Adductor Canal Block vs Intra-articular Catheter in Total Knee Arthroplasty: A Double Blinded Randomized Clinical Trial

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Abstract

Aims: Approximately half of patients undergoing Total Knee Arthroplasty (TKA) experience severe perioperative pain. The ideal analgesic regimen for perioperative pain control in patients undergoing TKA is yet to be determined.

Methods: A prospective, double-blinded, randomised clinical trial was performed, comparing adductor canal blocks versus intra-articular pain catheters in 100 patients undergoing unilateral total knee replacement by a single surgeon. All other analgesic aspects of the perioperative care were kept standard. Patients underwent an identical surgical approach and all received an Attune TKA (Depuy etc). Post-operative pain levels, Range of Movement (ROM) and opioid equivalent breakthrough analgesia were recorded. All assessors were blinded to group allocation. In addition patients completed WOMAC and Oxford knee scores. Southampton wound score was used to detect adverse outcomes.

Results: There were no differences in baseline demographics between the groups preoperative Visual Analogue Pain Score (VAS), Oxford Knee Scores (OKS) or WOMAC scores.

Conclusion: A single shot adductor canal block is not inferior to an intra-articular catheter for perioperative pain management in total knee arthroplasty.

Summary

Explore the short term efficacy and mid-term outcomes of intrarticular catheter versus single shot adductor canal block for total knee arthroplasty. Both intraarticular catheter and single shot adductor canal block are efficacious in perioperative pain management for total knee arthroplasty.

This study comprises a double blinded randomised control trial with minimum one year follow up. Limited perioperative outcomes including severity of osteoarthritis with or without degree of varus/valgus mal-alignment, tourniquet and/or operating time might affect the index outcomes.

Keywords

Knee; Arthroplasty; Analgesia; Recovery; Pain Medicine

Introduction

Total Knee Arthroplasty (TKA) is a successful surgical intervention to relieve knee pain and improve function. It is historically a painful procedure in the perioperative period [1]. Perioperative pain levels have previously been found to be the highest of patient concerns in the lead up to undergoing this procedure [1]. Approximately half of patients undergoing TKA experience extreme pain post-operatively [2]. There is scope to improve patient comfort levels, peri-operative experiences and potentially long term outcomes with improved pain control.

Uncontrolled peri-operative pain following TKA may have detrimental effects on patients with longer immobilisation subsequently increasing cardiovascular risk, inhibiting pulmonary function and increasing venous stasis [2,3]. From an institutional perspective there are longer inpatient length of stay, increased medication cost and an increased burden of care [2]. In the long term, patients may experience increased chronic pain levels, reduced range of movement and have poorer functional outcomes [4]. Up to 13% of patients 6 months post TKR may experience chronic pain following TKA [5].

Previous studies of specific analgesic agents have demonstrated improved short and long-term outcomes for patients undergoing TKA [4,6]. There are significant benefits for health care providers and hospitals in patients having a more comfortable and shorter peri-operative stay, particularly under a bundled healthcare model [6].

Numerous ways have been developed to improve this experience including high volume local anaesthetic infiltration, adductor canal blocks, intra articular blocks and various multimodal medication regimes [7]. As part of an enhanced recovery after surgery program, we have been performing periarticular injection since 2006 and adductor canal blocks since 2010. We have

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constantly been adjusting these regimes and we proposed a comparison of two effective, evidence based analgesic regimens to determine the most effective perioperative pain control for patients undergoing TKA. We collaborated with the heads of anaesthesia, acute and chronic pain team and the orthopaedic department at our institution to develop two evidenced based effective peri-operative pain strategies. We planned to compare these with a double-blinded randomised control trial to determine the most effective strategy. These regimens are currently utilised at our institution where we conducted a head to head comparison [8-10].

The two groups underwent a common regimen of anaesthesia consisting of intra-theal Morphine, Propofol sedation, intravenous Paracetamol, Parecoxib and Tropisetron. In addition the patients were randomised to one of the following two groups;

1. Adductor canal block with 20 ml 0.375% ropivacaine and 4 mg dexamethasone
2. Intra-articular catheter to deliver a dose intraoperatively followed by two doses post operatively of 10 ml 0.75% ropivacaine with 30 mg ketorolac and 1mcg adrenaline

Whilst these two techniques have shown promise in placebo control studies to improve pain control and outcomes in TKA, there has been no direct comparison to determine which is more effective. Previous studies have shown efficacy and safety of the two techniques [11]. We aimed to confirm the most effect analgesic regimen for patients undergoing this painful procedure.

Material and Methods

We conducted a prospective double-blinded randomized control trial of adductor canal blocks versus intra-articular catheters following TKA. A consecutive series of patients were recruited after consenting to surgery by a single surgeon in a high volume arthroplasty centre (Fig. 1). The inclusion criteria were; must be over the age of 18 and able to obtain informed consent and must be undergoing primary TKA for Osteoarthritis (OA). Exclusion criteria included workers compensation claims, chronic pain syndromes, allergy to either pain regimen or revision TKA. Patients were able to withdraw at any stage of the trial. Institutional Review Board (IRB) and clinical trial ethics approval was obtained prior to the commencement of this study.

Using a random number generator, patients were pre-operatively allocated to one of two interventions; Group 1: adductor canal block or Group 2: intra-articular catheter. To maintain patient blinding, those receiving adductor canal blocks had sham catheters placed under dressings; patients receiving intra-articular catheters had sham dressings placed over adductor canal injection sites. Allocation concealment was maintained for the duration of the study. Both treatments are given in addition to standard anaesthetic care. Both techniques are currently utilised by anaesthetists at the site for total knee arthroplasty.

All patients received spinal anaesthesia with 0.5% Heavy Marcaine and 150 mcg intrathecal morphine and light sedation with Propofol (target controlled infusion). An intraoperative

infiltration of 200-400 mg 0.2% ropivacaine in 200 mls, 1mcg adrenaline, 30 mg ketorolac and 2 g of tranexamic acid was administered by the surgeon. Post operatively for four weeks patients received a buprenorphine 5mcg topical patch, paracetamol 1g QID and celecoxib 100 mg/bd as is routine for practice post arthroplasty surgery at our institution. Patients also had access to Targin (oxycodone and naloxone), Endone (oxycodone) and tramadol for break through analgesia, doses of which were recorded.

Patients underwent an informed consent process and were randomised by a random generated number to one of two groups.

Group 1: Adductor canal block

Ultrasound guided injection into adductor canal to administer block of femoral nerve at this level of 20 ml 0.375% ropivacaine with 4 mg dexamethasone administered once only immediately prior to surgery, with a sham catheter placed under dressings to maintain allocation concealment.

Group 2: Intra-articular catheter

Intra-articular catheter was inserted prior to arthrotomy closure to ensure accurate placement. An infusion of 10 ml 0.75% ropivacaine with 1mcg adrenaline and 30 mg ketorolac via intra-articular catheter immediately after closure of the wound during surgery, in addition to this, the same dose was administered at 24 and 36 hours post operatively for both groups with a 'sham' dose of normal saline 0.9% given to ensure adequate blinding. Intra-articular catheter patients (group 2) had a sham dressing to replicate an adductor canal injection site.

The following primary outcome measures were recorded by medical, nursing, and allied health care staff caring for the patient post operatively, all of whom were blinded to the group allocation. The use of breakthrough analgesia was measured by the number of administered doses of Patient Controlled Analgesia (PCA) and the use of additional Per Required Need (PRN) analgesia; converted to a morphine equivalent score. Visual Analogue Scale (VAS) pain scores were measured daily for the first 3 days then on discharge day, at the 2 week follow up, at 6 weeks, 3 months and 6 months post operatively. Length of stay following surgery was determined from hospital records and institutional audit tools. Validated Patient Reported Outcome Measures (PROM) were collected pre-operatively and then at each follow-up timepoint, consisting of the Oxford Knee Score (OKS) and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC). Pre-operative and post-operative range of motion (ROM) was measured at each time point by a musculoskeletal physiotherapist using goniometer. The physiotherapist was blinded to the patient allocation. Patient satisfaction was recorded at different post-operative time points according to a numerical scale 1-5 (very unsatisfied (1), unsatisfied (2), neutral (3), satisfied (4) and very satisfied (5)).

Secondary outcome measures included the Southampton wound score, the rate of superficial or deep Prosthetic Joint Infections (PJI) and the overall rate of mortality.

Figure 1: CONSORT flowchart.

Statistical Analysis

A priori power calculation was performed based on previous similar studies generating a sample size of 50 patients per group to detect a significant difference, with a power of 0.80 and an alpha of 0.05. Statistical analyses comprised of a chi-square test for categorical variables and an independent samples t-test for continuous variables performed using SPSS V24.0 (IBM Pty Ltd); significance was set at $p < 0.05$.

Results

100 patients were recruited in to the study, 6 patients were lost to follow-up. There was no difference in baseline demographics between the groups nor preoperative VAS pain score

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(VAS), Oxford Knee Scores (OKS) or WOMAC scores (Table 1). There were no superficial or deep infections recorded in either group and there was no statistical difference in Southampton wound scores ($p=0.35$). There were no deaths during the study period.

Average length of stay was 3.20 (2-4) days for group one and 3.50 (2-5) days for group two ($p=0.2$). There was no difference in morphine equivalent breakthrough analgesia requirements between groups for the first 24 hours post operatively (59.8 vs 69.3 $p=0.26$) or up until two weeks post operatively (43.2 vs 35.8 $p=0.34$) (Fig. 2).

There was no difference between the groups for VAS pain scores (0-10) on day 1, 2 or discharge with low VAS pain scores reported (2.4 vs 2.8 $p=0.54$, 2.95 vs 2.64 $p=0.56$, 1.74 vs 2.06 $p=0.41$). This was consistent with longer-term follow-up at the 3 month and one year timepoints (1.39 vs 1.18 $p=0.58$, 0.24 vs 0.13 $p=0.53$) (Fig. 3).

There was no difference between the WOMAC scores (28 vs 29 $p=0.9$) and OKS (43.5 vs 42 $p=0.33$) both within the short term and at the one-year post-operative follow-up. This result was consistent for the overall score and for the individual pain components of the scores (Fig. 4).

There was a statistically significant difference in ROM at the 2 week post-operative review favouring the intra-articular block group (93 vs 81 $p=0.02$) however this was not clinically significant. Furthermore, there was no difference at any other recorded time point between the groups (79 vs 76 Day 1 $p=0.65$, 3 months 115 vs 117 $p=0.66$, 1year 128 vs 125 $p=0.60$) (Fig. 5).

Satisfaction was high for both groups in their postoperative stay with scores averaging between satisfied (4) and very satisfied (5) (Fig. 6).

Block		Catheter	P-value
Male	23	9	n=32
Female	24	38	n=62
Average Age	67.72	65.26	0.082
Flexion Deformity	3.6	3.4	0.85
ASA Grade	2.09	2	0.22
Length of Stay	3.2	3.5	0.2

Table 1: Baseline demographics.

Figure 2: Morphine equivalent (mg/day) breakthrough analgesia requirements over time (weeks).

Figure 3: Visual analogue scale pain score over time (weeks).

Figure 4: Patient reported outcome measures over time (weeks) (A) WOMAC (B) OKS.

Figure 5: Independent clinician recorded range of motion (degrees) over time (weeks).

Figure 6: Early post-operative patient reported satisfaction over time (weeks).

Discussion

Perioperative pain levels are the primary patient concern when undergoing total knee arthroplasty with good reason. Traditionally this has been a very painful procedure where half of patients may experience extreme pain levels [1,2]. This can have detrimental effects on patient satisfaction, length of stay, range of movement and functional outcome. As a result, it may also increase the risk of complications including deep vein thrombosis and pneumonia related to prolonged immobilisation [3].

The ideal analgesic regimen for perioperative pain control in patients undergoing TKA is yet to be determined with a range of multimodal analgesia employed to minimise perioperative pain including both regional and general techniques. With up to 50% of patients reporting severe pain in the perioperative period [1]. This may account for decreased mobility and range of motion, which subsequently has detrimental impacts on length of stay, patient satisfaction and long term outcomes.

Our hypothesis was that an adductor canal block with the addition of dexamethasone was not inferior to an intra-articular catheter to provide ongoing analgesic requirements and that this method would be simpler to administer with the potential for fewer complications.

The results of our double blinded randomized control trial support our hypothesis with no statistical or clinically significant difference demonstrated across the range of outcomes assessed. Furthermore, a cost based analysis demonstrated that the adductor canal block group had a cheaper consumables cost (AUD \$41.20) compared to the intraarticular catheter group (AUD \$64.40).

We had a 10% loss of subjects at the six-month mark mainly due to incomplete data sets which will impact the overall power of this study; however given the high p-values across the range of reported outcomes this was unlikely to affect the results. It must also be noted that this study was not powered for detection of complications.

Conclusion

This prospective, double blinded randomised clinical trial showed both regimens provide excellent pain control for patients undergoing TKA. There was no statistical or meaningful clinical difference across all measures between the two groups at any stage up until on year post operatively. A single adductor canal block with the addition of dexamethasone in combination with a standardised perioperative analgesia regimen provides simpler care for patients and is not inferior to an intra-articular catheter.

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