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Research Article

Single-Injection versus CFNC Block for Postoperative Pain Control Following TKA

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Keywords

- Total knee replacement
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- Postoperative pain
- Femoral nerve catheter
- Femoral nerve block

Abstract

Introduction: Immediately following total knee arthroplasty, Continuous Femoral Nerve Catheter (CFNC) and single-Injection Femoral Nerve Blocks (FNB) provide extended pain relief and improve functional outcomes. This study aimed to determine if immediate post-surgical outcomes are affected by the type of nerve block utilized.

Materials and Methods: A retrospective comparison study of 154 primary unilateral total knee replacement procedures was performed. Postoperative outcomes of patients who received a CFNC (Naropin®, APP Pharmaceuticals, and Schaumberg, IL) versus a FNB (Marcaine or Ropivacaine) were evaluated. The CFNC was removed the evening of postoperative day 1 (POD1).

Data comparison included information from postoperative day 1 (POD1) and postoperative day 3 (POD3): Narcotic usage, Visual Analog Scale (VAS) pain scores upon ambulation, surgical knee extension and flexion, longest distance walked, and hospital length of stay (LOS). Data analysis included ANOVA, ANCOVA, logistic regression, and chi-square goodness-of-fit test. Diagnostic techniques ensured validity of the results.

Results: 154 total patients (93 CFNC, 61 FNB) were evaluated. ANCOVA model fitted to the data indicated CFNC and FNB was a significant factor (p-value 0.02) on the pain improvement from POD1 to POD3, controlling for medication use, with logistic regression. VAS scores in the FNB group were significantly improved from POD1 to POD3 (p= 0.02). There is statistically significant evidence that pain improvement for FNB is greater than CFNC after controlling for narcotic use. No other significant differences were found.

Conclusion: Single-Injection Femoral Nerve Blocks may be more effective than CFNC Blocks in controlling postoperative pain following unilateral total knee replacement.

INTRODUCTION

Total knee replacement utilization in the United States more than doubled from 1999 to 2008, reaching 615,050 in 2008 [1]. Unfortunately, the postoperative pain impedes rehabilitation and delays hospital discharge. Continuous Femoral Nerve Catheter Blocks (CFNC) and single-Injection Femoral Nerve Blocks (FNB) are often utilized to provide extended pain relief and improved functional outcomes in the initial hospitalization period following total knee arthroplasty.

Two investigations have shown that CFNC are equivalent to postoperative epidural anesthesia and patient controlled analgesia [2,3]. Hirst et al. in a prospective randomized controlled trial found no difference between CFNC and FNB. The study was underpowered and this has been used as a criticism of the publication [4]. A randomized controlled trial between two groups of 18 patients compared CFNC and FNB. Significant differences favored CFNC for VAS for POD 1 through 3 and in narcotic requirements [5].

Our joint center allowed us to gather information on a large number of patients who had either CFNC or FNB. The nursing staff of the joint center believed that FNB was equally or even more effective than CFNC without the attendant nursing care that a CFNC requires. The purpose of this study was to determine if immediate post-surgical outcomes are affected by the type

of nerve block utilized. The null hypothesis was that there would be no difference between the two groups in immediate postoperative outcomes.

MATERIALS AND METHODS

The University of Minnesota institutional review board approved this investigation. A retrospective comparison study of 154 primary unilateral total knee replacement procedures was performed to evaluate postoperative outcomes of patients who received a CFNC (Naropin®, APP Pharmaceuticals, Schaumberg, IL) versus a FNB (Marcaine or Ropivacaine). Ninety-three (93) patients, 36 male, 57 female, with an average age of 71.3, received a CFNC. Sixty-one (61) patients, 20 male, 41 female, with an average age of 70.4, received a FNB. There were no statistically significant differences for gender (p=0.45) and age (p=0.58).

Inclusion criteria included sequential patients participating in the Joint Reconstruction clinical pathway from January of 2009 through December of 2009. We excluded patients who underwent bilateral total knee arthroplasty.

Eighty six of 93 patients in the CFNC group and 56 of 61 patients in the FNB group underwent spinal anesthetic. The remainder in each group had general anesthetic. TECHNIQUE

After informed consent in the supine position patients underwent either CFNC or FNB at the anesthesiologist's discretion.

Femoral nerve block

The femoral nerve block was performed pre-operatively by the anesthesiologist with conscious sedation. Either .25% or .5% Marcaine with or without epinephrine or .5% Ropivacaine was injected with nerve stimulation guidance with Stimuplex (B.Braun Medical, Bethlehem, PA). Volume of local anesthetic and type of local anesthetic varied by anesthesiologist.

Continuous FEM oral nerve catheter block

Similar technique was used with the femoral nerve catheter. Pre-operatively, a bolus was administered and infusion started in the pre-anesthetic area with .5% Ropivicaine. The catheter was removed on the evening of the first postoperative day.

Data collection

Data comparison included information from POD1 and postoperative day 3 (POD3): Visual Analog Scale (VAS) pain scores upon ambulation, narcotic usage (morphine equivalents), surgical knee flexion and extension, longest distance walked and hospital length of stay (LOS) were measured. The data was entered in a spreadsheet (Excel, Microsoft, and Redmond, WA) and the data was de-identified.

Statistical analysis

Data analysis included ANOVA, ANCOVA, logistic regression, and chi-square goodness-of-fit test. Also, various model diagnostic techniques were employed to ensure the validity of the results.

RESULTS AND DISCUSSION

Results

To eliminate the possible confounding effect of pain medication on testing the effect of FNB and CFNC on pain difference from POD1 to POD3, two other variables have been taken as covariates, narcotic equivalents for both POD1 and POD3. For this purpose, we analyzed the data using ANCOVA and found the amount of medication used was higher for CFNC group for both POD1 and POD3 (36.97 versus 29.75 and 18.10 versus 16.65). But these differences were not statistically significant (p-values 0.0969, and 0.6352).

ANCOVA model fitted to the data with FNB.CFNC POD1 narcotic equivalents, POD3 narcotic equivalents, interaction terms between FNB.CFNC and medication amounts show that only term FNB.CFNC was statistically significant (p-value 0.02). Therefore, there is statistically significant evidence that pain improvement for FNB is higher than CFNC after controlling for the medications, POD1 narcotic equivalents, and POD3 narcotic equivalents (see Figure 1, 2, Tables 1 and Table 2 analysis of variance table for the model).

Considering only the pain improvement from day 1 to day 3 (improved versus not improved), there is a statistically significant association between FNB.CFNC (Chi-square value=4.5795, p-value=0.0303). In fact, the proportions of patients who reported improvement are 57.38% for FNB, 39.78% for CFNC, see [Figures 3 and 4].

To control for the medication a logistic regression model has been fitted to the data with terms FNB.CFNC, POD1morph, and POD3morph. FNB.CFNC was determined to be the only significant variable on determination of the pain improvement turned

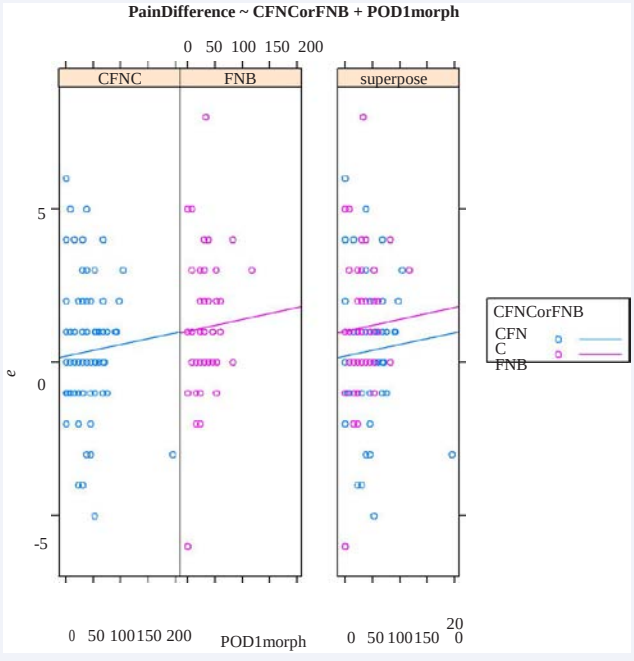

Figure 1 Plots of Pain Difference for POD1 to POD3 for CFNC or FNB controlling for POD1morph.

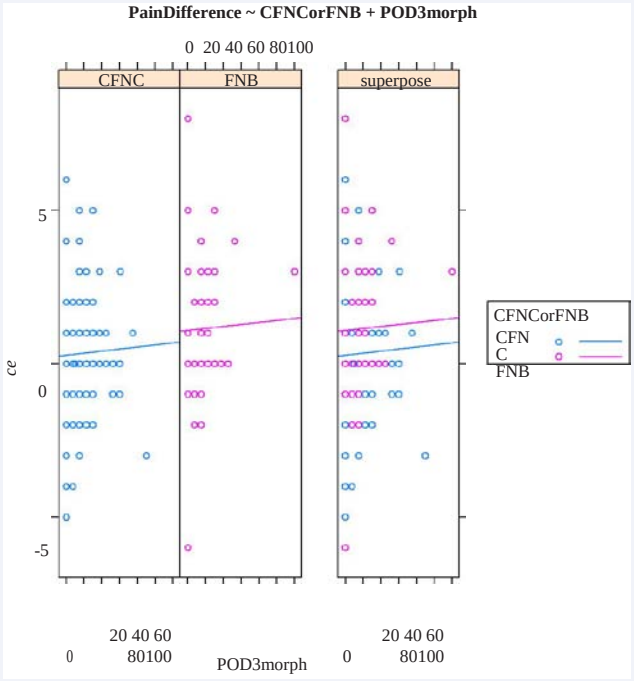

Figure 2 Plots of Pain Difference for CFNC or FNB controlling for POD3morph.

Table 1: ANCOVA model fitted to the data with FNB.CFNC POD1 narcotic equivalents, POD3 narcotic equivalents, and interaction terms between FNB. CFNC and medication amounts shows that only statistically significant term is the FNB.CFNC (p-value 0.02). Therefore, there is statistically significant evidence that pain improvement for FNB is higher than CFNC after controlling for the medications, POD1 narcotic equivalents and POD3 narcotic equivalents see.

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
CFNCorFNB	1	22.62	22.62	5.3598	**0.02198***
POD1morph	1	1.55	1.55	0.3681	0.54496
CFNCorFNB:POD1morph	1	7.88	7.88	1.8673	0.17386
Residuals	148	624.47	4.22		
Analysis of variance table for the model Pain Difference=CFNCorFNB+POD1morph+CFNCorFNB*POD1morph.					

Table 2: Analysis of variance table for the model Pain.

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
CFNC or FNB	1	22.62	22.62	5.3415	**0.0222***
POD3morph	1	0.56	0.56	0.1324	0.7165
CFNCorFNB:POD3morph	1	6.73	6.73	1.5892	0.2094
Residuals	148	626.62	4.23		
Difference=CFNCorFNB+POD3morph+CFNCorFNB*POD3morph					

(p-value 0.0346; see Table 3). The estimated coefficient for the FNB indicates that controlling for POD1 and POD3, patients in FNB group exp (0.726579) = 2.08 times more likely to show improvement on the pain (Figure 4 and Table 3).

There were no significant differences between the groups for age and gender. And no significant difference was noted in comparison of extension, flexion, longest distance walked on POD1 or POD3, or LOS.

There were no significant nerve injuries, paresthesias or infections related to the nerve block or catheter.

Discussion

There is statistically significant evidence that pain improvement for single-injection FNB is greater than continuous CFNC after controlling for narcotic use. The difference between groups was about 1 point on the VAS pain score during ambulation, a difference not considered clinically important. Immediate postoperative rehabilitation outcomes (extension, flexion, longest distance walked) and LOS did not differ

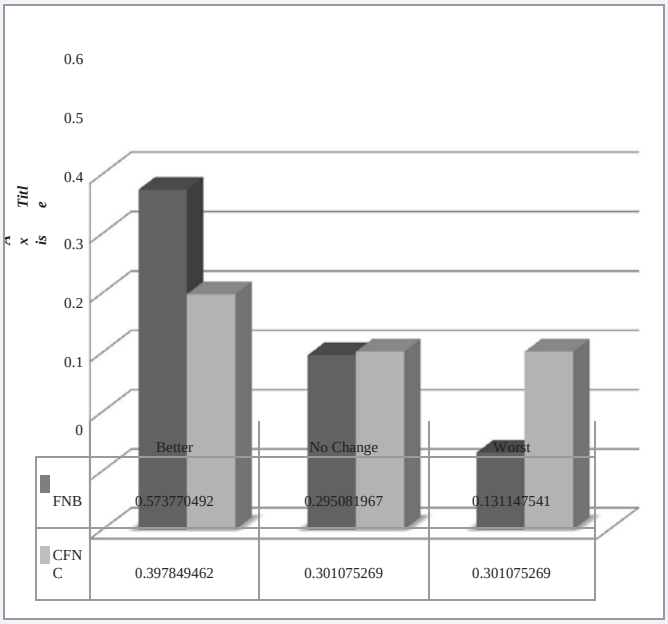

Figure 3 If only the pain improvement from day 1 to day 3 considered (improved versus not improved), there is a statistically significant association between FNB. CFNC (Chi-square value=4.5795, p-value=0.0303). In fact, the proportions of patients who reported improvement are 57.38% for FNB, 39.78% for CFNC, see figures 3 and 4.

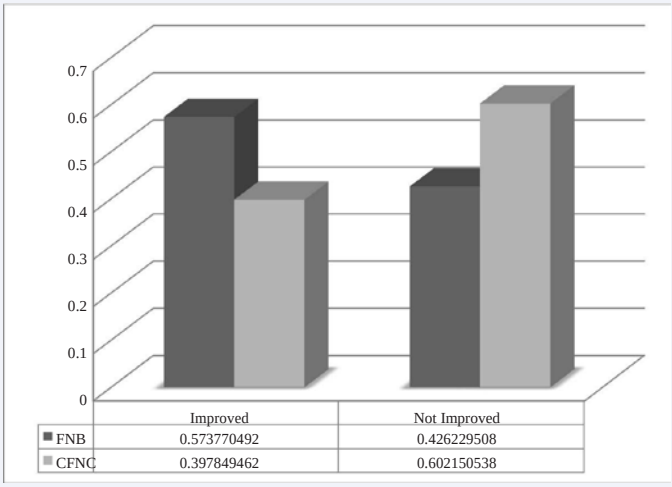

Figure 4 To control for the medication a logistic regression model has been fitted to the data with terms FNB.CFNC, POD1morph, and POD3morph. Only significant variable on determination of the pain improvement turned out to be FNB.CFNC (p-value 0.0346), see Table 3. The estimated coefficient for the FNB indicates that controlling for POD1 and POD3, patients in FNB group exp(0.726579)=2.08 times more likely to show improvement on the pain.

Table 3: Table supporting Figure 4 with terms included in the table.

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	-0.711360	0.324361	-2.193	**0.0283** *
as.factor(FNB)1	0.726579	0.343800	2.113	**0.0346** *
POD1morph	0.010559	0.008196	1.288	0.1977
POD3morph	-0.005426	0.011717	-0.463	0.6433

Significant codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
Null deviance: 209.77 on 151 degrees of freedom
Residual deviance: 204.08 on 148 degrees of freedom
AIC: 212.08

significantly between groups.

Capdevila et al. compared continuous epidural infusion, CFNC, or intravenous patient-controlled morphine for 56 adults after major knee surgery. The continuous epidural infusion and CFNC showed significant lower visual analog scale score at rest and during continuous passive motion, improved postoperative knee mobilization level, improved knee motion, and shorter durations of stay in a rehabilitation center compared with the patient-controlled morphine group. They concluded that CFNC yielded similar results to continuous epidural infusion [2]. Similarly, in 45 patients undergoing total knee arthroplasty, Singelyn et al. compared patient-controlled analgesia with morphine, CFNC [2], and epidural analgesia. Patients in the CFNC and epidural analgesia groups had lower pain scores, better knee flexion, faster ambulation, and shorter hospital stays. The CFNC group patients also reported a significantly lower incidence of side effects. The authors concluded because of the fewer side effects that the CFNC was the technique of choice [3]. To summarize, Capdevila et al. and Singelyn et al., using similar methodologies, both found the CFNC and epidural infusion to be superior to the patient-controlled [2]. The block is labeled as a 3-in-1 block in the publication, but the technique is of that for a femoral nerve catheter similar to Hirst et al. morphine treatment. Singelyn et al. also found fewer side effects associated with the CFNC group compared to the epidural anesthesia group [2,3].

Hirst et al. published a double-blind, randomized, and controlled study of 33 patients undergoing total knee arthroplasty that were randomized into 3 groups. Group 1 received a single injection femoral nerve block, group 2 had a catheter placed in the femoral nerve with a CFNC and group 3 was the control group, treated with opioids. They measured visual analog scale pain at rest and with motion of the knee as well as opioids consumption and side effects. In the recovery room, pain scores with motion were lower in the single injection and CFNC groups. Incidence of nausea was higher in the control group. There were no differences between groups with respect to overall patient satisfaction. The study, however, was underpowered with 33 patients divided into three groups.

Salinas et al. prospectively randomized 36 patients undergoing total knee arthroplasty to a CFNC group and a single femoral nerve block group. They found that the VAS scores were lower on POD1 and POD2 in the CFNC group both at rest and during physical therapy. The CFNC group had significantly lower oxycodone consumption on the first and second day after surgery. There was no difference in hospital length of stay or long-term functional recovery. They concluded that the lack of effect provided by the increased duration of analgesia from the CFNC may have minimal impact on the length of stay in functional long-term recovery in the contemporary healthcare environment within the United States. The study was adequately powered to detect a LOS difference of 1 day which was felt to be clinically relevant. Power analysis was not performed for VAS scores and oxycodone consumption, but significant differences were found within these parameters [5]. Measuring similar parameters in a much larger historical control type study, we did not find differences between the CFNC and FNB in these parameters. Our only significant outcome was the amount of improvement from POD1 to POD3 in the VAS pain scores, which is not clinically relevant. Disadvantages of catheter placement include nerve injury, incorrect placement, falls or bacterial colonization [6]. The CFNC is associated with costs due to the catheter, and requires more nursing and physician care.

LIMITATIONS

We didn't compare a third control group. Both Capdevilia et al. and Singelyn et al. found patient controlled anesthesia inferior to both CFNC and epidural infusion [2,3].

The ideal study design is a randomized controlled trial, particularly for topics such as this where one treatment is not patently better than another. But randomized trials are expensive, cumbersome, labor intensive, and take a long period of time to answer a question that may be answered with other means. We utilized data available to us through our joint center. We didn't receive any funding for the investigation. Chart review was performed on a volunteer basis. Instead of prospective randomized trial, we have a comparison of two large groups of patients in a historical fashion.

In our study, we included a large number of anesthesiologists with heterogenous techniques, although using standard well accepted protocols. While not desirable from a study protocol perspective, in actuality there is variability anesthetic technique in the clinical setting. With the large sample size in this investigation, those differences were neutralized.

Based on the results of this investigation, we have switched exclusively to the single injection femoral nerve block as it is less expensive, requires less nursing care and monitoring. A single injection nerve block will also eliminate any variation in dosing from the pain pump, which can occur.

CONCLUSION

There is statistically significant evidence that pain improvement from POD1 to POD3 for single-injection FNB is greater than continuous FNC after controlling for narcotic use. Single-injection femoral nerve blocks are as effective, or more effective, than CFNC blocks in controlling postoperative pain following unilateral total knee replacement.

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