Preoperative peripheral nerve blocks are not independently associated with improved functional outcome, patient satisfaction, or risk of chronic pain at one year following knee arthroplasty

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Aims

Control of acute pain following knee arthroplasty (KA) with a perioperative peripheral nerve block (PNB) may improve functional outcomes and reduce the risk of chronic postoperative knee pain (CPKP). The aims of this study were to assess whether a PNB influences patient-reported outcomes and risk of CPKP at one year following KA.

Methods

A retrospective study was conducted over a two-year period and included 3,338 patients who underwent KA, of whom 1,434 (43.0%) had a lower limb PNB. A total of 2,588 patients (77.6%) completed and returned their one-year follow-up questionnaire. The Oxford Knee Score (OKS) and pain component (OKS-PS), EuroQol five-dimension questionnaire (EQ-5D), and EQ-visual analogue scale (VAS) were collected preoperatively and at one year postoperatively. Patient satisfaction was also recorded at one year. The OKS-PS was used to define CPKP at one year.

Results

The PNB group were younger (mean difference (MD) 0.7 years, 95% CI 0.0 to 1.3; p = 0.039), had a worse OKS (MD 0.7, 95% CI 0.1 to 1.3; p = 0.027), and were more likely to have had a spinal anaesthesia relative to a general anaesthetic (odds ratio 4.2, 95% CI 3.23 to 5.45; p < 0.001). When adjusting for confounding factors, patients in the PNB group had a significantly reduced improvement in their OKS (MD -0.9, 95% CI -1.6 to -0.1; p = 0.022), which may not be clinically meaningful. There were no significant differences in the OKS-PS (p = 0.068), EQ-5D (p = 0.313), or EQ-VAS (0.855) between the groups when adjusting for confounding factors. When adjusting for confounding factors using binary regression analysis, there were no differences in patient satisfaction (p = 0.132) or in the risk of CPKP (p = 0.794) according to PNB group.

Conclusion

PNBs were independently associated with worse knee-specific outcomes, but whether these are clinically meaningful is not clear, as the difference was less than the minimal clinically important difference. Furthermore, PNBs were not independently associated with differences in health-related quality of life, patient satisfaction, or risk of CPKP.

Take home message

- Perioperative peripheral nerve blocks were independently associated with worse knee-specific outcomes following knee arthroplasty, but whether this difference is clinically meaningful is not clear.

Introduction

There is predicted to be a 34% rise in patients undergoing knee arthroplasty (KA) by 2038, which is estimated to have detrimental repercussions on healthcare resources.[1] Enhanced recovery after surgery (ERAS) has been shown to help improve patient outcomes perioperatively, and is associated with a shorter length of hospital stay.[2] Part of the ERAS process can include the use of nerve blocks to help control acute postoperative pain, potentially reducing the requirement of opioid-related analgesia that have side-effects and can inhibit an individual's recovery, as well as facilitating early mobilization.[3] Current Natonal Institute for Health and Care Excellence (NICE) guidelines recommend offering people having primary elective KA a choice of regional or general anaesthesia in combination with local infiltration of analgesia (LIA), with or without a peripheral nerve block (PNB) that does not impair motor function.[4]

Following KA, the intensity of pain stabilizes between three and six months following surgery.[5] Thus, chronic postoperative knee pain (CPKP) following KA is characterized as persistent and bothersome discomfort for three or more months following surgery.[6] Individuals experiencing enduring CPKP may find their functional outcomes disappointing.[7] Patients with CPKP have impaired joint-specific functional outcomes and health-related quality of life (HRQoL).[8] Despite positive outcomes for many patients, a systematic review by Beswick et al[9] demonstrated that between three months and five years following surgery, 10% to 34% of patients reported unfavourable pain outcomes. When considering the annual volume of KA surgery in the UK alone, it has been suggested that approximately 20,000 patients experience CPKP annually.[6] CPKP following KA in the UK alone is associated with excess healthcare costs of approximately £26 million per year.[8]

There are numerous patient-related factors associated with persistent CPKP following KA, some of which are reversible.[10] Acute postoperative pain has been shown to be an independent factor associated with CPKP following KA, and has been suggested to be a potential modifiable risk factor.[11] Furthermore, acute pain postoperative pain is also associated with chronic opioid use, which has negative effects on the individual's health and their outcomes.[12] Employment of a PNB in addition to LIA to help reduce the acute pain following KA may therefore result in a lower risk of ongoing chronic pain postoperatively and improve patients' functional outcomes.[13] The importance of the potential benefit of a PNB on a patient's outcome following KA is highlighted in a recent call by the National Institute for Health and Care Research (NIHR) in the UK.[14] This call specifically requested further investigation into the effect of a PNB on the risk of CPKP and HRQoL at a minimum of one year following KA.

The aim of this study was to assess whether PNB influenced knee-specific outcome, HRQoL, patient satisfaction, and risk of CPKP one year following KA.

Methods

This single-centre retrospective cohort study was conducted over 24 months from January 2018 to December 2019. The study centre (Southwest of London Orthopaedic Elective Centre; SWLEOC) has an established arthroplasty register that prospectively records patient demographics and routine pre- and postoperative patient-reported outcome measures (PROMs). There was no additional patient contact and, as such, this project was performed as a service evaluation without the need for formal ethical approval. The project was conducted in accordance with the Declaration of Helsinki and the guidelines for good clinical practice (2013).[15] Patients undergoing primary KA for arthritis and completed a preoperative Oxford Knee Score[16,17] were included. Patients undergoing revision were excluded.

The OKS and EuroQol (EQ) general health questionnaire[18] were administered preoperatively and at one year postoperatively via a postal questionnaire. Patients who did not return the questionnaire, or missed responses to specific questions, were routinely contacted via telephone to complete the OKS. The responses to each of the OKS questions were scored from 0 to 4.[16,17] A summative score of 48 is the best possible score (least symptomatic) and 0 is the worst possible score (most symptomatic). The minimal clinically important difference (MCID) in the OKS is five points after KA.[19] HRQoL was assessed using the EQ general health questionnaire which evaluates five domains (5D) with the responses recorded at three levels (3L).[18] The UK-specific index values were employed, which range from -0.594 (worst health) to 1 (best health). The EQ visual analogue scale (VAS) for general health was also used, where zero is the worst HRQoL and 100 is best.[18] The MCID after KA in the EQ-5D is 0.085 and 6.4 for the EQ-VAS.[20] The OKS was subgrouped to provide a pain score (OKS-PS),[21] which was used to define CPKP.[21,22] Pinedo-Villanueva et al[22] previously identified that patients with a score of 14 or lower on the seven-item OKS-PS component (on a scale of zero being the worst to 28 being the best) after surgery had pain that negatively affects their HRQoL. This has previously been used to define CPKP at one year following KA,[8] and therefore this definition was applied to this study group.

Patient satisfaction with their knee at one year was assessed using a VAS, which was measured on a scale from 0 (not satisfied) to 100 (very satisfied). Brokelman et al[23] demonstrated the VAS to have good reliability and validity in comparison with the Oxford Hip Score. A threshold of 50 or more was used to define those patients satisfied with their KA, and a score of less than 50 was defined as dissatisfied.[24]

Statistical analysis and matching

Statistical analysis was performed using SPSS v. 17.0 (SPSS, USA). Simple descriptive analysis was undertaken according to mean and SD. Paired and independent-samples *t*-tests were used to compare parametric continuous variables within and between groups, respectively. A chi-squared test was used to compare categorical variables between groups. Direct logistic regression analysis was undertaken to assess the impact of preoperative variables on the likelihood that patients would be satisfied with their knee or had CPKP one year following surgery. The models contained nine preoperative variables that met the assumptions of the model (Table I). The full models containing all predictors were statistically significant ($p < 0.001$, chi-squared test), indicating the models were able to distinguish between patients that were satisfied or had CPKP. The models as a whole explained between 5% and 8% (Cox and Snell R squared) and 5% and 15% (Nagelkerke R squared) of the variance in the pain status and correctly classified and 80.0% and 87.5% of the satisfied and CPKP cases, respectively. The Hosmer and Lemeshow test were not significant which

Table I. Preoperative demographics and patient-reported outcome measures of patients undergoing knee arthroplasty according to group.

Variable	No block group (n = 1,904)	Block group (n = 1,434)	Odds ratio/difference (95% CI)	p-value
Sex, n, (% of group)				
Male	760 (39.9)	555 (38.7)	1.05	0.480*
Female	1,143 (60.0)	878 (61.2)	(0.91 to 1.21)	
Missing	1 (0.10)	1 (0.10)		
Mean age, yrs (SD)	69.7 (9.3)	70.4 (9.3)	0.7 (0.0 to 1.3)	0.039‡
Mean OKS (SD)	19.7 (8.4)	19.0 (8.2)	0.7 (0.1 to 1.3)	0.027‡
Mean OKS-PS (SD)	10.2 (5.0)	9.9 (4.9)	0.3 (-0.1 to 0.6)	0.106‡
Mean EQ-5D (SD)	0.395 (0.327)	0.387 (0.326)	0.008 (-0.015 to 0.031)	0.516‡
Mean EQ-VAS (SD)	66.0 (20.8)	65.4 (21.6)	0.5 (-1.0 to 2.1)	0.489‡
Chronic pain, n (% of group)†				
No	354 (18.6)	254 (17.7)	1.06	0.527*
Yes	1,447 (76.0)	1,100 (76.7)	(0.89 to 1.27)	
Missing	103 (5.4)	80 (5.6)		
Spinal, n (% of group)				
No	354 (18.6)	74 (5.2)	4.20	< 0.001
Yes	1,550 (81.4)	1,360 (94.8)	(3.23 to 5.45)	

*Chi-squared test.
†130 patients did not fully complete the preoperative OKS and the OKS pain was possible to calculate.
‡Independent-samples *t*-test.
EQ-5D, EuroQol five-dimension questionnaire; EQ-VAS, EuroQol visual analogue scale; OKS, Oxford Knee Score; OKS-PS, Oxford Knee Score-pain score.

supports the goodness-of-fit of the models. A p-value < 0.05 was defined as significant.

Results

During the study period, 3,338 patients underwent KA, of whom 1,434 (43%) had a lower limb PNB. A total of 2,588 patients (77.6%) completed and returned their one-year follow-up questionnaire. Of the 750 patients lost to follow-up, 40 (5.3%) had died before one-year review. There were no significant (p ≥ 0.130) differences in sex, age, or preoperative OKS, OKS-PS, or EQ-5D scores between those alive and lost to follow-up and the study cohort.

The group undergoing a PNB were younger in age (mean difference (MD) 0.7, 95% CI 0.0 to 1.3; p = 0.039, independent *t*-test), had a worse OKS (MD 0.7, 95% CI 0.1 to 1.3; p = 0.027, independent-samples *t*-test) and where more likely to have had a spinal anaesthesia as opposed to a general anaesthetic (odds ratio 4.2, 95% CI 3.23 to 5.45; p < 0.001, chi-squared test) (Table I). There were no other significant (p ≥ 0.106) differences between the groups (Table I).

The PNB group had a significantly worse OKS at one year compared to those who did not undergo a block (MD 1.0, 95% CI 0.2 to 1.7; p = 0.014, independent-samples *t*-test) (Table II). However, there was no significant difference (p = 0.121, independent-samples *t*-test) in the overall improvement in the OKS between the groups, due to the worse preoperative baseline score (Table I). There were no other significant differences (p ≥ 0.074, independent-samples *t*-test) in one-year scores or improvement relative to baseline for OKS-PS, EQ-5D, or EQ-VAS (Table II). When adjusting for confounding factors (all preoperative variables listed in Table I), patients in the PNB group had a significantly reduced improvement in their OKS (MD -0.9, 95% CI -1.6 to -0.1; p = 0.022), but this was not greater than the MCID (Table III). There were no significant differences in the OKS-PS (p = 0.068), EQ-5D (p = 0.313), or EQ-VAS (0.855) between the groups when adjusting for confounding factors (Table III).

There were no differences in patient satisfaction with their knee (p = 0.143, chi-squared test) or in the risk of CPKP (p = 0.701, chi-squared test) between those patients who had a PNB relative to those who did not (Table IV). Furthermore, when adjusting for confounding factors using binary regression analysis, there remained no differences in patient satisfaction (p = 0.132) or in the risk of CPKP (p = 0.794) between those patients who had a PNB relative to those who did not (Table V).

Discussion

This study has shown that perioperative PNBs were independently associated with worse knee-specific outcomes but whether these are clinically meaningful is not clear as the difference was less than the MCID. Furthermore, PNBs were not independently associated with differences in HRQoL, patient satisfaction, or risk of CPKP one year following KA.

Table II. One-year postoperative OKS and pain score, EQ-5D, and EQ-VAS and the changes relative to baseline preoperative scores according to group.

PROM and timepoint	No block group	Block group	Mean Difference (95% CI)	p-value*
Mean OKS (SD) (n = 1,433 vs 1,040)	36.9 (9.7)	36.0 (9.5)	1.0 (0.2 to 1.7)	0.014
Mean change (SD) (n = 1,348 vs 974)	16.6 (9.8)	16.0 (9.5)	0.6 (-0.2 to 1.4)	0.121
95% CI	16.1 to 17.1	15.4 to 16.6		
p-value†	< 0.001	< 0.001		
Mean OKS-PS (SD) (n = 1,497 vs 1,092)	22.1 (5.9)	21.7 (5.9)	0.4 (-0.1 to 0.9)	0.097
Mean change (SD) (n = 1,497 vs 1,032)	11.6 (6.4)	11.3 (6.2)	0.3 (-0.2 to 0.8)	0.203
95% CI	11.2 to 11.9	10.9 to 11.6		
p-value†	< 0.001	< 0.001		
Mean EQ-5D (SD) (n = 1,474 vs 1,071)	0.760 (0.259)	0.749 (0.251)	0.011 (-0.009 to 0.031)	0.283
Mean change (SD) (n = 1,417 vs 1,016)	0.342 (0.330)	0.317 (0.325)	0.024 (-0.002 to 0.051)	0.074
95% CI	0.325 to 0.359	0.298 to 0.338		
p-value†	< 0.001	< 0.001		
Mean EQ-VAS (SD) (n = 1,499 vs 1,093)	76.6 (17.9)	76.3 (17.6)	0.4 (-1.0 to 1.8)	0.591
Mean change (SD) (n = 1,381 vs 974)	9.0 (21.4)	8.5 (20.6)	0.6 (-1.1 to 2.3)	0.505
95% CI	7.9 to 10.1	7.2 to 9.7		
p-value†	< 0.001	< 0.001		

The rows demonstrate the comparison of OKS, OKS-PS, EQ-5D, EQ-VAS, and the change between groups, while the columns demonstrate the comparison of the preoperative to one year postoperative outcomes within each of the groups.
*Independent-samples *t*-test.
†Paired *t*-test.
EQ-5D, EuroQol five-dimension questionnaire; EQ-VAS, EuroQol visual analogue scale; OKS, Oxford Knee Score; OKS-PS, Oxford Knee Score-pain score; PROM, patient-reported outcome measure.

PNBs were commonly employed (43.0%) to help control acute postoperative pain and were more likely to be used in younger patients, in combination with spinal (regional) anaesthesia, and in patients with worse preoperative knee-specific health. PNBs were independently associated with a significantly reduced improvement in knee-specific health at one year, but this was less than the MCID and may not be clinically meaningful.

There were several limitations of this retrospective study that should be acknowledged. This was a non-randomized study, and there will likely be bias in the selection of patients who underwent PNB, which may have influenced the findings. The study did adjust for confounding factors, for example the observed differences between the PNB groups in age and preoperative OKS, to try and account for potential selection bias. However, there are numerous other factors such as pain catastrophizing and mental health that were not included in the models, and these have been shown to influence knee-specific outcomes.[25,26] The current study included all PNBs that were undertaken during the study period, of which the majority were adductor canal blocks (ACBs) with the addition of LIA. There are several PNBs that can be employed to help control acute postoperative pain following KA.[27] These include an adductor canal block (ACB), femoral nerve block, genicular nerve block, and injection into the interspace between the popliteal artery, and the capsule of the posterior knee (IPACK).[27] These techniques facilitate early mobilization through their analgesic effect, but with sparing of motor function, which is associated with better long-term postoperative outcomes and reduced hospital length of stay.[3] The ACB has become popular since it provides sensory anaesthesia of knee pain without a motor deficit, and probably reflects current practice.[27] Finally, the current study did not assess the patients' acute postoperative pain or opioid consumption. A recent review by Lavand'homme et al[28] included five randomized controlled trials (RCTs) comparing a combination of ACB and LIA to LIA alone. They found the addition of the ACB was associated with improved pain control during the first 24 hours, and therefore should have had a positive effect on acute pain control in the current cohort. However, a major limitation of the current study is the lack of assessment of the acute postoperative pain control in relation to the block used, and how this may have influenced postoperative outcomes and CPKP.

The current study found no association with perioperative PNB and improved functional outcome one year following KA. This is consistent with the multiple RCTs that have assessed the effectiveness of an ACB on functional

Table III. Multivariable linear regression analysis was used to adjust for confounding factors to identify independent association of a perioperative nerve block (group) on improvement in patient-reported outcomes at one year following knee arthroplasty. Factors included in the models were age, sex, preoperative OKS, OKS-PS, EQ-5D, EQ-VAS, chronic pain, and spinal anaesthesia, in addition to group (no block or block).

PROM	Group	Mean difference	95% CI	p-value
OKS	No block	Reference		
	Block	-0.9	-1.6 to -0.1	0.022
OKS-PS	No block	Reference		
	Block	-0.4	-0.9 to 0.0	0.068
EQ-5D	No block	Reference		
	Block	-0.010	-0.030 to 0.010	0.313
EQ-VAS	No block	Reference		
	Block	0.1	-1.2 to 1.5	0.855

EQ-5D, EuroQol five-dimension questionnaire; EQ-VAS, EuroQol visual analogue scale; OKS, Oxford Knee Score; OKS-PS, Oxford Knee Score-pain score; PROM, patient-reported outcome measure.

Table IV. Percentage of patients satisfied with their knee and those with chronic postoperative pain at one year following knee arthroplasty according to group.

Variable	No block group	Block group	**Odds ratio** (95% CI)	p-value*
Satisfied, n (%)				
Yes	1,426 (91.9)	1,027 (90.3)	Reference	
No	125 (8.1)	110 (9.7)	0.81 (0.63 to 1.07)	0.143
Chronic pain, n (%)				
Yes	1,314 (87.8)	953 (87.3)	Reference	
No	183 (12.2)	139 (12.7)	1.05 (0.83 to 1.33)	0.701

*Chi-squared test.

outcomes at three to 24 months postoperatively.[29–32] McKee and Clement[33] undertook a retrospective study comparing functional outcomes at one year between patients who had an ACB compared to those who did not. Similar to the current study, they found no difference in the OKS, EQ-5D, or patient satisfaction when adjusting to confounding whether an ACB was employed or not. More specifically, the current study demonstrated a worse postoperative mean improvement in the OKS of 0.9 points in the PNB group. Despite this being statistically significant, this was below the MCID of five points.[19] However, the MCID may be lower than five points, and it has been suggested that a one-point difference may be clinically meaningful to a patient;[34] however, this is still greater that the 0.9-point difference observed. In addition, it is not clear how a PNB could worsen a patient's knee-specific outcome when all other outcomes (HRQoL and satisfaction) were equal between the groups. Therefore, this observed difference in the OKS may be due to selection bias, and those patients where there were concerns in relation to pain control postoperatively that may have resulted in a PNB being employed. In contrast to the current study, Sreckovic et al[13] demonstrated significantly better functional outcomes, according to the Knee injury and Osteoarthritis Outcome Score and Forgotten Joint Score, at two years following KA in patients undergoing ACB and IPACK block. This was, however, a non-randomized study comparing the blocks to no other intervention in the control group. There is good evidence that LIA alone is associated with reduced opioid analgesia use and reduced acute postoperative pain following surgery.[35] Therefore, to compare the blocks to no other intervention, such as LIA, may be a limitation of their study, but does suggest that better control of postoperative acute pain is associated with better knee function in the longer term.

The prevalence of CPKP observed in the No block and PNB groups, of 12% and 13%, respectively, are consistent with the 13% prevalence observed by Cole et al,[8] who also used the OKS-PS to define CPKP one year following KA. Those patients with CPKP following KA have worse knee-specific outcomes and HRQoL compared to those without.[8] Numerous preoperative and perioperative factors have been associated with CPKP following KA.[6,10,36] Sreckovic et al[13] are, to the authors' knowledge, the only other group to report the effect of PNB on CPKP following KA. They found that the group receiving ACB and IPACK blocks had a significantly lower risk of developing CPKP (20% vs 6%) two years after

Table V. Binary logistic regression analysis was used to adjust for confounding factors to identify the independent association of a perioperative nerve block (group) on patient satisfaction and risk of chronic postoperative knee pain one year following knee arthroplasty. Factors included in the models were age, sex, preoperative OKS, OKS-PS, EQ-5D, EQ-VAS, chronic pain, and spinal anaesthesia in addition to group (no block or block).

Outcome and group	Odds ratio (95% CI)	p-value
Satisfied		
No block	Reference	
Block	0.79 (0.59 to 1.07)	0.132
Chronic pain		
Yes	Reference	
No	1.04 (0.79 to 1.37)	0.794

EQ-5D, EuroQol five-dimension questionnaire; EQ-VAS, EuroQol visual analogue scale; OKS, Oxford Knee Score; OKS-PS, Oxford Knee Score-pain score.

surgery. However, this reduced risk was not observed in the current study according to whether a PNB was employed or not. Chronic pain is a recognized adverse consequence of surgery.[37] The literature in relation to CPKP following KA often uses the definition of persistent pain three to six months following surgery.[6] However, the majority of patients (77%) had chronic pain preoperatively, according to the current study, the effect of which has not been explored. The persistent exposure to pain may induce different pain mechanisms which involve peripheral inflammatory mediators and central pain processing mechanisms.[38] Psychophysical and neuroimaging have shown that patients with knee osteoarthritis have centrally mediated pain sensitization due to supraspinally mediated changes in nociceptive signalling, which is associated with a worse outcome following KA.[39] Therefore, despite a PNB potentially improving the acute postoperative pain, the established chronic changes within the nervous system may take far longer – perhaps up to two years – to reverse in some patients following KA.[40,41]

In conclusion, PNBs were not independently associated with improved knee-specific outcomes, HRQoL, patient satisfaction, or reduced risk of CPKP one year following KA. In relation to knee-specific outcomes, PNBs were associated with a worse improvement, but this difference may not be clinically meaningful. Further evidence is required to assess the effect of PNB on longer-term outcomes such as CPKP, HRQoL, and knee-specific outcomes following KA.

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