

Research Article

Adductor Canal Blocks May Result in Long-Term Neuropathy After Total Knee Arthroplasty

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Background

The aims of this study were to determine the incidence of block-related complications after adductor canal blocks (ACB) in total knee arthroplasty (TKA), identify associated risk factors, and investigate if there were any differences in clinical outcomes.

Methods

368 consecutive patients underwent primary TKA from January 2017 to December 2019, of which 207 had an ACB. Patient demography, comorbidities, intraoperative details, complications, and clinical outcomes were retrospectively reviewed. The relationship between these variables and block-related complications was investigated.

Results

At 6 weeks after surgery, 8.7% of patients who received an ACB reported symptoms over the saphenous nerve distribution while 6.3% and 4.8% had persistent symptoms at 1 year and 5 years respectively. 55.6% of these patients were treated for neuropathic pain in the early postoperative period. Significant association was found between neuropathy after an ACB and the presence of spine pathology, use of dexmedetomidine, administration of spinal anaesthesia (SA)-only and volume of local anaesthetic. Multivariate logistic regression analysis identified spine pathology and the administration of SA-only as significant contributors to the presence of neuropathy after an ACB. There were

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differences in early clinical outcomes between groups but not at 6 months and 1 year postoperatively.

Conclusion

Adductor canal blocks may result in persistent neuropathy and problematic symptoms after total knee arthroplasty.

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INTRODUCTION

Total knee arthroplasty (TKA) is a successful procedure for treating end-stage osteoarthritis of the knee. Nevertheless, pain following TKA can be severe in the early perioperative period and may not diminish until 48-72 hours after the surgery (Paul et al. 2010). Effective control of early postoperative pain is therefore essential to allow patients to commence early physiotherapy and ambulation, which has been shown to reduce the risks of deep vein thrombosis, stiffness and infection (Paul et al. 2010), as well as length of stay (Kessler et al. 2013), readmission rates (Coley et al. 2002) and cost of care (Azim et al. 2013). A multimodal approach is often employed to optimize postoperative pain control. Regional pain control techniques can provide excellent analgesia during initial mobilization while limiting patients' exposure to the adverse events related to traditionally-used opioids and their systemic effects (Sargant et al. 2018; Sato et al. 2011).

Recent clinical practice guidelines on regional nerve blocks recommend the use of a single-shot adductor canal block (ACB) over a femoral nerve block (FNB) when regional anaesthesia is used in primary TKA (Fillingham et al. 2022). The shift away from FNBs, the long-time standard, is due to its association with quadriceps weakness whilst the ACB, described as a sensory nerve block, provides a similar degree of analgesia with the intention of preserving quadriceps strength (Jaeger et al. 2013). Both the saphenous nerve and a sensory branch of the obturator nerve travel within the adductor canal of the thigh, and thus, injecting local anaesthetic into the canal provides ambulatory analgesia sufficient to allow mobilisation following TKA (Lund et al. 2011). However, not all studies have supported the efficacy of ACBs (Grosso et al. 2018).

In the literature, complications related to regional nerve blocks are well-described (Cuvillon et al. 2001; Wulf 2012). However, ACBs are generally perceived to be safe and benign (Sveom et al. 2022; Zhu et al. 2020) and hence its popularity. Nevertheless, studies detailing complications arising from the administration of ACBs are limited. Specifically, the incidence of nerve injury following ACBs is largely unknown. This is an important consideration for

both anaesthetists and surgeons and could influence routine counselling and consent for ACBs. In addition, information on whether ACB nerve injury affects TKA outcomes is crucial for patients when making an informed decision. Therefore, the aims of this study were (1) to determine the incidence of neuropathy after ACBs in TKA, (2) to determine the incidence of other block-related complications, (3) to identify risk factors associated with these complications and (4) to investigate if there were any differences in clinical outcomes following TKA in patients who had residual nerve symptoms. The study hypothesis is ACBs have a very low incidence of nerve injury and do not affect clinical outcome following TKA.

MATERIALS AND METHODS

This was a retrospective study of consecutive TKAs performed at the authors' institution from January 2017 to December 2019, approved by the local human research ethics committee (No. 2023ETH/0013) prior to commencement. The study was designed and conducted following the STROBE guidelines and in agreement with the Declaration of Helsinki. Patients who underwent primary TKA for end-stage knee osteoarthritis and who had an adductor canal block perioperatively were included while those who had a unicompartmental knee replacement or revision TKA were excluded. During the study period, 368 primary TKAs were performed, and of these, 207 patients received an ACB while 161 did not.

Information was retrieved from patient charts and the authors' institutional database on patient demography, American Society of Anesthesiologists (ASA) status, comorbidities, anaesthetic details including information regarding ACBs, clinical outcomes, and complications. Patients with spine pathology were those who have been diagnosed and received treatment for spinal degenerative disc disease, neural compression symptoms, or stenosis. Complications were categorized into ACB-related or surgery-related. ACB-related complications included infection, hematoma, neurological injury, vascular injury, and local anaesthetic systemic toxicity (LAST). LAST is a potentially life-threatening adverse reaction which presents with neurological and car-



Figure 1. Area of interest innervated by the medial crural cutaneous branches of the saphenous nerve when assessing for neuropathy

diovascular features resulting from circulating levels of local anaesthetic reaching toxic levels after administration. Neurological injury was detected during follow-up, when patients were asked regarding symptoms and examined for paresthesia over the area of distribution of the medial crural cutaneous branches of the saphenous nerve (Figure 1). Injury to the infrapatellar branch of the saphenous nerve is a well-known complication after TKA (Henningsen et al. 2013). Therefore, focusing on the cutaneous area over the medial aspect of the lower leg, which is innervated by the medial crural cutaneous branches of the saphenous nerve, eliminates surgery as a causative factor. The Knee Injury and Osteoarthritis Outcome Score, Joint Replacement (KOOS JR) and KOOS-12 scores were used to assess clinical outcomes at 3 months, 6 months and 1 year. Patients' overall satisfaction with surgery was measured on a 4-point Likert scale with response categories consisting of very satisfied (100 points), somewhat satisfied (75 points), somewhat dissatisfied (50 points), and very dissatisfied (25 points) (Mahomed et al. 2011). 'Very satisfied' and 'somewhat satisfied' responses were grouped as 'satisfied' while 'somewhat dissatisfied' and 'very dissatisfied' responses were grouped as 'dissatisfied'. Patients who experienced symptoms of neuropathy were asked during follow-up if the complication worried them and if they would have the ACB if they had to do it over again.

All surgeries were performed by the senior surgeon through a medial parapatellar approach with computer navigation, utilizing a fully cemented implant with routine patellar resurfacing and without a tourniquet. During the study period, the surgeon transitioned his practice from fixed-bearing cruciate retaining prostheses to mobile-bear-

ing posterior stabilized prostheses. Intraoperatively, peri-articular local anaesthetic infiltration (LAI) was routinely administered to periarticular capsule as part of the multimodal approach to postoperative pain control, whether the patient received an ACB or not. The decision to administer an ACB was at the discretion of the anaesthetist, influenced by their preference and training. ACBs consisting of ropivacaine, with or without dexmedetomidine, were performed under ultrasound guidance at the midlevel of the medial thigh (Figure 2), in addition to either spinal (SA) or general anaesthesia (GA), or both. Local anaesthetic doses were based on patient body mass index (BMI) and age. All anaesthetists in this study were trained to perform ultrasound-guided blocks and experienced with performing peripheral nerve blocks for orthopaedic surgery.

STATISTICAL ANALYSIS

An a priori power analysis on the difference between two independent proportions was performed using the G*Power software (Germany, version 3.1.9.6) and the minimum sample size required to achieve 80% power for detecting a medium effect ($d = 0.5$) with 5% marginal error was 203 patients. All data analysis was performed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA) and statistical significance was defined as $p < 0.05$. Normality was assessed and confirmed using the Kolmogorov-Smirnov and Shapiro-Wilk tests. Patients who received an ACB were grouped into those who experienced neuropathy and those who did not. To compare between these groups, the independent samples t-test, Pearson's chi-square test, and Fisher's exact test were used.

Univariate and multivariate logistic regression models were fitted to examine the relationship between variables and presence of neuropathy following an ACB. After performing univariate analysis on each variable, the multivariate regression model was constructed with purposeful selection of variables, selecting candidates based on a p-value cut-off point of 0.15. The performance of the models was assessed using goodness-of-fit tests.

RESULTS

In this study population, preoperative demography and comorbidities were comparable between those who received an ACB and those who did not, with the exception of ASA score (Table 1). Although there was a significant difference in ASA score between these 2 groups ($p = <0.001$), this difference was not observed in the ACB cohort between those who experienced neuropathy and those who did not ($p = 0.12$, Table 2). 18 (8.7%) out of 207 patients who received an ACB experienced neuropathy over the medial aspect of the lower leg during follow-up at 6 weeks (Figure 3). At 1 year, 6.3% had persistent symptoms while at 5 years, 4.8% reported persistent symptoms, with 1 patient lost to follow-up. Symptoms described include neuropathic pain, numbness, and tingling. 10 (55.6%) out of the 18 patients were treated with pregabalin for relief of neuropathic pain within the first 6 months after surgery. Of those who experienced

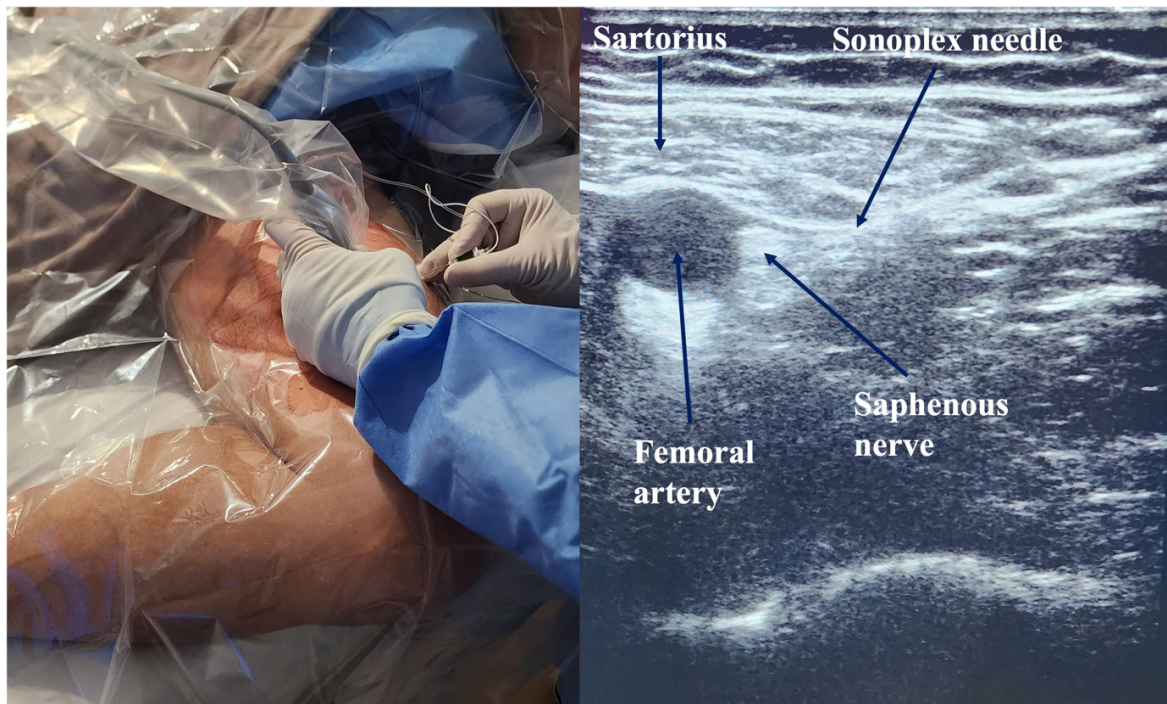


Figure 2. The subsartorial approach to the adductor canal under ultrasound guidance

persistent symptoms at 5 years, 40.0% were worried about this complication and would not have the ACB if they had to do it over again. None of the 161 patients who received LAI alone had neuropathy in the same area. There were no other ACB-related complications in this study cohort.

Analyses of demographic and preoperative clinical variables showed that the prevalence of spine pathology was significantly different between those who had neuropathy after an ACB and those who did not ($p = 0.01$) (Table 2), while evaluation of anaesthetic and ACB-related variables showed that the use of dexmedetomidine, administration of SA-only, as well as volume of local anaesthetic used were also significantly different between groups ($p = 0.03$, $p = 0.01$ and $p = 0.000$, respectively) (Table 3). No significant associations were found between all variables and those with persistent symptoms at 5 years.

Both groups in the ACB cohort showed comparable preoperative clinical scores ($p = 0.45$) (Table 2). Although patients who experienced neuropathy reported significantly worse clinical scores at 3 months postoperatively, there were no differences at 6 months and 1 year (Table 4). Satisfaction rates were similar in those who experienced neuropathy and in those who did not (94.4% and 96.8% respectively, $p = 0.49$). Overall, 6.8% of patients experienced complications related to surgery. These complications were: stiffness requiring manipulation under anaesthesia (MUA) (8), superficial wound infection (2), quadriceps tear (1), patella clunk (1), persistent wound drainage (1) and revision for posterolateral instability (1). There was no significant difference between groups in the ACB cohort with regards to complication rates ($p = 0.63$).

Univariate and multivariate regression models assessing the relationship between selected variables and the presence of neuropathy after an ACB are presented in Table

5. Univariate regression analysis showed that there were higher odds of experiencing neuropathy if spine pathology was present, when dexmedetomidine was used, or when only SA was administered. When all these variables were considered together, multivariate regression analysis showed that patients with spine pathology and those who had SA-only had higher odds of neuropathy after an ACB.

DISCUSSION

The principal finding from this study is that the incidence of neuropathy following ACBs in TKA is higher than recognized in the literature and can be persistent and long-term. Neuropathy is defined as nerve damage outside of the brain or spinal cord leading to pain, weakness, numbness or tingling. Neuropathy can be a result of one of a number of aetiologies but in our study are associated with the performance of adductor canal block. Four of the symptomatic patients did consult with a specialist neurologist and the diagnosis of saphenous neuropathy was made based on a combination of subjective decreased sensation in the region of medial malleolus and medial aspect of leg just above the medial malleolus and normal nerve conduction studies. On the recommendation of the neurologist, the diagnosis of saphenous neuropathy was made clinically by the finding of numbness in the region shown in figure 1, which is very different to the numbness seen with the infrapatellar branch of saphenous nerve often implicated in the surgical approach. No formal neurological exam was performed preoperatively, however the study made comparison with a control group without adductor canal block who had similar demographics, incidence of spine pathology and peripheral neuropathy and other co-morbidities. The incidence of subjective neuropathy was significantly different between the

Table 1. Preoperative clinical details of patients who underwent total knee arthroplasty

Variables	Overall	Received ACB	No ACB	p-Value
Gender				0.83 ^a
Male	167 (45.4)	95 (45.9)	72 (44.7)	
Female	201 (54.6)	112 (54.1)	89 (55.3)	
Age (years)	70.3 ± 8.2	70.1 ± 9.0	70.5 ± 7.1	0.70 ^b
BMI (kg/m²)	31.1 ± 5.6	30.7 ± 5.4	31.8 ± 6.0	0.10 ^b
ASA				<0.001 ^c
1	78 (21.2)	17 (8.2)	61 (37.9)	
2	193 (52.4)	111 (53.6)	82 (50.9)	
3	96 (26.1)	78 (37.7)	18 (11.2)	
4	1 (0.3)	1 (0.5)	0 (0.0)	
Diabetic				0.10 ^a
Yes	24 (6.5)	17 (8.2)	7 (4.3)	
No	344 (93.5)	190 (91.8)	154 (95.7)	
Spine pathology				0.88 ^a
Yes	53 (14.4)	29 (14.0)	24 (14.9)	
No	315 (85.6)	178 (86.0)	137 (85.1)	
Peripheral neuropathy (pre-existing)				0.64 ^c
Yes	4 (1.1)	3 (1.4)	1 (0.6)	
No	364 (98.9)	204 (98.6)	160 (99.4)	
History of CVA				0.08 ^c
Yes	9 (2.4)	8 (3.9)	1 (0.6)	
No	359 (97.6)	199 (96.1)	160 (99.4)	
Psychiatric disorder				0.74 ^a
Yes	40 (10.9)	24 (11.6)	16 (9.9)	
No	328 (89.1)	183 (88.4)	145 (90.1)	
Postoperative neuropathy[†]				<0.001 ^c
Yes	18 (4.9)	18 (8.7)	0 (0.0)	
No	350 (95.1)	189 (91.3)	161 (100.0)	

Values are expressed as frequency (percentage) and mean ± SD. ACB: Adductor canal block. BMI: Body mass index. ASA: American Society of Anesthesiologists. CVA: Cerebrovascular accident.

^ap-value determined by Pearson's chi-squared test.

^bp-value determined by independent samples t-test.

^cp-value determined by Fischer's exact test.

[†]Neuropathy over the area of distribution of the medial crural cutaneous branches of the saphenous nerve.

adductor canal block group and non-adductor canal block group.

Although neurological injury is an established complication of regional nerve blocks, with an incidence ranging from 3-15% for reversible injuries (Wulf 2012; Liguori 2004) and 0.024-0.3% for irreversible injuries (Wulf 2012; Auroy et al. 2002), the incidence of long-term neuropathy specific to ACBs is largely unquantified. Published research has shown that ACBs are safe, as no complications were reported in multiple studies (Sveom et al. 2022; Jaeger et al. 2012; Jæger et al. 2013; Shah and Jain 2014), leading to the perception that they are benign. Nevertheless, in routine clinical practice, neuropathy following an ACB is not readily identified because anaesthetists and surgeons do not routinely look for this complication in the outpatient setting, and especially when the injury does not result in more obvious deficits such as muscle weakness or paralysis. If this

was detected in the early postoperative period, it would often be attributed to the lingering effect of the ACB, and be expected to resolve.

In one of the few studies that did report complications following ACBs in TKA, *Seo et. al* (Seo et al. 2017) had found that neuropathy occurred in 6% of all patients. The authors believed that the neuropathy resulted from reduced blood flow due to the use of tourniquets rather than direct injury or intraneural injection as these blocks were performed under ultrasound guidance. Most of these patients fully recovered within 3 weeks without requiring any intervention. However, this cannot explain the findings from the present study as tourniquet was not used and symptoms persisted for longer than 3 weeks. In addition to the study above, there are also two case reports which described iatrogenic superficial femoral artery pseudoaneurysms following continuous ACB (Cappelleri, Molinari, and Stanco

Table 2. Preoperative clinical details of patients who developed neuropathy versus no neuropathy following ACB

Variables	Overall	Neuropathy	No neuropathy	p-Value
Gender				0.11 ^a
Male	95 (45.9)	5 (27.8)	90 (47.6)	
Female	112 (54.1)	13 (72.2)	99 (52.4)	
Age (years)	70.1 ± 9.0	67.1 ± 6.1	70.4 ± 9.1	0.13 ^b
BMI (kg/m²)	30.7 ± 5.4	29.5 ± 3.3	30.8 ± 5.6	0.34 ^b
ASA				0.12 ^c
1	17 (8.2)	4 (22.2)	13 (6.9)	
2	111 (53.6)	11 (61.1)	100 (53.2)	
3	78 (37.7)	4 (22.2)	74 (39.4)	
4	1 (0.5)	0 (0.0)	1 (0.5)	
Diabetic				0.65 ^c
Yes	17 (8.2)	2 (11.1)	15 (7.9)	
No	190 (91.8)	16 (88.9)	174 (92.1)	
Spine pathology				0.01 ^a
Yes	29 (14.0)	6 (33.3)	23 (12.2)	
No	178 (86.0)	12 (66.7)	166 (87.8)	
Peripheral neuropathy (pre-existing)				1.00 ^c
Yes	3 (1.4)	0 (0.0)	3 (1.6)	
No	204 (98.6)	18 (100.0)	186 (98.4)	
History of CVA				0.52 ^c
Yes	8 (3.9)	1 (5.6)	7 (3.7)	
No	199 (96.1)	17 (94.4)	182 (96.3)	
Psychiatric disorder				0.45 ^c
Yes	24 (11.6)	3 (16.7)	21 (11.1)	
No	183 (88.4)	15 (83.3)	168 (88.9)	
KOOS JR	47.8 ± 13.3	49.0 ± 19.7	47.7 ± 12.9	0.81 ^b
KOOS-12	37.4 ± 14.7	39.3 ± 20.4	37.2 ± 14.3	0.72 ^b
KOOS-12 Pain	43.6 ± 16.2	42.1 ± 18.4	43.7 ± 16.1	0.81 ^b
KOOS-12 Function	43.0 ± 17.1	45.6 ± 21.9	42.8 ± 16.8	0.68 ^b
KOOS-12 QOL	25.6 ± 17.9	30.6 ± 24.7	25.3 ± 17.5	0.45 ^b

Values are expressed as frequency (percentage) and mean ± SD. ACB: Adductor canal block. BMI: Body mass index. ASA: American Society of Anesthesiologists. CVA: Cerebrovascular accident. KOOS: Knee injury and osteoarthritis outcome score. QOL: Quality of life.

^ap-value determined by Pearson's chi-squared test.

^bp-value determined by independent samples t-test.

^cp-value determined by Fischer's exact test.

2016) and intra-articular catheter placement into the adductor canal (Van Roekel et al. 2023). Other regional nerve block-related complications published in the literature include infection, 0-3% (Cuvillon et al. 2001), hematoma formation, 0-0.9% (Cuvillon et al. 2001) and LAST, 0.098% (Barrington et al. 2009). Besides neuropathy, none of these complications were encountered in this study cohort.

Nerve injury following regional nerve blocks can occur due to mechanical, vascular and chemical mechanisms (Hogan 2008). Several patient risk factors such as age (Lauf et al. 2020), BMI (Nielsen et al. 2005), smoking (Lauf et al. 2020) and preoperative neural compromise (Welch et al. 2009) have been attributed to a higher likelihood of complications. Mechanical injury is usually due to direct needle and nerve contact, or the direct injection of local anaesthetic into nerve fascicles (Steinfeldt et al. 2011) and

ultrasound-guidance has been advocated to reduce such damage. Although ultrasound-guidance significantly increased the success rate of regional nerve blocks (Gelfand et al. 2011) and decreased the risk of LAST (Sites et al. 2012), there is no evidence to date that it decreases the incidence of peripheral nerve injury (Sites et al. 2012). Visualization of the saphenous nerve on ultrasound is arguably not essential for the ACB, as the nerve is not always reliably well imaged (Head et al. 2015). Administration of local anaesthetic can still be performed next to the femoral artery in the plane between the sartorius and vastus medialis muscles. Therefore, there is the theoretical risk of direct injury to the saphenous nerve despite the use of ultrasound-guidance. Another possible cause of mechanical nerve injury is neural stretch resulting from a mass effect such as large-volume boluses. In TKA, large-volume local

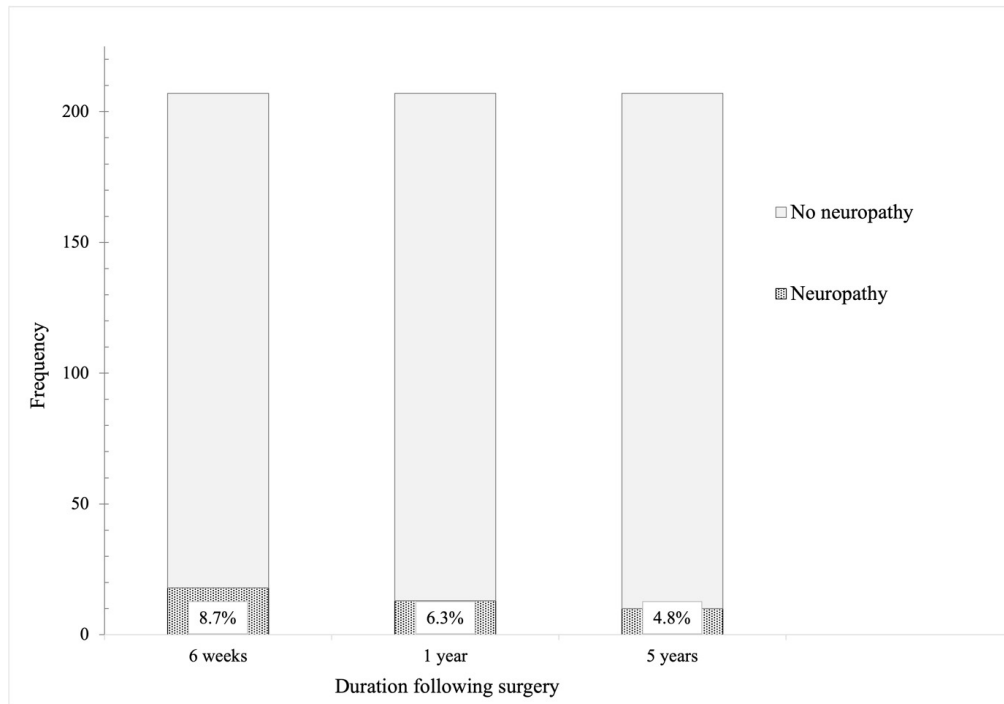


Figure 3. Bar chart depicting proportion of patients who reported sensory symptoms after an adductor canal block

Table 3. ACB and anaesthetic procedural details between groups

Variables	Overall	Neuropathy	No neuropathy	p-Value
Administration				0.09 ^a
Single shot	140 (67.6)	9 (50.0)	131 (69.3)	
Continuous	67 (32.4)	9 (50.0)	58 (30.7)	
Dexmedetomidine				0.03 ^a
Yes	111 (53.4)	14 (77.8)	97 (51.3)	
No	96 (46.6)	4 (22.2)	92 (48.7)	
Volume (mls)	19.2 ± 2.9	20.0 ± 0.0	19.2 ± 3.0	0.000 ^b
Volume per unit BMI	0.6 ± 0.1	0.7 ± 0.1	0.6 ± 0.1	0.13 ^b
LA dose (mg)	64.4 ± 34.1	54.4 ± 17.8	65.4 ± 35.1	0.21 ^b
LA per unit BMI	2.1 ± 1.1	1.9 ± 0.6	2.2 ± 1.2	0.09 ^b
Spinal only				0.01 ^a
Yes	91 (44.0)	13 (72.2)	78 (41.3)	
No	116 (56.0)	5 (27.8)	111 (58.7)	
GA only				0.21 ^c
Yes	39 (18.8)	1 (5.6)	38 (20.1)	
No	168 (81.2)	17 (94.4)	151 (79.9)	
GA and spinal				0.21 ^c
Yes	77 (37.2)	4 (22.2)	73 (38.6)	
No	130 (62.8)	14 (77.8)	116 (61.4)	

Values are expressed as frequency (percentage) and mean ± SD. ACB: Adductor canal block. BMI: Body mass index. LA: Local anaesthetic. GA: General anaesthesia.

^ap-value determined by Pearson's chi-squared test.

^bp-value determined by independent samples t-test.

^cp-value determined by Fischer's exact test.

anaesthetic is usually administered in ACBs for analgesic effect. Although there was a significant difference in the volume of local anaesthetic administered between groups

in this review, this difference was very small and likely clinically insignificant.

Table 4. Postoperative clinical outcomes of patients who received an ACB

Variables	Overall	Neuropathy	No neuropathy	p-Value
Postoperative 3-months				
KOOS JR	74.5 ± 12.3	65.6 ± 9.5	75.4 ± 12.5	0.09 ^a
KOOS-12	73.6 ± 16.2	57.0 ± 16.4	75.2 ± 15.4	0.02^a
KOOS-12 Pain	77.2 ± 17.8	56.2 ± 15.0	79.3 ± 16.8	0.005^a
KOOS-12 Function	79.0 ± 16.4	69.0 ± 16.0	80.0 ± 16.2	0.16 ^a
KOOS-12 QOL	64.7 ± 21.5	46.0 ± 23.8	66.6 ± 20.5	0.04^a
Postoperative 6-months				
KOOS JR	78.5 ± 12.6	79.0 ± 18.1	78.5 ± 12.3	0.93 ^a
KOOS-12	79.8 ± 15.8	74.4 ± 30.0	80.2 ± 14.6	0.69 ^a
KOOS-12 Pain	83.9 ± 15.7	75.2 ± 26.9	84.5 ± 14.7	0.48 ^a
KOOS-12 Function	83.7 ± 13.7	81.6 ± 19.9	83.9 ± 13.3	0.72 ^a
KOOS-12 QOL	71.7 ± 22.0	66.2 ± 43.9	72.1 ± 20.1	0.78 ^a
Postoperative 1-year				
Range of motion				
Extension	0.6 ± 2.0	0.6 ± 2.4	0.6 ± 2.0	0.95 ^a
Flexion	117.5 ± 7.8	118.6 ± 9.2	117.4 ± 7.7	0.52 ^a
KOOS JR	80.9 ± 14.8	78.5 ± 16.7	81.3 ± 14.5	0.52 ^a
KOOS-12	81.1 ± 17.7	76.1 ± 20.5	81.9 ± 17.3	0.26 ^a
KOOS-12 Pain	83.9 ± 18.1	79.5 ± 19.8	84.6 ± 17.9	0.34 ^a
KOOS-12 Function	85.3 ± 15.3	79.9 ± 17.6	86.2 ± 14.8	0.16 ^a
KOOS-12 QOL	74.1 ± 23.5	68.9 ± 26.4	75.0 ± 23.0	0.38 ^a
Satisfaction				0.49 ^b
Satisfied	200 (96.6)	17 (94.4)	183 (96.8)	
Dissatisfied	7 (3.4)	1 (5.6)	6 (3.2)	
Complications (TKA-related)			0.63 ^b	
Yes	14 (6.8)	2 (11.1)	12 (6.3)	
No	193 (93.2)	16 (88.9)	177 (93.7)	

Values are expressed as mean ± SD and frequency (percentage). KOOS: Knee injury and osteoarthritis outcome score. TKA: Total knee arthroplasty.

^ap-value determined by independent samples t-test.

^bp-value determined by Fischer's exact test.

Dexmedetomidine is a highly selective α_2 -adrenergic receptor agonist with sedative, analgesic and anti-anxiety properties as well as inhibition of sympathetic activity (Bilotta and Pugliese 2020). It is used as an adjuvant to prolong the duration of analgesia (Goyal et al. 2017), while reducing the quantity of local anaesthetics (Wang et al. 2021). However, its mechanism of action is not fully understood, and adverse reactions reported in the literature include bradycardia, hypotension, and excessive sedation (Esmaoglu et al. 2010). Contrary to the observations in this study, previous studies did not find any evidence of nerve injury with the use of dexmedetomidine (Lu et al. 2016) and its usage leading to a potential risk for neurological injury has not been described. On the other hand, Brummett et al (Brummett et al. 2008). and Kim et al (Kim et al. 2018). found that dexmedetomidine could confer some protective effect for local anaesthetic-induced perineural inflammation.

A reasonable concern for surgeons with regards to patients experiencing long-term neuropathy after ACBs is

whether it affects TKA clinical outcomes. In this study, early clinical scores were worse in patients with neuropathy at 3 months after surgery, especially in the pain and quality of life domains. Although no other cause could be identified to explain the difference between groups, the effect of unpleasant sensory symptoms on these scores should be considered, as half of those who were affected were treated for these symptoms. Nevertheless, similar clinical scores between groups were observed at 6 months and 1 year after surgery in knee function, pain, and quality of life, suggesting that once the acute phase had resolved, residual neuropathy did not lead to a difference in clinical outcome.

The present study provides new information on long-term follow-up of an underrecognized complication of a preferred regional nerve block technique in a common surgical knee procedure. With the increasing use of ACBs in TKA, awareness of the possibility of persistent neuropathy following an ACB and the risk factors associated with it is paramount for both anaesthetists and surgeons during the informed consent process, and to recognize the complica-

Table 5. Regression models for neuropathy after ACB

Variable	Univariate		Multivariate	
	OR (95% CI)	p-Value	OR (95% CI)	p-Value
Gender		0.12		
Male	2.36 (0.81, 6.89)		-	
Female	Ref.		-	
Age (years)	0.96 (0.91, 1.01)	0.13	-	
Spine pathology		0.02		0.01
Yes	3.61 (1.24, 10.55)		5.02 (1.47, 17.12)	
No	Ref.		Ref.	
Administration		0.10		0.26
Single shot	0.44 (0.17, 1.17)		0.53 (0.18, 1.59)	
Continuous	Ref.		Ref.	
Dexmedetomidine		0.04		0.17
Yes	3.35 (1.07, 10.57)		2.59 (0.67, 10.03)	
No	Ref.		Ref.	
Volume per unit BMI	19.35 (0.42, 883.55)	0.13	10.11 (0.13, 774.05)	0.30
Spinal-only		0.02		0.02
Yes	3.70 (1.27, 10.80)		4.51 (1.28, 15.90)	
No	Ref.		Ref.	
Goodness-of-fit statistics				
Hosmer-Lemeshow	-		p = 0.92	
R-square	-		0.22	

OR: odds ratio. CI: confidence interval. ACB: Adductor canal block. BMI: Body mass index.
No multicollinearity present.

tion when it happens. In addition, it is important to discuss these possible complications with patients before surgery, and to thoroughly consider the risks and benefits, especially in patients with risk factors, as they can potentially lead to patient morbidity and dissatisfaction. A recent review of closed malpractice claims related to regional nerve blocks demonstrated that the majority of claims were due to permanent minor injuries with delayed onset paresthesia as the main presenting symptom of regional anaesthetic complication (Saba et al. 2019). Therefore, findings from this study may alert clinicians in obtaining a timely diagnosis in patients with nerve injury, and provide early intervention, including counselling and reassurance, which may decrease anxiety and ultimately decrease the likelihood of litigation.

There are several limitations in this study. First, it is a retrospective review of cases performed by a single surgeon with a relatively small sample size. Second, the ACBs were performed by multiple anaesthetists. Although all received prior training before performing ACBs, this procedure is operator dependent, and the influence of each individual's skill on the outcome is expected but not considered in this study. Third, there was a lack of documentation as to whether the ACBs were performed with the patient awake or under anaesthesia and thus this could not be analyzed. Additionally, it is difficult to define the ACB as the singular cause of the patient's symptoms, but with the design of this study, the association between ACB and these symptoms is

significant. Finally, this study was performed on patients who had undergone TKA and were older in age with unsurprisingly more comorbidities. Therefore, the findings may not be generalizable when the ACB is used in other types of knee surgery in a different patient cohort.

CONCLUSION

Adductor canal blocks may result in persistent neuropathy and problematic symptoms after total knee arthroplasty.

List of abbreviations

ACB Adductor canal block
ASA American Society of Anesthesiologists
BMI Body mass index
FNB Femoral nerve block
GA General anaesthesia
KOOS JR Knee Injury and Osteoarthritis Outcome Score, Joint Replacement
LAI Local anaesthetic infiltration
LAST Local anaesthetic systemic toxicity
TKA Total knee arthroplasty

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