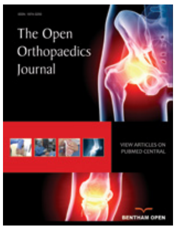
1874-3250/20

Send Orders for Reprints to reprints@benthamscience.net



The Open Orthopaedics Journal

Content list available at: https://openorthopaedicsjournal.com

CrossMark

REVIEW ARTICLE

Evidence-based Review of Periarticular Injections and Peripheral Nerve Blocks in Total Knee Arthroplasty

Alexander Gaukhman[1], Simon Garceau[1], Ran Schwarzkopf[1,*] and James Slover[1]

[1]*NYU Langone, Division of Orthopedics – Adult Joint Reconstruction, New York, NY, USA*

Abstract:

Background:

Recently, post-operative pain management after Total Knee Arthroplasty (TKA) has focused on a multimodal approach for reducing opioid requirements, promoting early rehabilitation, and expediting discharge from hospital. Regional anesthesia, in the form of Periarticular Injections (PAI) and Peripheral Nerve Blocks (PNB), has shown promise as adjunctive therapy to oral analgesics.

Objective:

To review the current literature surrounding regional anesthesia for TKA.

Discussion:

PNBs provide effective analgesia after TKA. Historically, femoral nerve blocks (FNB) have been commonly employed. FNBs, however, lead to the significant motor blockade to the quadriceps musculature, which can dampen early rehabilitation efforts and increase the risk of post-operative falls. Adductor Canal Blocks (ACB) have shown excellent results in reducing post-operative pain while minimizing motor blockade. Periarticular injections (PAI), and infiltration between the popliteal Artery and Capsule of the Knee (IPACK) have similarly helped in reducing patient discomfort after TKA and providing analgesia to the posterior capsular region of the knee.

Conclusion:

PAIs, and PNBs are important elements in many multimodal postoperative pain management protocols after TKA. Current evidence appears to suggest that a combination of an ACB supplemented by posterior capsular analgesic coverage through PAI or IPACK may provide optimal results.

KeyWords: Total knee arthroplasty, Regional anesthesia, Peripheral nerve blocks, Periarticular injections, Multimodal pain management, Joint replacement.

Article History	Received: January 17, 2020	Revised: March 24, 2020	Accepted: April 02, 2020

1. INTRODUCTION: PAIN CONTROL IN TOTAL KNEE ARTHROPLASTY

Pain control strategies after total knee arthroplasty (TKA) have significantly evolved over the last three decades. The 1980s heralded the conception of intramuscular narcotic injection, followed by patient-controlled analgesic pumps in the 1990s [1]. In the mid-2000s, driven in part by early rehabilitation protocols and faster discharge from the hospital, there was a shift toward multimodal analgesia protocols and avoidance of narcotic medications. Currently, most regiments include a combination of multimodal oral medications and Periarticular Injection (PAI) with a selective motor-sparing nerve block, such as adductor canal nerve blocks (ACB) [1].

2. PERIPHERAL NERVE BLOCKS: PROS, CONS AND COMPARATIVE EFFECTIVENESS

Peripheral nerve blocks (PNB) are commonly used in TKA as a means of adjunctive analgesia. Sensory innervation of the knee originates anteriorly from the femoral nerve, and posteriorly from the posterior cutaneous nerve of the thigh emanating from the sciatic nerve. Additionally, variable contributions from the saphenous nerve and the lateral femoral cutaneous nerve provide sensory innervation to the medial and lateral aspects of the knee, respectively [1, 2]. These nerves and their respective tributaries are common targets for peripheral nerve blockade. PNBs have the purported benefit of

* Address correspondence to this author at the Division of Orthopedics – Adult Joint Reconstruction, New York, NY, USA;
E-mail: schwarzk@gmail.com

reducing hospital Length Of Stay (LOS), allowing for earlier participation in post-operative physical therapy, as well as reducing opioid consumption and the side-effects associated with such medications [3 - 5]. Furthermore, compared to epidural anesthesia, a reduction in the risk of post-operative hypotension and urinary retention has been observed [6].

Historically, Femoral Nerve Blocks (FNB) have been the mainstay of PNBs performed for TKA [2]. The resultant effect consists of both a motor and sensory blockade through the diffusion of a local anesthetic to the femoral, lateral femoral cutaneous, and obturator nerves. The term "three-in-one block" has been coined to describe the FNB. The resultant anesthetic effect is localized to the anterior, lateral, and medial aspects of the knee. Overall, FNBs have demonstrated to provide excellent analgesia, especially when combined with a Sciatic Nerve Block (SNB) [7, 8]. In a recent Cochrane review, FNBs were found to provide similar analgesic effect and greater patient satisfaction, while reducing post-operative nausea and vomiting when compared to epidural anesthesia [9]. The resultant motor blockade associated with FNBs, however, leads to profound quadriceps weakness [10, 11]. This inhibition has been associated with a slower post-operative rehabilitation process and a risk of falls estimated at 7% [11]. Furthermore, in a study by Sharma *et al*, the risk of reoperation secondary to falls in the post-operative period was noted to be 0.4% [12]. Lastly, when an SNB is utilized in conjunction with an FNB, the resultant analgesic effect to the heel can place patients at risk of developing pressure ulcers if precautionary measures are not ensured during the post-operative period [13, 14].

ACBs are performed under ultrasound guidance and affect the peripheral nerves within the adductor canal: the saphenous nerve, articular branches of the obturator nerve, medial retinacular nerve, and nerve to vastus medialis [2]. The use of ACB has gained popularity, especially with the push towards outpatient TKA, as it provides a good analgesic effect on the anteromedial aspect of the knee with minimal motor blockade [10]. In a randomized, double-blind, placebo-controlled study by Jaeger *et al*., FNBs and ACBs using ropivacaine were compared for quadriceps weakness. The authors noted that in healthy volunteers, the adductor canal block reduced quadriceps strength by only 8% compared with 49% who received a femoral nerve block [10]. Furthermore, a reduction in the early post-operative visual analogue scale scores and opioid consumption was noted, whereas early mobility at one- and six-hours post-blockade was improved for patients having undergone an ACB compared to an FNB. However, ACBs, similar to FNBs, do not provide analgesia to the posterior capsule of the knee. Therefore, a combination of ACB and PAI is often employed to supplement deficiencies in analgesic coverage. Results of such a combination, although intuitively logical, have demonstrated mixed results [15]. Significant variation in PAI technique and location is likely to play a role in the varied results [16]. Recent interest in infiltration between the popliteal artery and capsule of the knee (IPACK) to provide additional, targeted analgesia to the posterior aspect of the knee has demonstrated promising early results [17 - 19].

3. PERIARTICULAR INJECTIONS: WHERE AND WHAT TO INJECT?

Nerve sensation to the knee is in part provided by the femoral, saphenous, obturator, common peroneal, and tibial nerves. The current literature would suggest that 45-80% of nerve fibers in the knee are nociceptors [20]. Furthermore, numerous studies have looked at the nociceptor anatomic distribution in the knee. Biedert *et al*., performed a histologic survey of 8 human cadaveric knees in order to identify nociceptor density within the various structures of the knee and found the highest concentrations were located in the medial and lateral retinacula, patellar tendon, pes anserinus, and meniscofemoral ligaments [21]. Other studies have identified the capsule and periosteum as a pain generator when interrogated during arthroscopy in awake participants [22].

The pharmacology of PAI cocktails has been studied extensively. Injections are usually a mixture of a long-acting anesthetic, NSAIDs, and epinephrine as a base. The addition of corticosteroids has been more variable. Chia *et al*., randomized patients to receive either a conventional cocktail without corticosteroids or cocktails containing various dosages of corticosteroids [23]. No difference was noted among groups. Kulkarni *et al*., however, demonstrated a reduction in visual analogue scale (VAS) scores at 24hrs and 72hrs after surgery with the addition of methylprednisolone to PAI in TKA [24]. Furthermore, they noted an increase in post-operative flexion, as well as an increase in inflammatory signs in those patients receiving corticosteroid infiltration [24]. The addition of morphine to PAIs has also been studied. Iwakiri *et al*., randomized patients to receive periarticular cocktails with and without morphine and demonstrated similar VAS scores between groups, with an increase in the number of vomiting episodes, and the total dose of antiemetic drugs in patients receiving morphine [25].

4. PAI VS BLOCKS

The evolution of pain control strategies has shifted toward local and regional pain control. ACBs have become more popular due to equivalent pain control and decreased motor blockade as compared to FNBs [1]. Grosso *et al*., performed a study randomizing patients to receive ACB alone, PAI alone, or ACB plus PAI [26]. Patients that received ACB alone had higher pain scores and increased opioid consumption versus patients who received PAI alone or PAI plus ACB. The latter two were found to have equivalent pain scores. Similar outcomes have been noted in the anesthesia literature. Sawhney *et al*., performed an RCT with three groups of patients identical to that of Grosso *et al*., and found similar results with patients undergoing ACB alone having increased pain scores [27].

5. LIPOSOMAL BUPIVACAINE

The introduction of liposomal bupivacaine (LB), was initially approved for use in surgical wounds to provide postoperative analgesia. The efficacy of LB over traditional bupivacaine is yet unproven due to differences in study design, methodology, infiltration techniques, *etc*. The PILLAR study attempted to reconcile confounding variables that may have contributed to inconsistent results and randomized two sets of patients undergoing TKA to receive standard bupivacaine versus LB [28]. Using robust statistics, the authors were able to show a significant difference in improved pain control in patients receiving the liposomal bupivacaine cocktail. However, a large systematic review and meta-analysis failed to provide a true clinical benefit for the use of liposomal bupivacaine in either PAIs or PNBs [29].

CONCLUSION

There has been a strong impetus in the orthopedic community and elsewhere to provide opioid-sparing analgesia in surgical patients. As a result, there has been an emphasis on administering care in the context of multimodal pain control with periarticular injections and nerve blocks being important elements in many protocols. PNBs and PAI play an important role in the mitigation of post-operative pain, with the ideal therapy providing robust analgesia, minimal risk of adverse events, and allowing for early engagement in post-operative rehabilitation. Current evidence appears to suggest that a combination of an ACB supplemented by posterior capsular analgesic coverage through PAI or IPACK may provide optimal results.

CONSENT FOR PUBLICATION

Not applicable.

FUNDING

None.

CONFLICT OF INTEREST

The author declares no conflict of interest, financial or otherwise.

ACKNOWLEDGEMENTS

The authors would like to thank and acknowledge the faculty and staff at NYU Langone Orthopaedic Department.

REFERENCES

[1] Chung AS, Spangehl MJ. Peripheral Nerve Blocks *vs* Periarticular injections in total knee arthroplasty. J Arthroplasty 2018; 33(11): 3383-8. [http://dx.doi.org/10.1016/j.arth.2018.08.006] [PMID: 30197218]

[2] Moucha CS, Weiser MC, Levin EJ. Current strategies in anesthesia and analgesia for total knee arthroplasty. J Am Acad Orthop Surg 2016; 24(2): 60-73. [http://dx.doi.org/10.5435/JAAOS-D-14-00259] [PMID: 26803543]

[3] Lund J, Jenstrup MT, Jaeger P, Sørensen AM, Dahl JB. Continuous adductor-canal-blockade for adjuvant post-operative analgesia after major knee surgery: preliminary results. Acta Anaesthesiol Scand 2011; 55(1): 14-9. [http://dx.doi.org/10.1111/j.1399-6576.2010.02333.x] [PMID: 21039357]

[4] Jenstrup MT, Jæger P, Lund J, *et al.* Effects of adductor-canal-blockade on pain and ambulation after total knee arthroplasty: A randomized study. Acta Anaesthesiol Scand 2012; 56(3): 357-64. [http://dx.doi.org/10.1111/j.1399-6576.2011.02621.x] [PMID: 22221014]

[5] Macfarlane AJ, Prasad GA, Chan VW, Brull R. Does regional anesthesia improve outcome after total knee arthroplasty? Clin Orthop Relat Res 2009; 467(9): 2379-402. [http://dx.doi.org/10.1007/s11999-008-0666-9] [PMID: 19130163]

[6] Fowler SJ, Symons J, Sabato S, Myles PS. Epidural analgesia compared with peripheral nerve blockade after major knee surgery: A systematic review and meta-analysis of randomized trials. Br J Anaesth 2008; 100(2): 154-64. [http://dx.doi.org/10.1093/bja/aem373] [PMID: 18211990]

[7] Abdallah FW, Brull R. Is sciatic nerve block advantageous when combined with femoral nerve block for postoperative analgesia following total knee arthroplasty? A systematic review. Reg Anesth Pain Med 2011; 36(5): 493-8. [http://dx.doi.org/10.1097/AAP.0b013e318228d5d4] [PMID: 21857266]

[8] Abdallah FW, Madjdpour C, Brull R. Is sciatic nerve block advantageous when combined with femoral nerve block for postoperative analgesia following total knee arthroplasty? a meta-analysis. Can J Anaesth 2016; 63(5): 552-68. [http://dx.doi.org/10.1007/s12630-016-0613-2] [PMID: 26896282]

[9] Chan EY, Fransen M, Parker DA, Assam PN, Chua N. Femoral nerve blocks for acute postoperative pain after knee replacement surgery. Cochrane Database Syst Rev 2014; (5): CD009941 [http://dx.doi.org/10.1002/14651858.CD009941.pub2] [PMID: 24825360]

[10] Jaeger P, Nielsen ZJ, Henningsen MH, Hilsted KL, Mathiesen O, Dahl JB. Adductor canal block versus femoral nerve block and quadriceps strength: A randomized, double-blind, placebo-controlled, crossover study in healthy volunteers. Anesthesiology 2013; 118(2): 409-15. [http://dx.doi.org/10.1097/ALN.0b013e318279fa0b] [PMID: 23241723]

[11] Ilfeld BM, Shuster JJ, Theriaque DW, *et al.* Long-term pain, stiffness, and functional disability after total knee arthroplasty with and without an extended ambulatory continuous femoral nerve block: a prospective, 1-year follow-up of a multicenter, randomized, triple-masked, placebo-controlled trial. Reg Anesth Pain Med 2011; 36(2): 116-20. [http://dx.doi.org/10.1097/AAP.0b013e3182052505] [PMID: 21425510]

[12] Sharma S, Iorio R, Specht LM, Davies-Lepie S, Healy WL. Complications of femoral nerve block for total knee arthroplasty. Clin Orthop Relat Res 2010; 468(1): 135-40. [http://dx.doi.org/10.1007/s11999-009-1025-1] [PMID: 19680735]

[13] Todkar M. Sciatic nerve block causing heel ulcer after total knee replacement in 36 patients. Acta Orthop Belg 2005; 71(6): 724-5. [http://dx.doi.org/10.1007/s00590-005-0046-z] [PMID: 16459865]

[14] Apsingi S, Dussa CU. Can peripheral nerve blocks contribute to heel ulcers following total knee replacement? Acta Orthop Belg 2004; 70(5): 502-4. [PMID: 15587044]

[15] Hinarejos P, Capurro B, Santiveri X, *et al.* Local infiltration analgesia adds no clinical benefit in pain control to peripheral nerve blocks after total knee arthroplasty. Knee Surg Sports Traumatol Arthrosc 2016; 24(10): 3299-305. [http://dx.doi.org/10.1007/s00167-016-4187-x] [PMID: 27299450]

[16] Sardana V, Burzynski JM, Scuderi GR. Adductor canal block or local infiltrate analgesia for pain control after total knee arthroplasty? A systematic review and meta-analysis of randomized controlled trials. J Arthroplasty 2019; 34(1): 183-9. [http://dx.doi.org/10.1016/j.arth.2018.09.083] [PMID: 30360981]

[17] Kim DH, Beathe JC, Lin Y, *et al.* Addition of infiltration between the popliteal artery and the capsule of the posterior knee and adductor canal block to periarticular injection enhances postoperative pain control in total knee arthroplasty: A randomized controlled trial. Anesth Analg 2019; 129(2): 526-35. [http://dx.doi.org/10.1213/ANE.0000000000003794] [PMID: 30234517]

[18] Jinadu S, Pai P, Lai Y. Ambulatory knee replacements with IPACK block. J Clin Anesth 2020; 60: 55-6. [http://dx.doi.org/10.1016/j.jclinane.2019.08.021] [PMID: 31445181]

[19] Sankineani SR, Reddy ARC, Eachempati KK, Jangale A, Gurava Reddy AV. Comparison of adductor canal block and IPACK block (interspace between the popliteal artery and the capsule of the posterior knee) with adductor canal block alone after total knee arthroplasty: A prospective control trial on pain and knee function in immediate postoperative period. Eur J Orthop Surg Traumatol 2018; 28(7): 1391-5. [http://dx.doi.org/10.1007/s00590-018-2218-7] [PMID: 29721648]

[20] Ross JA, Greenwood AC, Sasser P III, Jiranek WA. Periarticular injections in knee and hip arthroplasty: Where and what to inject. J Arthroplasty 2017; 32(9S): S77-80. [http://dx.doi.org/10.1016/j.arth.2017.05.003] [PMID: 28602535]

[21] Biedert RM, Stauffer E, Friederich NF. Occurrence of free nerve endings in the soft tissue of the knee joint. A histologic investigation.

Am J Sports Med 1992; 20(4): 430-3.
[http://dx.doi.org/10.1177/036354659202000411] [PMID: 1415886]

[22] EP S. The sensitivity and innervation of the articular capsule. J Bone Joint Surg 1950; 84-92.

[23] Chia SK, Wernecke GC, Harris IA, Bohm MT, Chen DB, Macdessi SJ. Peri-articular steroid injection in total knee arthroplasty: A prospective, double blinded, randomized controlled trial. J Arthroplasty 2013; 28(4): 620-3.
[http://dx.doi.org/10.1016/j.arth.2012.07.034] [PMID: 23107810]

[24] Kulkarni M, Mallesh M, Wakankar H, Prajapati R, Pandit H. Effect of methylprednisolone in periarticular infiltration for primary total knee arthroplasty on pain and rehabilitation. J Arthroplasty 2019; 34(8): 1646-9.
[http://dx.doi.org/10.1016/j.arth.2019.04.060] [PMID: 31155459]

[25] Iwakiri K, Ohta Y, Kobayashi A, Minoda Y, Nakamura H. Local efficacy of periarticular morphine injection in simultaneous bilateral total knee arthroplasty: A prospective, randomized, double-blind trial. J Arthroplasty 2017; 32(12): 3637-42.
[http://dx.doi.org/10.1016/j.arth.2017.07.020] [PMID: 28811107]

[26] Grosso MJ, Murtaugh T, Lakra A, *et al.* Adductor canal block compared with periarticular bupivacaine injection for total knee arthroplasty: A prospective randomized trial. J Bone Joint Surg Am 2018; 100(13): 1141-6.
[http://dx.doi.org/10.2106/JBJS.17.01177] [PMID: 29975272]

[27] Sawhney M, Mehdian H, Kashin B, *et al.* Pain after unilateral total knee arthroplasty: A prospective randomized controlled trial examining the analgesic effectiveness of a combined adductor canal peripheral nerve block with periarticular infiltration versus adductor canal nerve block alone versus periarticular infiltration alone. Anesth Analg 2016; 122(6): 2040-6.
[http://dx.doi.org/10.1213/ANE.0000000000001210] [PMID: 27028771]

[28] Mont MA, Beaver WB, Dysart SH, Barrington JW, Del Gaizo DJ. Local infiltration analgesia with liposomal bupivacaine improves pain scores and reduces opioid use after total knee arthroplasty: Results of a randomized controlled trial. J Arthroplasty 2018; 33(1): 90-6.
[http://dx.doi.org/10.1016/j.arth.2017.07.024] [PMID: 28802777]

[29] Yayac M, Li WT, Ong AC, Courtney PM, Saxena A. The efficacy of liposomal bupivacaine over traditional local anesthetics in periarticular infiltration and regional anesthesia during total knee arthroplasty: A systematic review and meta-analysis. J Arthroplasty 2019; 34(9): 2166-83.
[http://dx.doi.org/10.1016/j.arth.2019.04.046] [PMID: 31178385]