Nerve supply to the hip joint is complex and variable among individuals. However, the main peripheral nerves thought to innervate the hip joint are femoral (posterior divisions of L2-L4), obturator (anterior division of L2-L4) and sacral plexus branches (L4-L5, S1-S3)[9]. Although less well defined, osteotomal innervation is thought to be via L2 and L3 primarily[10]. As the L2 nerve root contributes to several peripheral nerves including genitofemoral, lateral femoral cutaneous, femoral, and obturator nerves, sensory blockade at this nerve root level would appear to be beneficial in hip surgery. Direct anterior approach total hip arthroplasty has been suggested as a less-invasive surgical technique which may be associated with less postoperative pain and shortened hospital stay compared to the posterior-lateral approach[1]. However, pain following any arthroplasty is universal and aggressive pain control with minimization of motor weakness is warranted to enable patients to participate in physical therapy and rehabilitation. Previously we had investigated the use of single-shot T12-L2 PVB for DA-THA, and had favorable results[7]. However, in that case series duration of block was not assessed. In this current case series we investigated

Table 2
Postoperative motor strength, basic mobility, and pain scores

Patient ID	POD1 Motor strength at hip (Oxford scale)	POD1 Basic Mobility Score	POD0 maximum pain	POD1 Static Pain	POD1 Dynamic pain
1	3	17	7	0	5
2	5	18	2	1	5
3	3	17	8	3	3
4	5	24	7	0	0
5	3	23	4	2	7
6	3	18	6	5	8
7	2	17	6	0	2
8	n/a	19	0	0	4
9	5	18	8	0	0
10	3	16	3.5	0	7
11	5	18	0	0	0
12	4	19	7	0	2
13	3	17	9	2	4
14	3	19	10	0	6
15	5	23	0	0.5	2
16	2	15	8	4.5	6
17	3	18	7	3.5	4
18	3	17	6	2	2
19	3	18	5	1	2
20	3	17	5	0	0
Mean ± SD	3.5 ± 1.0	18.4 ± 2.3	5.4 ± 3.0	1.2 ± 1.6	3.5 ± 2.5

if continuous L2 PVB catheter could be a suitable alternative for postoperative analgesia. Dynamic and maximum pain scores were comparable to our previous study of paravertebral blockade use, although POD0 maximum pain scores were lower in that initial study. Additionally, dynamic pain scores at 24 hours are in agreement with a previous study of L2 PVB catheter use in this patient population[8].

Regarding patient mobility, it is interesting to note that even though over half of the patients had hip weakness soon after initial dosing of the PVB catheter, 17 patients had hip strength scores greater than or equal to 3/5 the morning after surgery. Of the 3 patients who required assistance with ambulation preoperatively, two had required assistive devices preoperatively: one with a single point cane and the other with a 3-4 wheeled rolling walker. The initial presentation of motor weakness may be secondary to the initial dose of 50mg of ropivacaine volume of injectate. Previous literature suggests that the use of large injectate volumes in the paravertebral space may lead to epidural or unpredictable spread[11-13]. In the Wardhan study investigating the use of L2 PVB catheter for DA-THA, after an initial bolus of 15ml of local anesthetic, motor weakness was found to be no different than that associated with continuous lumbar plexus blockade. While the injectate volume large enough to cause epidural spread or motor weakness is not clear, it is possible that 10ml may be sufficient to extend spread of local anesthetic beyond the paravertebral space. However, no patient had bilateral sensory deficit suggestive of epidural spread at any point during the study.

Mean basic mobility score the day after surgery was 18.4 on a scale of 24, which approximately equates to a degree of functional impairment of 42-45%[14]. While the mean degree of functional impairment as measured by this metric has yet to be established in the general DA-THA population, one recent study suggested that mobility scores could be predictive

Table 3

Postoperative opioid use and discharge

Patient ID	POD0 Morphine Equivalent (mg)	POD1 Morphine Equivalent (mg)	Day of Discharge	Discharge Destination
1	15.83	15	2	Home
2	10	25	2	Home
3	40	26.33	3	Home
4	13.33	5	2	Home
5	35	30	2	Home
6	40	28.33	3	Home
7	15	10	2	Home
8	10	6	2	Home
9	21.67	15	2	Home
10	40	25	2	Home
11	10	15	2	Home
12	28.33	25	2	Home
13	28.33	40	2	Home
14	41.67	2.5	2	Home
15	10	0	1	Home
16	23.33	15	2	Home
17	38.33	30	2	Home
18	5	5	2	Home
19	23.33	5	2	Home
20	0	7.5	3	Nursing facility
Mean ± SD	22.5 ± 13.3	16.5 ±11.4	2.1 ± 0.5	

of discharge destination: patients who had a BMS of approximately 21 being more likely to be discharged home, while patients with a BMS of 14 were more likely to be discharged to an institution[15]. At our institution, the majority of patients undergoing DA-THA have sufficient mobility to be discharged home with home-based physical therapy. Thus, the fact that 19 of the 20 patients in our case series were in fact discharged directly to home is very encouraging and supports the possibility that the degree of functional impairment seen from an L2 paravertebral catheter was not significant enough to hinder physical therapy or alter discharge destination.

Previous studies show variable results regarding mean opioid use after DA-THA. Mean opioid use as high as 32.2mg-50.7mg IV morphine equivalents has been reported on POD0 and POD1, respectively[16] Another study described much lower values of 11.2mg and 13.9mg for POD0 and POD1 mean intravenous morphine consumption, respectively[17] Interestingly, opioid use in our current investigation may be higher than that previously seen with use of single shot T12-L2 paravertebral blocks[7]. Mean cumulative opioid consumption until 48 hours after end of surgery was 39 mg compared to 25mg until the morning of POD2 in our previous single shot PVB investigation. However, because time period definitions are different in the two studies, the comparison may be biased toward inclusion of more opioid administrations in our current study. Overall, opioid use was comparable to that of a previous investigation of L2 PVB catheter for minimally invasive hip surgery[8].

There are several limitations to our non-randomized retrospective study. First, motor weakness immediately after placement of PVB catheter, if present, was graded with a standard Oxford motor examination scale from 0 to 5, and not with the BMS scale. Only the presence of a change from baseline

motor 5/5 strength was noted. Thus, the degree of mobility inhibition caused by initial PVB catheter bolusing and its contribution, if any, to POD1 weakness can only be inferred. Second, follow-up sensory deficit testing, while assessing L2 blockade, did not assess spread to sciatic dermatomes. Thus, it is possible that greater-than-expected spread occurred, which may have contributed to any motor weakness seen. Additionally, temporary sensory deficit and motor weakness secondary to surgical technique cannot be excluded. However, no patient had continued sensory deficit after PVB catheter removal. Third, our study is subject to observer bias. The anesthesiology fellow or attending was not blinded to the analgesic technique; furthermore, the practitioner placing the block was also involved in follow-up. However, postoperative sensory and motor testing was performed as described in the methods section by acute pain nurses, and thus we believe that bias favoring blockade success was minimized via this approach. Lastly, this case series by definition lacks a comparison group; thus the degree of efficacy compared to placebo or lumbar plexus catheter cannot be inferred. It is important to note that although no major complications were documented among our 20 patients, this observational case series was not designed to study the side effects of lumbar paravertebral blocks.

Conclusions

While over half of the patients in our case series had some hip weakness postoperatively, participation in physical therapy was not hindered. An L2 PVB catheter, combined with a multimodal postoperative pain control regimen, provided adequate analgesia after anterior-approach THA at our institution. The majority of patients were discharged on postoperative day 2. Further investigations should be done to determine the effects of L2 PVB on motor preservation and to determine more about the safety and efficacy of this analgesic technique, as well as its applicability to other settings

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