Southern African Journal of Anaesthesia and Analgesia. 2021;27(6 Suppl 1):S175-178
https://doi.org/10.36303/SAJAA.2021.27.6.S1.2719

South Afr J Anaesth Analg
ISSN 2220-1181 EISSN 2220-1173

FCA REFRESHER COURSE

Lower limb regional anaesthesia: What's new?

C Quan

Department of Anaesthesia, School of Clinical Medicine, Faculty of Health Sciences, Chris Hani Baragwanath Academic Hospital, University of the Witwatersrand, South Africa
Corresponding author, email: *barrowceleste@gmail.com*

Lower limb regional anaesthesia is complex as it is a field where the research is growing at a rapid rate producing new blocks, new approaches to established blocks and new data is emerging regarding old techniques. This article explores the choice of general anaesthesia (GA) versus neuraxial anaesthesia (NA). It also explores the impact of peripheral nerve blocks on lower limb anaesthesia. We also then look at newer techniques of regional anaesthesia options for the lower limb. For hip surgery, newer options include: PEricapsular Nerve Group (PENG) block, the Anterior Block of Capsule (ABC) block, the Supra Inguinal Fascia Iliaca (SIFI) block and the Quadratus Lumborum (QL) block. For knee surgery options include: adductor canal block, Nerve to Vastus Medialis (NVM) block, genicular nerve blocks and the Infiltration between Popliteal Artery and Capsule of the Knee (IPACK) block.

Keywords: regional anaesthesia, lower limb

Introduction

Lower limb surgery is open to a multitude of anaesthetic options and permutations. Choice overload can result in difficulty in choosing an optimal anaesthetic plan suited to the patients' needs, surgical approach, the anaesthetists' skill sets, the context of the healthcare environment as well as the social setting of the patient. To confuse matters further, descriptions of new regional techniques are constantly emerging as are the results of big data on older techniques.

General (GA) versus neuraxial anaesthesia (NA)

The ICAROS recommendations regarding primary hip and knee arthroplasty were published in 2019.[1] Big data from multinational collaboration is required to produce research powered enough to detect differences in postoperative complications based on anaesthetic technique.

Total hip arthroplasty (THA)[1]

NA without GA was associated with fewer complications in most categories except for urinary retention when compared with patients receiving GA. Categories included were: pulmonary complications, thromboembolism, central nervous system, cardiac, gastrointestinal complications, acute renal failure and all-cause mortality. In addition, there was also less blood loss and falls in the NA group.

Total knee arthroplasty (TKA)[1]

Patients who received NA in comparison to GA had improved outcomes with regards to pulmonary complications, acute renal failure, urinary tract infections, wound infections and blood transfusions. No significant differences were found in the odds for mortality, central nervous system, gastrointestinal or cardiac complications.

NA + GA versus GA[1]

There were significantly reduced odds for combined NA + GA compared to GA alone for mortality, pulmonary and gastrointestinal complications, acute renal failure, all-cause infections and blood transfusions.

Summary and limitations[1,2]

The utilisation of NA over GA for THA was associated with a lower complication risk. Furthermore, the utilisation of NA combined with GA was also associated with better perioperative outcomes compared with GA alone, albeit with decreased magnitude and diversity. The level of evidence with respect to NA versus GA for TKA as opposed to THA was similar but lower.

The ICAROS study reviewed literature from 1946. Perioperative medicine and surgical techniques have evolved significantly since then, especially with respect to the conduct of GA. In addition, the effect of procedural sedation and its depth was not analysed due to lack of data. Moreover, the cost of big data comes at the expense of causality and anaesthesia technique is only one of many perioperative interventions influencing outcomes. The question also remains if the ICAROS recommendations can be extrapolated to surgeries other than THA and TKA on the lower limb, bearing in mind the profile of the patients presenting for arthroplasty.

Peripheral nerve blocks (PNBs)

The ICAROS group has also recently published their review and meta-analysis looking at the effect of PNB anaesthesia and analgesia for patients undergoing primary hip and knee

arthroplasty.[3] PNBs included were lumbar plexus, psoas compartment, paravertebral, femoral, fascia iliaca compartment, three in one (femoral, obturator and lateral femoral cutaneous nerves) and adductor canal blocks. Anaesthesia with PNB's was compared to any anaesthesia without PNB use which involved systemic analgesia, intravenous analgesia, patient-controlled analgesia, intravenous patient-controlled analgesia, local infiltration analgesia and periarticular infiltration.

Perioperative impact of PNB use in THA[3]

PNB use was associated with significantly reduced complication odds for cardiac, pulmonary, gastrointestinal and renal complications. In addition, odds were also reduced for postoperative delirium, infectious complications, thromboembolic events and blood transfusions.

Perioperative impact of PNB use in TKA

In patients undergoing TKA, PNB use was associated with significantly improved outcomes for cardiac and pulmonary complications, respiratory failure and cognitive dysfunction. A decrease in infectious complications, thromboembolic complications, blood transfusions and blood loss were also demonstrated.

Summary

PNB utilisation for THA and TKA was associated with reduced odds for numerous complications, especially for respiratory failure and cognitive dysfunction. Furthermore, because of the low incidence of block-related nerve injury (0.4 per 1 000 blocks)[4] and the common recovery from these injuries, the ICAROS group concluded that the numerous benefits of PNB outweigh the potential risk of harm.

Which PNB?

Regional anaesthesia and, more specifically, ultrasound-guided regional anaesthesia (UGRA) is a field of anaesthesia that is developing at a rapid rate. The literature supports the use of ultrasound in the field of regional anaesthesia as it allows for decreased block performance time, decreased block onset time, increased rate of complete sensory block and increased analgesic efficacy.[5] The latest developments have been aimed at the introduction of more targeted blocks at increasingly distal sites, the major aim of which is to produce motor-sparing blocks. This results in earlier mobilisation with adequate analgesia and subsequent potential earlier discharge. Thus, there is always a trade off between analgesia and mobilisation.

Hip surgery

Anatomy

Innervation of the hip joint capsule consistently involves three nerves: the femoral nerve (FN) and obturator nerve (ON) which both supply the anterior capsule; and the nerve to quadratus femoris which supplies the posterior capsule.[6] Four additional nerves inconsistently supply the capsule: accessory obturator nerve (AON), sciatic nerve, superior gluteal nerve and the inferior gluteal nerve.[6]

Additionally, when choosing a PNB, one must bear in mind the relevant dermatome, myotome and osteotome involved in the surgical approach.

PENG block

The PENG block is an iliopsoas plane block which was described in 2018.[7] This block targets the hip articular branches of the FN and AON. The anterior hip capsule is innervated by ON, AON and the FN. The majority of sensory innervation (both mechanoreceptors and nociceptors) are concentrated in the anterior capsule, and thus, it makes sense to target the nerves supplying the anterior capsule. However, importantly, the AON and FN may play a greater role than previously reported.[8] The block is performed by placing a curvilinear probe between the anterior inferior iliac spine and the iliopubic eminence. Local anaesthetic (LA) is then injected between the psoas tendon anteriorly and the pubic ramus posteriorly. It is possible that LA can spread medial to the plane between the pectineus and obturator externus muscle where the articular branches of the ON can be found. However, dye injection studies would be needed to confirm this. In addition, the PENG block may spread pericapsular into the iliopsoas muscle blocking nerve endings in this myotome.[9] Recently, high volume (30–40 ml) PENG blocks have been described which may spread proximally and reach the lateral femoral cutaneous nerve and result in a lumbar plexus block.[10] This would expand the indications of the PENG block to more distal surgeries of the leg. PENG blocks have been utilised successfully in hip fracture surgeries, namely intertrochanteric, subcapital and acetabular fractures. Subtrochanteric fractures are possibly too distal to be effectively blocked. Currently no randomised controlled trials have been identified regarding PENG blocks and THA. As far as hip arthroscopy is concerned, pain results from a multitude of sources including distention of the hip capsule, traction, skin incisions and articular surfaces. Further research is required to establish the exact role of the PENG block in THA and hip arthroscopy.

ABC block

The ABC block has recently been described by Sala-Blanch.[11] He purports that this block is more distal and medial to the PENG block and therefore has a higher possibility of blocking the articular branches of the ON. However, further studies are required to determine the efficiency of this block.

SIFI block

The SIFI block was initially described by Hebbard et al. in 2011[12] and later modified by Bullock et al. in 2016.[13] The rationale for the SIFI block is that the course and the branching of the lateral femoral cutaneous nerve is variable below the inguinal ligament as opposed to consistent above the inguinal ligament.[13] In addition, Grant purports that the additional advantages of

a suprainguinal approach are that it affords a denser lateral femoral cutaneous block and a less dense FN block which aids in mobilisation. He also states that the FN branches to the hip joint take off more proximally, whereas the branches to the quadriceps take off more distally.[14] The SIFI block probably does not block the ON. The SIFI is effective for hip fracture surgery and probably for THA.[14]

QL block

Anterior, lateral and posterior QL blocks have been employed in hip surgery. No meta-analyses or reviews were identified regarding the QL block and hip surgery. The role of the different types of QL blocks in the setting of different types of hip surgery has yet to be established.

Summary

The PROSPECT guidelines for THA were published in May 2021 and were a review of trials between July 2010 and December 2019.[15] Fascia iliaca blocks or local infiltration analgesia are recommended. Epidural analgesia, FN and lumbar plexus nerve blocks are not recommended as the adverse effects outweigh the benefits. Intrathecal morphine 0.1 mg can be used, however, the risks and side-effects may be avoided with the use of basic analgesics and regional techniques. The caveat remains, however, as stated in an editorial in the same journal, that unfortunately, newer blocks such as the PENG, ACB, QL blocks are so new that they were not included in this review.

Regarding hip fracture surgery and hip arthroscopy, the surgical approaches as well as the type of injury are diverse. The choice of regional technique therefore must be individualised.

Knee surgery

Adductor canal block

The adductor canal extends from the apex of the femoral triangle to the adductor hiatus. Its roof is formed by the sartorius muscle, its lateral border by the vastus medialis and its medial border by adductor longus and magnus. It contains the superficial femoral artery, superficial femoral vein and the posterior division of the FN. It consistently also contains the saphenous nerve as well as the NVM, both of which are branches of the femoral nerve. The adductor canal inconsistently contains the medial femoral nerve (a branch of the femoral nerve) as well as the anterior cutaneous branch and the posterior branch of the ON. The only motor nerve within the adductor canal is the nerve to vastus medialis. Therefore, the advantage of performing an adductor canal block is that it is motor sparing.

NVM block[16]

The NVM innervates most of the medial joint capsule and is probably more important than the saphenous nerve with respect to analgesia post knee arthroplasty. At the level of the midthigh, the NVM lies between the vastus medialis and sartorius muscles and is usually more lateral than the saphenous nerve which lies just lateral to the femoral artery. The two nerves are separated by the vastoadductor membrane. The NVM is not always easily identified on ultrasound but must be actively looked for in the plane between sartorius and vastus medialis. A nerve stimulator can be used when blocking the NVM to confirm a motor response at the medial knee from contraction of the medial vastus head.

Genicular nerve blocks[17]

There are six sensory nerves of the knee in addition to the sciatic, saphenous and obturator nerves:

1. Superior medial (from the tibial nerve)
2. Inferior medial (from the tibial nerve)
3. Superior lateral (from the saphenous nerve)
4. Inferior lateral (from the peroneal nerve)
5. Suprapatellar (from the saphenous nerve)
6. Recurrent genicular (from the peroneal nerve)

The inferior lateral and recurrent genicular nerves are not blocked to avoid the risk of blocking the peroneal nerve, and causing foot drop. The suprapatellar nerve is often blocked separately with a femoral or adductor canal block. In addition to the genicular nerves, the nerve to vastus intermedius can also be blocked. Currently, the evidence for genicular blocks is only in case series or case studies and has been employed for TKA as well as anterior cruciate ligament surgery. More research is required to define its exact role in knee surgery.

IPACK block

The IPACK block was introduced at the American Society of Regional Anesthesia meeting in Spring 2012 by Sinha. It is an alternative to a sciatic nerve block for posterior knee pain. Disadvantages of sciatic nerve blocks in knee surgery are that they cause foot drop and may mask a surgically-induced peroneal nerve injury. This is especially true if a TKA is performed in a patient with a valgus deformity as the peroneal nerve is stretched when the deformity is corrected. A selective tibial nerve block may be performed with low volume (5–8 ml) instead of a sciatic nerve block, but this causes numbness of the sole of the foot. Additionally, even with low volumes, the peroneal nerve may be inadvertently blocked. To this end, the IPACK block was introduced. The IPACK may be done proximally (cephalad to the superior border of the patella) or distally (at the level of the femoral condyles). A more distal injection could be more likely to provide superior analgesia.[18] In addition, the IPACK block is likely to be superior to local infiltration analgesia.[18]

Conclusion

Choosing a regional anaesthetic for surgery of the lower limb is complex. Regional techniques can be used solely or in combination with GA or in combination with a multitude of PNB options. It is, however, clear that as far as hip and knee arthroplasty is concerned, NA is a better option than GA and NA in combination with GA is better than GA alone. In addition, combining a PNB to your anaesthetic technique is advantageous.

The ultimate choice of PNB is multifactorial and is dependent on balancing analgesia against mobility. Finally, as more research is done, we will hopefully get clearer ideas as to which blocks will be more optimal under certain conditions and for which patients.

ORCID

C Quan https://orcid.org/0000-0003-1039-4819

References

1. Memtsoudis SG, Cozowicz C, Bekeris J, et al. Anaesthetic care of patients undergoing primary hip and knee arthroplasty: consensus recommendations from the International Consensus on Anaesthesia-Related Outcomes after Surgery group (ICAROS) based on a systematic review and meta-analysis. Br J Anaesth. 2019;123(3):269-87. https://doi.org/10.1016/j.bja.2019.05.042.
2. Cozowicz C, Memtsoudis SG. General versus spinal anesthesia in joint arthroplasties. Ann Transl Med. 2015;3(12):161.
3. Memtsoudis SG, Cozowicz C, Bekeris J, et al. Peripheral nerve block anesthesia/analgesia for patients undergoing primary hip and knee arthroplasty: recommendations from the International Consensus on Anesthesia-Related Outcomes after Surgery (ICAROS) group based on a systematic review and meta-analysis of current literature. Reg Anesth Pain Med. 2021;46(11):971-85. https://doi.org/10.1136/rapm-2021-102750.
4. Barrington MJ, Watts SA, Gledhill SR, et al. Preliminary results of the Australasian regional anaesthesia collaboration: a prospective audit of more than 7000 peripheral nerve and plexus blocks for neurologic and other complications. Reg Anesth Pain Med. 2009;34(6):534-41. https://doi.org/10.1097/AAP.0b013e3181ae72e8.
5. Salinas FV. Evidence basis for ultrasound guidance for lower-extremity peripheral nerve block. Reg Anesth Pain Med. 2016;41(2):261-74. https://doi.org/10.1097/AAP.0000000000000336.
6. Laumonerie P, Dalmas Y, Tibbo M, et al. Sensory innervation of the hip joint and referred pain: A systematic review of the literature. Pain Med. 2021;22(5):1149-57. https://doi.org/10.1093/pm/pnab061.
7. Girón-Arango L, Peng PWH, Chin KJ, et al. Pericapsular Nerve Group (PENG) block for hip fracture. Reg Anesth Pain Med. 2018;43(8):859-63. https://doi.org/10.1097/AAP.0000000000000847.
8. Short A, Barnett J, Gofeld M, et al. Anatomic study of innervation of the anterior hip capsule: implication for image-guided intervention. Reg Anesth Pain Med. 2018;43:186-92.
9. Chin KJ. PENG block for hip surgery - What's the evidence for its use? [Internet]. Ki-Jinn Chin. Available from: https://www.youtube.com/watch?v=x-VzJep0YMg. Accessed 10 Sept 2021.
10. Ahiskalioglu A, Aydin M, Celik M, Ahiskalioglu E, Tulgar S. Can high volume pericapsular nerve group (PENG) block act as a lumbar plexus block. J Clin Anesth. 2020;61:109650. https://doi.org/10.1016/j.jclinane.2019.109650.
11. Sala-Blanch X. Hip blocks. ISURA (International Symposium of Ultrasound); 2021 Jun 6; Toronto.
12. Hebbard P, Ivanusic J, Sha S. Ultrasound-guided supra-inguinal fascia iliaca block: a cadaveric evaluation of a novel approach. Anaesthesia. 2011;66:300-5. https://doi.org/10.1111/j.1365-2044.2011.06628.x.
13. Bullock MW, Yalamuri SM, Gregory SH, Auyong DB, Grant SA. Ultrasound-guided suprainguinal fascia iliaca technique provides benefit as an analgesic adjunct for patients undergoing total hip arthroplasty. J Ultrasound Med. 2017;36:433-8. https://doi.org/10.7863/ultra.16.03012.
14. Grant S. Quadratus lumborum blocks and fascia iliaca blocks for total hip arthroplasty. ISURA 2021; 2021 Jun 6; Toronto.
15. Anger M, Valovska H, Beloeil P, et al. PROSPECT guideline for total hip arthroplasty: a systematic review and procedure-specific postoperative pain management recommendations. Anaesthesia. 2021;76(8):1082-97. https://doi.org/10.1111/anae.15498.
16. Dooley J, Bullock WM, Kumar A, Macleod DB, Gadsden J. Systemic sonographic and evoked motor identification of the nerve to vastus medialis during adductor canal block. Reg Anesth Pain Med. 2020;45(11):937-8. https://doi.org/10.1136/rapm-2019-101232.
17. Gadsden J. Nerve blocks for total knee arthroplasty: beyond the adductor canal [Internet]. 2021. Available from: https://www.youtube.com/watch?v=4i5W8VfdCw0. Accessed 10 Sept 2021.
18. Chan E, Howle R, Onwochei D, Desai N. Infiltration between the popliteal artery and the capsule of the knee (IPACK) block in knee surgery: a narrative review. Reg Anesth Pain Med. 2021;46:784-805. https://doi.org/10.1136/rapm-2021-102681.