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Research Article

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Regional Anesthesia and the Adolescent Opioid Epidemic

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Abstract

Rationale: *The legitimate use of prescription opioids in high school seniors increases the risk of future misuse after high school by 33%. Medial patellofemoral ligament reconstruction (MPFLR) is an operation to correct recurrent patellar instability occurring primarily in teenagers with joint hyperlaxity. MPFLR is associated with the extensive use of prescription opioids for significant postoperative pain and prolonged recovery. The hypothesis of this study is that the addition of a single injection proximal sciatic nerve block would significantly reduce opioid requirements and pain scores in adolescents undergoing MPFLR with an adductor canal continuous peripheral nerve block (CPNB).*

Objectives: *The primary end-point of the study is cumulative post-operative opioid consumption (mg/kg morphine equivalents) while hospitalized after MPFLR between the two groups.*

Findings: *We retrospectively compared 25 patients who received an adductor canal CPNB with a single injection proximal sciatic nerve block (Group A/S) and 23 patients who received only an adductor canal CPNB (Group A). Morphine consumption was less than half in group A/S compared to Group A. Eighty-eight percent of patients in Group A/S did not require opioids on the DOS. Maximum and mean pain scores on DOS and POD 1 were significantly lower in Group A/S than Group A.*

Conclusions: *This study suggests the addition of a proximal sciatic nerve block to the adductor canal CPNB significantly reduces opioid requirements and pain scores in the first 24-32 hours after MPFLR in adolescent patients and supports a randomized clinical trial to confirm these findings.*

Keywords: Adductor canal block, Adolescent, Medial Patellofemoral ligament Reconstruction Opioids, Sciatic nerve block,

Introduction

The opioid epidemic has reached crisis proportions in the United States. Sixteen percent of the US population (40 million people) currently has an opioid addiction [1]. Although often over looked, children and adolescents are also affected. The National Survey on Drug Use and Health found that adolescents now choose prescription opioids over marijuana as their primary initial drug of choice [2]. Thirteen percent of high school seniors have admitted to the nonmedical use of prescription opioids (NMUPO). Eighty percent of those reporting NMUPO first used the leftover medications from a legitimate prescription for recreational use [3]. The legitimate use of prescription opioids in high school seniors increases the risk of future misuse after high school by 33% [4]. The prescribing of opioids and the treatment of pain for adolescent orthopedic outpatient surgery remains unexplored [5].

Medial patellofemoral ligament reconstruction (MPFLR) is a surgical procedure to treat recurrent patellar dislocation secondary to chronic patellar instability (CPI). CPI most often occurs in female adolescents with joint hyperlaxity with a reported incidence of 31 per 100,000 [6]. The procedure is painful and often requires extended opioid usage with months of physical therapy and rehabilitation [7]. We are unaware of a study evaluating peripheral nerve blockade for postoperative pain control after MPFLR. In a pilot study we retrospectively compared opioid requirements (mg/kg morphine equivalents) in 15 patients having MPFLR with an adductor canal continuous peripheral nerve block (CPNB) with 15 patients having knee surgery in a similar location (Anterior Cruciate Ligament Reconstruction (ACLR)) with a combination adductor canal CPNB and proximal sciatic nerve block. We found dramatically reduced opioid requirements in the ACLR group receiving both blocks (0.25mg/kg vs 0.03 mg/kg, p<0.0004). Based on this data we initiated a standardized anesthesia protocol in October2018combiningthe adductor canal and proximal sciatic nerve blocks in all MPFLR patients. We hypothesized that patients undergoing MPFLR who received a combination adductor canal CPNB and a proximal single-injection sciatic nerve block would have reduced opioid requirements compared with MPFLR patients who received only an adductor canal CPNB. The primary end-point of the study is cumulative post-operative opioid consumption (mg/kg morphine equivalents) while hospitalized after MPFLR between the two groups. Secondary end-points are median and maximum pain scores in the hospital and length of stay.

Methods

We retrospectively reviewed 68 consecutive patients 10 to 20 years of age undergoing MPFLR at our institution from 10/05/2017 to 4/2/2019. Approval was obtained for all parts of the study by the Quality Improvement and Utilization Review Departments of Shriners Hospital for Children. In October 2018 a standardized anesthesia protocol was established which included the combination of the adductor canal and proximal sciatic nerve blocks for all patients undergoing MPFLR. Prior to this from October 2017 until October 2018, patients undergoing MPFLR were treated with an adductor canal or femoral nerve block only. Patients were grouped into two cohorts corresponding to the preprotocol and postprotocol implementation: the adductor canal group (n=23) and the adductor canal/sciatic cohort (n=25).Patients with a documented failed block, neuromuscular disease or neurologic deficit in the involved leg were excluded. Medical records were reviewed for patient demographics including age, gender and BMI. Surgical data were reviewed for attending surgeon, anesthesiologist placing the block, procedure type, block type and tourniquet time. Post-operative opioid consumption, mean and maximum daily pain scores and length of stay were extracted from the electronic medical record for MPFLR patients with an adductor CPNB (Group A) and compared to those patients having an adductor canal CPNB and a single injection proximal sciatic nerve block. (Group A/S) Post-operative opioid consumption while hospitalized, including the post-anesthesia care unit (PACU), was converted into oral morphine equianalgesic equivalent doses (mg) using standardized opioid conversion tables and presented as dose per weight in kilograms [8].

All surgical procedures were performed by one of three attending pediatric orthopedic surgeons. Peripheral nerve blockade was performed by one of five pediatric anesthesiologists. All blocks were done using ultrasound guidance and dosed through the needle with 0.5% Ropivicaine. The total local anesthetic dose was 0.5 cc/kg up to a total of 30cc. Continuous peripheral nerve blockade was employed with all adductor canal blocks with 0.2% Ropivicaine for 48 to 72 hours and removed by the patient after discharge to home. Sciatic nerve blocks were proximal single-injection blocks using the sub-gluteal or anterior approach performed using ultrasound guidance with peripheral nerve stimulation via a stimulating needle. All patients received a multimodal analgesia protocol with scheduled acetaminophen and a non-steroidal anti-inflammatory drug (NSAID) and oxycodone as a rescue analgesic for a patient reported pain score equal to or greater than 4.

Statistics

A prospective power analysis based on the difference in opioid usage observed in the pilot study comparing ACLR patients with both blocks (A/S) and MPFLR patients with a single adductor canal block (A) determined a per-group sample size of 10 to obtain a power of 0.90 and an alpha level of 0.05 for a two-sample t-test assuming equal variances. We elected to include more patients to account for possible variance introduced by comparing two similar but not identical surgeries on the knee.

Two sided two-sample t-tests were used to compare age, body mass index (BMI) and tourniquet times between the two groups. Chi square tests with Monte Carlo simulation were used to compare the distribution of the surgeon, anesthesiologist, and Fulkerson osteotomy. We used linear regression analysis to compare opioid usage, length of stay and mean and maximum pain scores on the day of surgery (DOS) and post-operative day 1 (POD 1) in the two groups after accounting for the effect of the Fulkerson osteotomy. Logistic regression analysis was used to compare the number of patients without pain and who did not require opioids on the day of DOS and POD 1 in groups A and AS, also after adjusting for the effect of the Fulkerson osteotomy. Confidence intervals on the effect of group are reported for both linear regression and logistic regression analysis. For logistic regression analysis, confidence intervals are reported on the odds ratio. The significance level was set at $p < 0.05$.

Results

Of the 68 patients reviewed48met the inclusion criteria, including 23 who received an adductor canal block (Group A) and 25 who had a combination adductor canal block and single-injection proximal sciatic nerve block (Group A/S). Eighteen patients received a femoral nerve block and were excluded from further analysis. Two patients were excluded with a failed block. A comparison of the demographic data is presented in (Table 1). We found no clinically significant differences between the two groups with respect to age, gender or BMI. The surgical data averages and t-test p-values are presented in (Table 2). We found no significant differences in surgeon, anesthesiologist or tourniquet time. The number of patients having a Fulkerson osteotomy in addition to the MPFLR was not significantly different between groups. There were 8 anterior sciatic blocks and 16 subgluteal sciatic blocks.

Table 1: Demographic data

	GROUP A	GROUP A/S	P VAL
MEAN AGE (YRS) (SD)	15.1 (2.2)	14.2 (2.6)	0.206
MEAN BMI (SD)	26(8)	24(6)	0.310
GENDER (F/M%)	19/23 (83% F)	16/25 (64% F)	0.199

[a] A=Adductor Canal Block
A/S=Adductor Canal and Sciatic Blocks
Age and BMI mean and standard deviation.
Gender percent of total.

Table 2: Surgical data

	GROUP A	GROUP A/S	P VAL
TOURN TIME (MIN)(SD)	91 (23)	87 (26)	0.574
MPFL WITH FULKERSON	13/23(57%)	9/25(36%)	0.248
SURGEON (T/BR/BA)	15/4/4	13/6/5	0.676
ANESTH (H/T/M/V/B)	8/3/3/5/3	7/7/5/3/3	0.813

[a]A= Adductor Canal Block
A/S= Adductor Canal and Sciatic Nerve Blocks
Tourniquet time mean and standard deviation.
Fulkerson percent of total.

Opioid consumption in the hospital (morphine equivalents mg/kg) for the A/S group was less than half of Group A. (A/S0.11 mg/kg vs A 0.24 mg/kg, p=<0.027).The number of patients was significantly larger in group A/S with respect to both not requiring opioids on the DOS (A/S 22/25(88%) vs A 14/23 (47%), p=<0.048) and POD 1(A/S 15/25 (60%) vs A 2/23 (8%), p=<.022). (Table 3)

Table 3: Opioid usage

	GROUP A	GROUP A/S	P VAL
OPIOID USE (MG/ KG) (SD)	0.24 (0.22)	0.11 (0.18)	0.038
NO OPIOIDS DOS / TOTAL (%)	14/23 (47%)	22/25 (88%)	0.048
NO OPIOIDS POD 1 / TOTAL(%)	2/23 (8%)	15/25 (60%)	0.022

[a]Group A=Adductor Canal Block
Group AS=Adductor Canal and Sciatic Nerve Blocks
Opioid usage mean and standard deviation.

Group A/S was significantly more likely to have no pain on the DOS (AS 11/25 (44%) vs A 2/23 (8%), p=<0.009) and POD 1 (A/S 9/25 (36%) vs A 2/23 (8%), p=<0.035) (Table 4). Maximum and mean pain scores on DOS and POD 1 were significantly lower in-group A/S than Group A. (Table 4) there was no substantial evidence suggesting differences in mean length of stay between groups. (Table 4)

Table 4: Pain scores and length of stay

VARIABLE (VAS 0-10)(SD)	GRP A	GRP A/S	P VALUE	CONFINT
MAX PAIN SCORE DOS	5.7(3.3)	2.4 (2.7)	0.001	-5.122 / -1.461
MAX PAIN SCORE POD 1	4.8(3.2)	2.3((2.5)	0.006	-4.245 / -0.760
MEAN PAIN DOS	4.4(2.9)	1.4(1.9)	0.000	-4.364 / -1.433
MEAN PAIN POD 1	3.6(2.6)	1.5(1.9)	0.004	-3.392 /-0.690
NO PAIN DOS	2/23(8%)	11/25(44%)	0.021	+1.569/52.882
NO PAIN POD 1	2/23(8%)	9/25(36%)	0.029	+1.416/49.471
LOS(HRS:MIN)(SD)	27:58(0.08)	28:53(0.13)	0.614	-0.249/-0.138

[a]Group A=Adductor Canal Block
Group A/S=Adductor Canal and Sciatic Nerve Blocks
LOS = Length of Stay
VAS= Visual Analogue Pain Score
CONF INT =Confidence Interval
Pain scores and length of stay mean and standard deviation
Incidence of pain percentage of total.

There were no adverse events reported with the sciatic nerve block. One patient that had received only a femoral nerve block fell at home when his crutches slipped out from under him on POD 2.

Discussion

In an era of rampant opioid dependence, and in light of evidence that the use of postoperative opioids contributes to long-term addiction in adolescents, it is critical we find regional anesthetic techniques that dramatically reduce opioid requirements in teenagers [9]. Eighty-eight percent of adolescent patients having both the adductor canal and proximal sciatic nerve block in this study did not require opioids on the day of surgery after MPFLR. Over the entire study period (range 24-32 hours) opioid usage was less than half in patients who had both blocks. This study suggests the addition of a proximal sciatic nerve block to the adductor canal CPNB can substantially reduce opioid requirements and pain scores after MPFLR in adolescent patients.

This study has limitations inherent in a retrospective study. We made an effort to reduce the scope of potential confounders by continuing our standardized multi-modal pain regimen after the decision was made to add the sciatic block. The nurses, who were solely responsible for recording the patient reported pain scores and administering the prescribed opioids, were unaware of the study. Surgeons and anesthesiologists were similarly distributed between groups. The tourniquet times were not significantly different between groups. We found no differences in opioid usage with the two approaches of the sciatic block. The Fulkerson osteotomy, relocating the attachment of the patellar tendon on the tibia, is performed in conjunction with the MPFLR when the patellar attachment point is greater than 20 mm from the preferred point of attachment [10]. Significant differences in opioid usage and pain scores persisted between Groups A/S and a after adjusting for the use of the Fulkerson osteotomy. There may have been other confounding factors that could have affected opioid usage. However, the opioid reduction with the combination of both blocks was highly significant and in a time of widespread opioid abuse we believe warrants a formal randomized clinical trial to confirm these results and document reduced opioid requirements throughout the postoperative period.

The use of a proximal sciatic nerve block combined with a femoral or adductor canal block for operations involving the knee is controversial. Some surgeons are reticent to include a proximal sciatic nerve block for knee surgery to avoid masking a common peroneal nerve injury and an increased risk of falls postoperatively. We were unable to find a report of a common peroneal nerve injury after MPFLR. The common peroneal nerve is not in proximity to the surgical site during MPFLR. Our patients are young, healthy adolescents maintained in a knee brace in locked extension during weight bearing for the first two weeks after surgery and are not allowed out of bed without assistance and the use of crutches until POD 1. Patients are not discharged to home until they have been evaluated by a physical therapist and demonstrate adequate mobility with crutches.

One surprising finding was that nearly half the patients in the A/S group had no pain on the DOS. We also observed a variable degree of motor block associated with the sciatic block. The differing analgesic and motor block intensity of the sciatic nerve block may be secondary to unintentional partialintraneural injection of local anesthetic. Bioezart et al. recently demonstrated in a cadaver model, using a marker that stays within the injected compartment of a nerve, that intraneural injection (subepinuerium) frequently occurs and is not detectable by ultrasound. The "doughnut" of local anesthetic typically seen around the nerve was, on higher mangnification, visualized deep to the circumneurium and within the subepineural compartment [11]. Ultrasound visualization of the sciatic nerve is not optimal during a proximal sciatic nerve block and unrecognized subepineural injection of local anesthetic is possible.

Anatomic studies have demonstrated considerable variability in innervation of the knee from branches of the femoral, common peroneal, posterior tibial, saphenous and obturator nerves [12,13]. In a 2part meta-analysis Vorobeichik and Sehmbi et al found that neither the femoral nerve or adductor canal block significantly reduced opioid requirements compared to multimodal analgesia following ACLR and did not support the routine use of either block for patients having ACLR [14]. Our results from the adductor canal only group support this recommendation for patients undergoing MPFLR.

We were unable to demonstrate a change in the length of stay with the addition of the proximal sciatic nerve block. Per surgeon request, all patients were admitted prior to 10 am the day of surgery and discharged after clearance by physical therapy the next day regardless of readiness for discharge the day of surgery. Had we released patients the day of surgery we would likely have observed a difference in length of stay secondary to inadequate pain control.

This is the first study we are aware of to evaluate the use of peripheral nerve blockade for postoperative analgesia following MPFLR. This study suggests the addition of a proximal sciatic nerve block to the adductor canal CPNB significantly reduces opioid requirements and pain scores in the first 24-32 hours after MPFLR in adolescent patients and supports a randomized clinical trial to confirm these findings.

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References
1. Lembke A Drug Dealer MD (2016) How Doctors Were Duped, Patients Got Hooked, and Why It's So Hard to Stop. Baltimore, Maryland: John Hopkins University Press.
2. Manchikanti L, Singh A (2008) Therapeutic Opioids: a Ten-Year Perspective on the Complexities and Complications of the Escalating Use, Abuse and Nonmedical Use of Opioids. Pain Physician 11: S63-S88.
3. McCabe SE, West BT, Teter CJ, Boyd CJ (2012) Medical and Nonmedical Use of Prescription Opioids among High School Seniors in the United States. Arch Pediatr Adolesc Med 166: 797-802.
4. Miech R, Johnston L, O'Malley PM, Keyes KM, Heard K (2015) Prescription Opioids in Adolescence and Future Opioid Misuse. Pediatrics 136: e1169-e1177.
5. Dautremont EA1, Ebramzadeh E, Beck JJ, Bowen RE, Sangiorgio SN (2017) Opioid Prescription and Usage in Adolescents Undergoing Orthopedic Surgery in the United States. JBJS Reviews 5: e5.
6. Parikh SN, Lykissas MG (2016) Classification of Lateral Patellar Instability in Children and Adolescents. Orth Clin North Amer 47: 145-152.
7. Fithian DC, Powers CM, Khan N (2010) Rehabilitation of the Knee After Medial Patellofemoral Ligament Reconstruction. Clin Sports Med 29: 283-290.
8. Canadian Pharmacisits Assoiation CPS (2014) Compendium of Pharmaceuticals and Specialites. 45th ed. Ottawa, Ontario, Canada: Canadian Pharmacists Association.
9. Fulkerson JP (1983) Anteromedialization of the Tibial Tuberosity for Patellofemoral Malalignment. Clin Orthop Relat Res 177: 176-181.
10. Boezaart A, Sala-Blanch X, Monzo E, Reina MA (2019) Our Best Anesthetic Blocks Are Probably Related to Unintentional and Unnoticed Intraneural Injection. Reg Anesth Pain Med 44: 279-280.
11. Horner G, Dellon A (1994) Innervation of the Human Knee Joint and Implications for Surgery. Clin Orth Relat Res 301: 221-226.
12. Kennedy JC, Alexander OJ, Hayes KC (1982) Nerve Supply of the Human Knee and Its Functional Importance, Am J Sports Med 10: 329-335.
13. Vorobeichik L, Brull R, Joshi G, Abdallah FW (2017) Evidence Basis for Regional Anesthesia in Ambulatory Anterior Cruciate Ligament Reconstruction: Part 1-Femoral Nerve Block. Anesth-Analg 128: 58-65.
14. Sehmbi H, Brull R, Jitendra U, Shah UJ, El-Boghdadly Kel, et al. (2017) Evidence Basis for Regional Anesthesia in Ambulatory Arthroscopic Knee Surgery and Anterior Cruciate Ligament Reconstruction: Part 2: Adductor Canal Block-A Systematic Review and Meta-Analysis, Anesth Analg 128: 1-16.