Original Article

Peripheral nerve blocks for above knee amputation in high-risk patients

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Abstract

Background and Aims: Above knee amputation (AKA) is associated with considerable mortality and morbidity. There is paucity of data describing the use of peripheral nerve blocks (PNB) as the sole anesthetic technique in high-risk patients undergoing AKA. Our objectives were to evaluate the use of PNB as sole anesthetic technique in the above-mentioned population and its clinical outcomes.
Material and Methods: This was a retrospective descriptive study conducted in a tertiary hospital. For this study, patients with American Society of Anesthesiologist [ASA] IV physical status underwent AKA using PNB between January 2010 and December 2016, were identified. The primary outcome measured was the success of the operation. The secondary outcomes were block details, intraoperative hemodynamics, usage of sedation and analgesia, patients' comorbidities, mortality rates at 30 days and one year.
Results: Out of fifty-seven patients, the median age (interquartile range) was 74 (57 – 81) years and 60% were males. The results show 91% successfully underwent surgery with PNB (95% CI 81% to 96%). 95% required intraoperative sedation and analgesia. 67% received combined femoral, obturator and sciatic nerve blocks, in which nine cases had an additional lateral femoral cutaneous nerve block. Interestingly, 33% only received combined femoral and sciatic nerve blocks, and they required higher sedation analgesia ($p = 0.013$). The 30-day and one-year mortality were 12.3% & 47.4%. Majority had stable hemodynamics during the surgery.
Conclusion: This study shows that PNB is a viable option for reliable anesthesia for AKA in high-risk patients. Combined FOS nerve block would reduce the dose for sedation–analgesia during the operation.

Keywords: Above knee amputation, high-risk patients, peripheral nerve blocks, regional anesthesia, survival

Introduction

Patients undergoing non-traumatic major lower extremity amputation (MLEA) such as above knee amputation (AKA) commonly have multiple comorbidities like diabetes mellitus, cardiovascular and renal disorders[1,2] and they are at risk of significant postoperative morbidity and mortality.

AKA is often the last resort following failed limb salvage treatment.[3] When performed as an emergency, it is for prompt infectious source control in overwhelming soft-tissue or bone infection. Patients at this point of presentation are in severe sepsis with multi-organ dysfunction confounded by poor comorbidities translating to high risk of perioperative complications. In one study[2], a patient with ASA grade ≥4 undergoing MLEA was associated with a greater than fourfold increase in 30-day mortality, and a twofold increase in long-term mortality. The long-term survival for those undergoing AKA is dismal.[4]

Peripheral nerve block (PNB) is the preferred choice of anesthetic technique for high-risk patients undergoing MLEA

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Access this article online	
Quick Response Code:	Website: www.joacp.org
	DOI: 10.4103/joacp.JOACP_346_17

How to cite this article: Chandran R, Beh ZY, Tsai FC, Kuruppu SD, Lim JY. Peripheral nerve blocks for above knee amputation in high-risk patients. J Anaesthesiol Clin Pharmacol 2018;34:458-64.

in our center. However, the effects of peripheral nerve blocks (PNB) as the sole anesthetic technique in high-risk patients undergoing AKA have not been fully evaluated and only a few case series were reported.[5-7] We aimed to evaluate the use PNB as sole anesthetic technique for the above-mentioned population and its clinical outcomes.

Material and Methods

This retrospective descriptive study (January 1, 2010 to December 31, 2016) was conducted with a waiver of informed consent approved by SingHealth Centralized Institutional Review Board (CIRB Ref: 2018/2010), https://research.singhealth.com.sg. All patients categorized as high risk [American Society of Anesthesiologist (ASA) IV and V] who underwent nontraumatic transfemoral, AKA using PNB in the above-mentioned period were included. Major amputations secondary to trauma were excluded.

Data collection source included patients' hospital electronic medical records, anesthesia files, and departmental nerve block audit database. Patients' demographic profiles, ASA status, comorbidities, and investigation results were retrieved from the hospital electronic records. Details of the PNB, intraoperative hemodynamic status, usage of sedation and analgesia were obtained from the nerve block audit database and anesthesia records.

We evaluated the success of the operation using PNB, nerve blocks details, intraoperative hemodynamic status, and usage of sedation and analgesia, plus postoperative monitoring destination. Patients' survival at 30 days and 1 year were determined. We defined block success[8] in this study as the ability to proceed with the surgery without conversion to general anesthesia or spinal anesthesia.

Patients' various comorbidities were further evaluated using the Charlson comorbidity index, a validated scoring system which contains 19 categories of comorbidities, and predicts the one-year mortality.[9] The mortality rate increased with increasing Charlson Score: none (0), 7%; low (1 – 2), 22%; moderate (3 – 4), 31%; and high (≥5), 40%.[9]

Additional sedation and analgesia are commonly required to facilitate AKA.[5-7] The commonly used drugs for sedation and analgesia included fentanyl, midazolam, ketamine, and propofol. As for the intraoperative usage of sedation and analgesia, we considered mild sedation-analgesia if only one or two agents in low dose were used, such as fentanyl (<1mcg/kg), midazolam (<0.05mg/kg), ketamine (<0.5mg/kg), propofol (< 25mcg/kg/min or target controlled infusion < 0.5mcg/ml). Any usage of more than two agents or using higher dose with a single agent would be considered as moderate to deep sedation-analgesia. For the purpose of the study, hypotension was defined as a decreased in mean arterial pressure (MAP) of >20% from the baseline value and required vasopressors. The intraoperative hemodynamics status for the first 120 minutes after administering the PNB was evaluated and the usage of vasopressors, such as ephedrine and phenylephrine, during the surgery was determined.

Statistical analysis

Descriptive statistics for categorical data were presented as frequency and percentage. Numerical data were presented as median [(interquartile range) IQR] unless otherwise specified. The differences in characteristics were examined using Mann–Whitney *U*-test for numerical variables; Chi-square test or Fisher's exact test were adopted for categorical variables. A two-tailed, *P* value <0.05 was considered statistically significant. Statistical data analysis was performed with SPSS statistical software, version 19.0 (IBM Corp. Armonk, NY).

Results

Patient characteristics

During the study period, 57 ASA IV patients underwent AKA using PNB [Table 1]. None of the patients with ASA V status were identified. The demographic data and the duration of surgery are given in Table 1.

Major comorbidities

Table 2 shows that the patients were generally very sick. Each of them had at least four major comorbidities. The

Table 1: Above knee amputation on high-risk patients - characteristics and association with mortality

Characteristics		Association with mortality (*P*)
Age (years)		
Median (IQR)	74 (57-81)	0.538*
Gender, *n* (%)		
Male	34 (59.6)	0.629*
Female	23 (30.4)	
BMI (kg/m^2)		
Median (IQR)	21.5 (20.5-26.4)	0.542*
Discipline, *n* (%)		
Vascular surgery	33 (57.9)	0.843*
Orthopedic	24 (42.1)	
Charlson comorbidity index		
Median (IQR)	8.0 (7.0 – 10.0)	0.048
Duration of surgery, minute		
Median (IQR)	85 (50-120)	N/A

**Pearson's Chi-square test; N/A=Not applicable, IQR=Interquartile range, BMI=Body mass index*

Table 2: Major comorbidities and its association with mortality

Major comorbidities	Cases (%)	Association with mortality (*P*)
Hypertension	55 (96.5)	0.172
Diabetes mellitus with end organ damage (retinopathy, neuropathy, nephropathy)	55 (96.5)	0.940
Cardiovascular problem		
Known IHD	49 (86)	0.872
Recent* ACS (STEMI, NSTEMI, troponin leak due to sepsis)	9 (15.8)	0.848
Cardiac arrhythmia with or without pacemaker	4 (7)	0.913
CHF	32 (56.1)	0.129
PVD	35 (61.4)	0.439
Neurological problem		
Old CVA	12 (21.1)	0.139
Acute CVA†	5 (8.8)	
Others - dementia, parkinsonism, meningioma	11 (19.3)	
Renal problem		
CKD 1-3	25 (43.8)	0.064
CKD 4-5	6 (10.5)	
Sepsis		
Sepsis‡	53 (93)	0.55
Septic shock (at clinical presentation)	4 (7)	
Bleeding potential		
Mild coagulopathy (requires FFP transfusion)	2 (3.5)	0.36
Antiplatelet and anticoagulation therapy	43 (75.4)	
Other significant comorbidities		
Lung disorders (pleural effusion, asthma, chronic obstructive pulmonary disease, superimposed pneumonia)	4 (7)	N/A
Previous lower limb deep vein thrombosis (with or without caval filter)	3 (5.3)	
Clinical hypothyroidism	1 (1.7)	
Chronic liver disease	2 (3.5)	

*All values are expressed in numbers and percentages; Pearson's Chi-square test or Fisher's exact test were adopted for categorical variables, where appropriate. *Recent ACS defined as diagnosis within 3 months prior to surgery or during current hospital admission; One of them had STEMI, 3 had NSTEMI and 3 had raised troponin level likely secondary to sepsis as diagnosed by cardiologists, †Two unilateral MCA territory infarct, 1 unilateral PCA infarct, and 1 bilateral cerebellar infarct; ‡Evidenced by clinical signs, raised total white cell counts, raised inflammatory markers, i.e., CRP bacteremia from blood cultures. CRP=C-reactive protein, N/A=Not applicable, FFP=Fresh frozen plasma, IHD=Ischemic heart disease, CHF=Congestive heart failure, PVD=Peripheral vascular disease, CVA=Cerebrovascular accident, STEMI=ST elevation myocardial infarction, NSTEMI=Non-ST elevation myocardial infarction, MCA=Middle cerebral artery, PCA=Posterior cerebral artery, CKD=Chronic kidney disease*

median Charlson comorbidity index was 8.0 (IQR 7.0 – 10.0, *p* value 0.048) which indicates high one-year mortality. Forty nine (86%) patients had recent transthoracic echocardiography (performed within the last 6 months) or during the current hospital admission; 14 cases (24.6%) had preserved left ventricular function (ejection fraction ≥50%); 35 cases had impaired left ventricular function (mean ejection fraction 38 ± 15%) and the lowest ejection fraction was 10%; 2 patients had poor heart function with left ventricular apical clot. Four cases had a history of cardiac arrhythmias such as sick sinus syndrome, complete heart block, and chronic atrial fibrillation. One of them had pacemakers inserted.

All patients had evidence of sepsis from the affected lower extremity. Of the four patients presented with septic shock on admission, three had been successfully weaned from vasopressor before operative procedure. Various comorbidities are listed in Table 2.

Peripheral nerve blocks and patient survival

Ninety-one percent (52 patients) successfully underwent surgery with PNB [Table 3]. Only 5% of the operations were performed under PNB without the usage of sedation or analgesia in the intraoperative period. Sixty-seven percent received combined femoral, obturator, and sciatic (FOS) nerve blocks, in which nine cases had an additional lateral femoral cutaneous nerve (LFCN) block (lateral FOS). The rest of the patient had combined femoral and sciatic nerve (FS) blocks. The FS group required higher sedation and analgesia compared to the FOS and FOSL groups (*P*-value = 0.013).

Two patients had bilateral AKA in the same operative setting, in which blocks were performed in stages. PNB was given to one side first. Another round of PNB was delivered at the contralateral limb after completion of the first amputation. All received FOSL and both cases were successfully operated using PNB.

Sixty-five percent of the blocks were performed with ultrasound, and the rest used dual guidance (ultrasound and peripheral nerve stimulator). Variable local anesthetic (LA) concentrations and volumes [Table 4] were used by specialists experienced in performing PNB. All subjects received standard ASA monitoring. For hemodynamic monitoring, 40% of the patients had an arterial line. Majority of the patients were hemodynamically stable during operation [Figure 1] except for 10 patients which required vasopressor during operation. Patients in our study had a 1-year survival of 53% [Table 5]. The 30-day mortality was noted at 12%. The intraoperative mortality and within 48 h after surgery was observed to be zero. The earliest recorded death was on the sixth postoperative day.

Table 3: Characteristics of peripheral nerve block (PNB)

Type of PNB	FS† (*n*=19)	FOS† (*n*=29)	FOSL*,† (*n*=9)	*P*
Block success, *n* (success rate=91%)	16	27	9	0.339
Nerve localization technique, *n*				
Ultrasound	10	20	7	0.346
US + peripheral nerve stimulator	9	9	2	
Intraoperative				
Sedation and analgesia				
Not required	0	1	2	0.013**
Mild	6	17	9	
Moderate-deep	9	9	0	
Hemodynamic				
Stable	16	22	9	0.243
Required vasopressor	3	7‡	0	

*All values are expressed in numbers; Pearson Chi-square test and Fisher's exact test were used where appropriate. *Two cases had bilateral AKA in the same operative setting in which blocks were performed in stages, one after another amputation: all received FOSL. **Comparison made between type of PNB and group with moderate-deep sedation plus group with mild or no sedation. †Sciatic nerve block - 82% proximal approach (parasacral, transgluteal, subgluteal), 15% mid-thigh level, 3% popliteal approach. ‡One case had dopamine infusion preoperatively and no further escalation of dose during operation. N/A=Not applicable, FS=Femoral plus sciatic nerve block, FOS=Femoral, obturator, and sciatic nerve block, FOSL=Femoral, obturator, sciatic nerve, and lateral femoral cutaneous nerve block, AKA=Above knee amputation, US=Ultrasound*

Table 4: Characteristics of local anesthetic

Type of local anesthetic*	Concentration (%)	Total volume (ml)	Additive
Ropivacaine	0.4, 0.5, 0.6, 0.7, 0.75	20-40	23% used epinephrine 5 μg/ml
Bupivacaine	0.25, 0.375, 0.5	20-25	
Levo-bupivacaine	0.25, 0.5	20-25	
Lignocaine	1-1.5	20-30	

**53% used admixture of long-acting and short-acting LA (bupivacaine or levo-bupivacaine mixed with lignocaine). LA=Local anesthetic*

Table 5: Patients' survival after AKA

Survival after operation	Number (%)
Survived >1 year	30 (53)
Died within 30 days	7 (12)
1 month <died ≤3 months	7 (12)
3 months <died ≤6 months	4 (7)
6 months <died ≤1 year	9 (16)

Discussion

Our study has confirmed that PNB could be used as the sole anesthetic technique in high-risk patients having AKA with high success rate. We present a relatively large number of ASA IV patients underwent AKA with PNB. The existing literatures were just a small case series of four patients[5] and two individual case reports.[6,7]

The neuraxial anesthesia in the form of a subarachnoid block has always been considered as the gold standard technique for lower extremity surgeries.[10-13] However, it is unsafe to perform neuraxial blocks on high-risk patients with deranged coagulation secondary to sepsis or the use of anticoagulant/antiplatelet medications.[14,15] Further, anesthesiologists may choose to avoid subarachnoid blocks in patients with limited cardiovascular reserve due to the risk of significant hemodynamic instability.

PNB give greater hemodynamic stability than any other anesthetic techniques.[16-18] Figure 1 showed stable hemodynamic trend over 120 minutes after receiving PNB. Only 18% of the cases required some amount of vasopressor during operation, and that could be due to the usage of higher sedation-analgesia, and patients had limited cardiovascular reserve and bleeding during operation. PNB has also proven to provide excellent anesthesia and analgesia[17-19] for a variety of surgeries, with a particular benefit on those undergoing the upper and lower extremity surgeries. [7,20]

In the textbook, the recommended PNB of choice for AKA surgery would be lumbar plexus block combined with sciatic nerve block.[19,21,22] A lumbar plexus block should block the femoral, obturator, lateral femoral cutaneous and genitofemoral nerves. However, it is a deeply seated block in a highly vascular area requiring a high volume of LA. The anatomy poses an increased risk of local anesthetic systemic toxicity (LAST) and hematoma. The presence of coagulopathy or the use of anticoagulants or antiplatelet further enhances the risk of hematoma. In addition, most literature[23] described lumbar plexus block as a technique for intra-operative and post-operative analgesia following lower limb surgeries. The quality of anesthesia is inconsistent for it to be used as a sole anesthetic for any surgical procedure (even when combined with sciatic nerve block). Therefore, the anesthesiologists selectively block the main components of lumbar plexus – femoral and obturator nerves in 67% of the patients, lateral femoral cutaneous nerve (LFCN) is also blocked for some patients.[7]

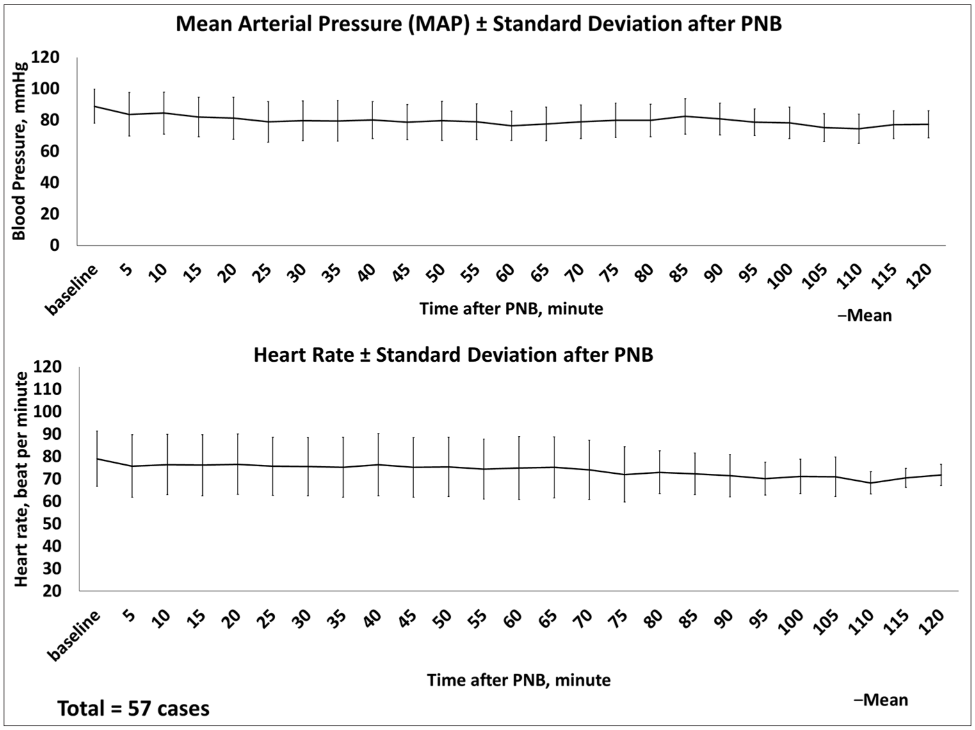

Figure 1: Changes of MAP and heart rate from baseline and 2 h after peripheral nerve block

Some anesthesiologists did not block the obturator and lateral femoral cutaneous nerve, which is essential to achieve complete anesthesia for AKA. Owing to poor documentation, we could not determine the reason for blocking only femoral and sciatic nerve. Our assumptions – patients were mostly very sick and small size hence limiting the LA dose and volume, the sonoanatomy might not be clearly visualized due to tissue edema and not every operator was familiar with obturator nerve or LFCN block. The operators probably believed, the medial and lateral aspect incision discomfort could be overcome with sedation analgesia and local infiltration by the surgeon. Therefore, we are not surprised that the FS group required higher sedation analgesia.

Sixty-five percent of the blocks were performed with ultrasound, and the rest used dual guidance (ultrasound plus peripheral nerve stimulator). The use of ultrasound in lower extremity block had shown to decrease block performance time, reduce block onset time, increase the rate of sensory block and improve the efficacy of analgesia.[24,25] Dual guidance is useful in cases involving deep and challenging blocks whereby the visualization of sonographic images of the needle and neural structure is poor.

Mortality

Several studies on MLEA which include AKA and below knee amputation (BKA)[1,26,27], have quoted high mortality rates of 13.5 – 22% at 30 days and 44 – 48.3% at one year. The above-mentioned studies did not evaluate the choice of anesthetic technique used. Scott *et al*.[2], found no association between the choices of anesthetic technique (neuraxial regional anesthesia or general anesthesia) with survival after MLEA when corrected for other variables. However, patients in their study did not receive PNB. The overall 30-day mortality in their study[2] was 12.4%, but in patients with ASA grade 4 or 5 was 23.2%. Our study showed 30-day mortality of 12.3% and 1-year mortality of 47.4%. Our study had no control group. The perceived mortality benefits from this study need to be supported by randomized control study (RCT). Various factors that can affect in-hospital mortality apart from the anesthetic technique are cardiac complications, nosocomial infection, venous thromboembolism and poor wound healing.[27] Nevertheless, our study showed that PNB could reliably provide stable hemodynamic throughout the operation without any reported case of intraoperative mortality.

Limitations

Our study only involved a single center with a relatively small cohort number to determine the mortality benefit. This study is also based on the analysis of retrospective data. Poor documentation such as the need for LA infiltration by surgeon precludes our further evaluation of failed block cases. We had no standardized LA type, concentration, or volume [Table 4]. LA dosages used in PNB are based on the principle of maximal allowable dose. A maximal allowable dose may be calculated and diluted into a large, convenient to administer volume (usually 30–40 ml). In this study, the attending anesthesiologist determined the volume based on the preference of LA, patient's body weight, and intended amount to achieve a successful block of each nerve. The amount of LA used was also dependent on technical difficulties encountered due to patient, operator, or equipment factors, i.e., edematous soft tissue resulting in a bad ultrasound image and/or associated with a reduced motor response on the use of peripheral nerve stimulator. This information was often not documented in the database and hence precluded further analysis. Our study revealed that several patients had received LA doses, which had marginally exceeded the upper limit of dosage recommendation based on body weight. There was no reported incidence of LAST in this study. Bech *et al*.[5] had used LA volume of 60–70 ml admixture of bupivacaine 0.5% plus carbocaine 2% with epinephrine in four high-risk patients that underwent AKA using PNB.

It is well appreciated that the relationship between dosage of LA and a successful PNB is complicated and not well understood. Many anatomical, physiological, pharmacological, and procedural factors determine the likelihood of block success.[28] Use of combinations of LA is well known in PNB, i.e., the use of faster onset of short-acting LA with the prolonged duration of long-acting LA. In our study, 53% cases received admixture of long-acting and short-acting LA [Table 4]. This may offer a safety advantage by dose sparing of the long-acting LA, which is potentially more cardiotoxic than the short-acting LA. However, practitioners should be aware that LAST can be secondary to an additive effect and careful consideration should be given to the total dose of LA administered.[28] Also, our study population consisted mostly of elderly patients with multiple comorbidities such as poor heart function and liver impairment. These conditions warrant administration of a lower dose of LA. Aging affects the pharmacokinetics and pharmacodynamics of LA, composition, and characteristics of tissues and organs and physiological function of the body. Changes in the systemic absorption, distribution, and clearance of LA lead to an increased sensitivity, decreased dose requirement, and a change in the onset and duration of action in the elderly. Likewise, in patients with congestive heart failure, there is a reduction in the volume of distribution and impairment of clearance. As a result, plasma concentration of LA in this group of patients is usually higher.

Conclusion

Findings of this study showed PNB is a viable option for reliable anesthesia for AKA in high-risk patients. A majority of these patients (95%) had supplemental analgesia and sedation during the procedure. Combined FOS nerve block would reduce the dose for sedation–analgesia during the operation. Majority had stable hemodynamic during the operation.

Acknowledgement

The authors would like to thank Ms Carmen Kam, M.Sc. Statistics, Research Officer from the Department of Clinical Trials and Research Unit, CGH for her assistance with statistical analysis.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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