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Review Article

Current Concepts in Postoperative Pain Management Surgeries of Hip Joint: A Narrative Review

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Abstract

Hip surgery is a common surgical procedure in the elderly and leads to significant pain postoperatively. The hip joint has a complex innervation which is unlikely to be covered with any single modality of pain relief. Multimodal analgesia has been critical in facilitating early recovery and rehabilitation in these patients. Regional analgesia is an important component of multimodal analgesia regimens and is instrumental in achieving optimal patient outcomes. Single shot or continuous central or peripheral nerve blocks provide effective and safe postoperative analgesia, lower opioid consumption, faster rehabilitation, and a high level of patient satisfaction. An ideal regional anaesthesia technique for hip surgery should be motor sparing while providing effective perioperative pain relief. Regional anaesthesia has seen enormous growth in the recent past due to advances in technology and research. These blocks have shown analgesic efficacy, have an opioid-sparing effect, and enable better patient positioning for central neuraxial blocks. Some of the novel interfascial plane blocks like Pericapsular Nerve Group (PENG) block are now being explored for hip analgesia. Within a few years of being described, these novel nerve blocks have seen tremendous favour in the literature and are being extensively used in the current practice of analgesia for hip surgery. In the present review, we aim to discuss the various modalities of analgesia which have been utilised in the past and would discuss few of the newer blocks for hip surgery.

Keywords: Nerve blocks, Ultrasonography, Analgesics, Total hip arthroplasty, Fascia illiaca block, Multimodal analgesia, Transmuscular, Quadratus lumborum block

Background

Hip fractures are associated with significant morbidity and a need for long-term care in the elderly and the literature documents the 1-year mortality as high as 30%. Early surgical intervention has been shown to reduce morbidity and mortality [1]. Total hip arthroplasty (THA) is a frequently performed surgical procedure and is associated with significant postoperative pain. Pain management in this elderly population poses a unique challenge. Pre-emptive multimodal analgesia techniques can facilitate early rehabilitation, functional recovery, patient satisfaction, improvement in quality of life and considerably decrease postoperative morbidity, chronic pain incidence, length of hospital stay and associated costs. It is especially important in elderly patients with multiple comorbidities who are at risk for venous thromboembolic disease. However, despite being a common surgical procedure, there is no uniform standard which can be followed for the perioperative analgesic management for THA. Parenteral opioid analgesics are commonly used as a component of multimodal analgesia but have significant adverse effects, including respiratory depression, which can be prohibitive in the elderly population. Central neuraxial blocks have been extensively utilised for perioperative analgesia but can delay the patient's recovery and ambulation. The past decade has seen tremendous

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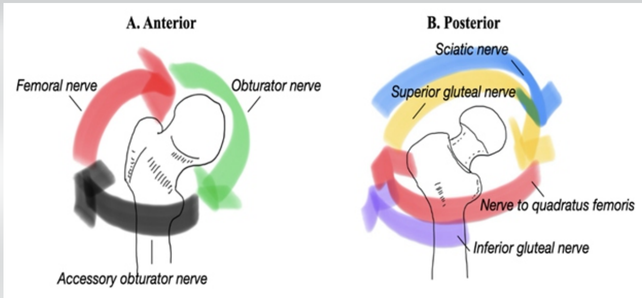

Figure 1: Innervation of the hip joint: A- anterior hip; B- posterior hip

growth in the popularity of peripheral nerve blocks and interfascial plane blocks for this procedure. These nerve blocks have demonstrated analgesic efficacy, opioid-sparing effect which improves patient recovery, possible beneficial effects on postoperative delirium in the elderly, reduced hospital length of stay and decreased incidence of pulmonary complications. In the present article, we have reviewed the commonly used analgesia techniques including parenteral analgesics, peripheral nerve blocks, newer interfascial plane blocks and current evidence of their application in hip fracture patients.

Functional anatomy of hip joint

The hip joint is formed by the articulation of the pelvic acetabulum with the head of the femur. It is surrounded by a capsule which is reinforced by ligamentum teres, transverse ligament and three primary fibrous capsular ligaments- iliofemoral, pubofemoral and ischio-femoral ligaments. It is innervated by both lumbar (L1-L4) and sacral (L4-S4) plexuses (Figure 1A and B). The sensory nerve supply of the hip joint is derived predominantly from the femoral nerve, obturator nerve and nerve to quadratus femoris, with contribution from superior gluteal, inferior gluteal, accessory obturator and sciatic nerves [2].

Systemic analgesics

The Association of Anaesthetists has recently published the PROSPECT guideline for postoperative pain management after THA. Systemic non-opioid analgesics, like paracetamol in combination with NSAIDs or COX-2-selective inhibitors, are recommended for THA patients unless contraindicated [3]. Paracetamol can cause hepatotoxicity if >4 gm is administered in 24 hrs in healthy adults. Dose reduction is recommended in elderly patients and its use should be limited in patients with compromised hepatic function. The side effects of NSAIDs (ketorolac, diclofenac etc.) include gastrointestinal mucosal damage, renal dysfunction and platelet dysfunction. Selective COX-2 inhibitors (celecoxib, meloxicam etc.) have minimal adverse gastrointestinal and antiplatelet effects; thus, they are preferred in the perioperative period. The oral route is non-inferior to intravenous analgesia and is encouraged once a patient is orally allowed [4]. Gabapentinoids (pregabalin, gabapentin etc.) may reduce postoperative opioid consumption following hip replacement surgery. However, they are not routinely recommended due to clinically relevant side-effects like dizziness, sedation etc. [3]. A single dose of intravenous dexamethasone 8-10 mg is recommended for its analgesic and antiemetic effects. Equipotent doses of alternative glucocorticoids are equally safe and effective [3]. Intravenous (IV) lidocaine (1.5-2 mg/kg bolus followed by an infusion of 2 mg/kg/hr) results in lower pain scores and opioid consumption in ambulatory surgeries. However, it has not been observed to be useful in hip surgery. IV magnesium sulphate (30-50 mg/kg bolus followed by an infusion of 10-15 mg/kg/hr) may offer good systemic analgesia with minimal toxicity, but its efficacy is yet to be proven in hip surgery. IV dexmedetomidine (1 mcg/kg loading dose over 10 minutes followed by an infusion of 0.2-0.7 mcg/kg/hr) relieves pain, reduces opioid requirement but is associated with sedation and a high incidence of bradycardia.

Supplemental opioid analgesics are used if needed within the immediate postoperative period. Oral controlled release-oxycodone has an equivalent analgesic effect [5] and better tolerance [6] compared to patient-controlled analgesia (PCA) regimes. Furthermore, patients are more readily able to ambulate and function independently by removing the required IV access and connection to a PCA pump [4]. Intravenous opioids are reserved as rescue analgesics [3]. Commonly used IV opioids in the postoperative period are fentanyl, tramadol and morphine. Despite their high analgesic profile, they can result in serious adverse effects like sedation, respiratory depression, urinary retention etc which can delay ambulation. Repeated and prolonged use can also lead to the development of opioid tolerance and dependence. PCA is a drug delivery system based on the use of a sophisticated microprocessor-controlled infusion pump, with which patients self-administer small, predetermined doses of analgesic medication to relieve their pain. The basic composition of PCA models includes an initial loading dose, bolus (demand) dose, lockout interval and a background infusion rate. Opioids commonly used for PCA are morphine, fentanyl, hydromorphone and sufentanil (Table-1). The advantages of PCA are rapid onset, programmability, and uniform and sustainable analgesia. However, it is

Table 1: Intravenous patient-controlled analgesia in adults

Drug	Demand dose	Lockout interval (min)	Background infusion
Morphine	0.5-2.5 mg	5-10	0.5-2.5 mg/hr
Hydromorphone	0.05-0.25 mg	5-10	0.05-0.25 mg/hr
Fentanyl	10-20 mcg	4-10	20-100 mcg/hr
Sufentanil	2-5 mcg	4-10	2-5 mcg/hr

Table 2: Regional analgesia modalities in hip surgery
1. Spinal analgesia (intrathecal morphine)
2. Epidural analgesia
3. Lumbar plexus block (Psoas compartment block)
4. '3 in 1' block
5. Femoral nerve block
6. Obturator nerve block
7. Sciatic nerve block
8. Local infiltration analgesia
Novel interfascial plane blocks
1. Fascia iliaca compartment block
2. Quadratus lumborum block
3. Erector spinae plane block
4. Pericapsular nerve group (PENG) block

invasive, requires monitoring, delays ambulation and may be associated with opioid-related side effects like nausea, vomiting, urinary retention, constipation, pruritus, sedation, respiratory depression etc [7].

Regional anaesthesia for hip surgery

Classical regional anaesthesia techniques

a. Spinal and epidural analgesia

Central neuraxial anaesthesia (subarachnoid and/or epidural block) is a commonly employed anaesthetic technique for hip surgery. In addition to providing excellent surgical anaesthesia, it can continue to provide effective analgesia in the postoperative period. Regional anaesthesia offers additional advantages like decreased intraoperative blood loss, decreased incidence of deep venous thrombosis and early wound healing.

Regional anaesthesia for hip surgery can be performed by spinal anaesthesia, epidural anaesthesia (with or without indwelling catheters) and combined spinal-epidural technique. Intrathecal morphine 0.1 mg results in lower pain scores and provides a long duration of analgesia (at least 24 hrs) in the postoperative period [8]. It is easy to perform, efficacious and a cost-effective method for hip analgesia. A small dose (0.1mg or less) has limited adverse effects [3]. However, pruritus, nausea, vomiting, urinary retention etc. observed with intrathecal morphine may delay ambulation and oral intake, thus affecting patient satisfaction.

Epidural anaesthesia and analgesia require placing a specially designed needle into the epidural space. Drugs may be injected directly through the needle or via an epidural catheter. The indwelling catheter can be used subsequently to administer drug boluses or a continuous drug infusion. Commonly used local anaesthetics via epidural route are mentioned in Table-3. The advantages of epidural analgesia and surgical outcomes have been well documented in the literature. Compared with parenteral opioid use after surgery, the utilisation of continuous epidural infusion provides superior relief in postoperative pain with few adverse outcomes [9]. A commonly used continuous epidural infusion regime is to administer a loading dose of 3-6 mL of 0.125% bupivacaine or 0.2% ropivacaine at least 30 minutes before the end of surgery followed by an infusion of 0.0625% bupivacaine or 0.1% ropivacaine with 2 mcg/mL fentanyl at 3-5 mL/hour, once the patient is shifted to the recovery room (Table-4). Uncorrected hypovolemia, increased intracranial pressure, local site infection, allergy to local anaesthetic agent and coagulopathy are contraindications of regional anaesthesia. Furthermore, there is a potential risk of epidural hematoma in patients receiving thromboprophylaxis in the perioperative period. The limitations of epidural analgesia involve failed or dislodged catheters, unilateral blocks, hypotension and motor impairment [9].

The DepoDur is a novel, FDA-approved extended-release liposomal formulation of morphine. It is used as a single-shot lumbar epidural dose, thereby avoiding the adverse effects of a continuous local anaesthetic infusion and indwelling catheters, particularly in patients receiving anticoagulants. A dose of 15 mg is recommended for hip surgery and can provide excellent analgesia for up to 48 hours [10].

Table-3: Commonly used local anaesthetics for epidural analgesia

Drug	Concentration (%)	Onset time (min)	Duration (min)
Lidocaine	1-2	10-20	60-120
Bupivacaine	0.0625-0.25	15-20	160-220
Ropivacaine	0.1-0.375	15-20	140-220
Levobupivacaine	0.0625-0.25	15-20	150-225

Table 4: Postoperative epidural infusion regimens for hip surgery [11]
1. Bupivacaine 0.0625% + fentanyl 1-2 mcg/mL at 3-5 mL/hr
2. Ropivacaine 0.1% + fentanyl 1-2 mcg/mL at 3-5 mL/hr
3. Bupivacaine 0.125% + morphine 40 mcg/mL at 3 mL/hr, 1 mL patient controlled bolus, 10 min lockout interval, 25 mL/4 h max
4. Bupivacaine 0.25% + buprenorphine 0.0006% at 3 mL/hr
5. Bupivacaine 0.0625% + morphine 50 mcg/mL at 4 mL/hr
6. Ropivacaine 0.2% at 4-6 mL/hr, 6 mL 0.2% ropivacaine patient controlled boluses every 30 minutes prn

b. Lumbar plexus block (Psoas compartment block)

The lumbar plexus is formed by L1-L4 nerve roots that enter the psoas major muscle after leaving the intervertebral foramina. Psoas compartment block (PCB) is a regional anaesthetic technique that blocks the main components of the lumbar plexus, namely the femoral, lateral femoral cutaneous and obturator nerves as they run within the psoas major muscle. It is also known as the posterior lumbar plexus

block. The drug is administered into the 'compartment' within the posterior $1/3^{rd}$ of the psoas muscle anterior to the quadratus lumborum muscle, which spreads cephalad within the fascial plane resulting in lumbar plexus block [12].
The use of ultrasound (USG) imaging for PCB has not been as useful as other peripheral nerve blocks due to the depth of the plexus at 5-8 cm, necessitating the use of lower frequency USG probes (5-8 MHZ), resulting in reduced image resolution [12]. It is a technically challenging block that requires advanced skills and can be time-consuming. The lumbar paravertebral region is highly vascular and non-compressible, placing patients on anticoagulants at high risk of bleeding complications. A large volume of drug is usually needed to block the plexus, increasing the risk associated with inadvertent neuraxial or intravascular injection [1]. With the growing use of safer alternatives to PCB, its use has been on a declining trend in recent years.

c. '3 in 1' block

Winnie et al first described the '3 in 1' block in 1973. It was postulated that the lumbar plexus can be blocked by a single injection slightly distal to the inguinal ligament (same site as the femoral nerve block). They suggested that this single injection would result in anaesthesia of femoral, lateral femoral cutaneous and obturator nerves due to cephalad distribution of local anaesthetic along the fascial layer [13]. This hypothesis has not been confirmed and subsequent MRI studies have shown that there is a lateral and medial spread of local anaesthetic after injection, but not cephalad. It has been suggested that the block should better be referred to as '2 in 1' and the term '3 in 1' should be abandoned, as the obturator nerve is rarely blocked [14]. The femoral, obturator and lateral femoral cutaneous nerves can be blocked independently with USG guidance instead of a '3 in 1' block.

d. Femoral, obturator and sciatic nerve blocks

A single shot, low volume femoral nerve block has a limited role after THA as this approach is too distal to provide clinically useful analgesia of the hip [15]. In contrast, continuous femoral nerve block provides equivalent analgesia following THA when compared with PCA morphine and epidural analgesia [16]. However, anaesthesia of the hip joint is incomplete without obturator and sciatic nerve blockade. The addition of sciatic nerve block to continuous femoral nerve block has been shown to enhance the analgesic effect at 6 and 12 hrs after THA [17]. The limitations of these nerve blocks are they are time-consuming, the need for multiple injections and delayed ambulation in the postoperative period due to the motor blockade.

e. Local infiltration analgesia

Local infiltration analgesia (LIA) is based on the systematic infiltration of a mixture of long-acting local anaesthetic, a non-steroidal anti-inflammatory drug and epinephrine into the tissue around the surgical field to achieve satisfactory pain control with little physiological disturbance [18]. In a recent meta-analysis by Ma et al, LIA resulted in significant benefits during the first 24 hrs in terms of less pain at rest and during movement, and a reduction in opioid consumption after THA [19]. It is a good alternative to intrathecal morphine as rescue analgesic consumption, pain intensity on mobilisation and side effects like nausea, vomiting, pruritus etc are lower at 24-48 hrs after surgery in patients who received LIA after THA, compared to those who received intrathecal morphine [18]. Multiple doses and continuous infusions of LIA have also been used, but analgesia due to the systemic effect of the local anaesthetic cannot be ruled out. PROSPECT guideline for THA recommends single-injection LIA for postoperative pain management, especially if there are contraindications to basic analgesics and/or in patients with high expected postoperative pain [3].

Newer regional anaesthesia techniques (Table-5)

a. Suprainguinal fascia iliaca compartment block

The fascia iliaca compartment block (FICB) was first described by Dalens et al in 1989 [20]. It is considered an anterior approach to the lumbar plexus where local anaesthetic is injected deep into the fascia iliaca, to block the femoral, obturator and lateral femoral cutaneous nerves simultaneously. It can be performed either under USG guidance or with a loss of resistance technique. The USG longitudinal suprainguinal approach to FICB has a better block success rate compared to the infrainguinal approach, as the local anaesthetic is injected more cranially, allowing a more consistent block of the three nerves [21].
Compared with placebo, FICB is a safe and effective method to reduce postoperative pain scores, morphine consumption and nausea in patients after THA and hip fracture, with no greater risk of falls [22, 23]. A single-shot FICB is the only peripheral nerve block recommended as a component of multimodal analgesia in the PROSPECT guideline for pain management in hip surgery [3]. It is a relatively safe anaesthesia technique as the needle is pointed away from the femoral nerve and vessels. It is a superficial block, technically easy to perform and associated with a low complication rate. However, it does not provide complete analgesia for hip surgery as the sciatic nerve, nerve to quadratus femoris, and superior and inferior gluteal nerves are not blocked. Therefore, analgesia of the hip joint cannot be fully achieved with a FICB alone [21].

b. Lumbar erector spinae plane block

USG-guided erector spinae plane block (ESPB) is an interfascial plane block, first described by Forero et al in 2016 for the treatment of thoracic neuropathic pain [24]. ESPB has been reported to provide effective analgesia in the thoracic region, but its effect in the lumbar region is still being explored. Lumbar ESPB for THA was first reported in 2017 by Tulgar et al, where they injected the local anaesthetic between erector spinae muscle and transverse process of L4 vertebra under USG guidance (Figure 2). They observed excellent and long-lasting (up to 18 hrs) pain relief using single-shot ESPB without any significant motor blockade [25]. Since then, other authors have also published case reports of lumbar ESPB for THA with favourable outcomes [26, 27]. Continuous ESPB catheters have also been used for postoperative analgesia in THA [28, 29]. In 2020, Ahiskalioglu et al conducted an observational study on fifteen high risk elderly patients undergoing hip surgery and demonstrated that lumbar ESPB when combined with mild propofol sedation provides adequate and safe anaesthesia for hip surgery. A high volume of local anaesthetic when deposited in the interfascial plane spreads to the lumbar plexus. Therefore, lumbar ESPB acts as a lumbar plexus block, both radiologically and clinically [30]. ESPB block is technically easy to perform and is associated with a lower risk of damage to nerves, vessels and inadvertent intravascular injection. It provides extensive sensorial coverage when compared to the lumbar plexus block, as local anaesthetic spreads to L4-L5 nerve roots that are part of the sacral plexus as well [30]. It can be given safely in anticoagulated patients or when spinal-epidural is contraindicated. Continuous ESPB resulted in increased early ambulation by elective primary THA patients when compared to continuous FICB [31].

c. Quadratus lumborum block

Quadratus lumborum block (QLB) is an abdominal interfascial plane block first described by Blanco in 2007 [32]. In QLB, local anaesthetic is deposited in a fascial plane surrounding the quadratus lumborum muscle to block the nerves. QLB is classified into lateral, posterior and anterior (transmuscular) types based on the location of local anaesthetic placement about the quadratus lumborum muscle and other abdominal muscles [33]. In transmuscular QLB, the drug spreads posteriorly into the lumbar paravertebral space. It provides good analgesia, however, the outcome is not consistent with all approaches. It is a deep block and can be technically difficult to perform. Both transmuscular QLB and ESPB provide good postoperative pain control in hip surgeries, but QLB provides a better analgesic profile when compared to ESPB [34]. A recent systematic review and meta-analysis concluded that QLB reduced opioid consumption and pain scores in patients undergoing hip surgeries as a part of a multimodal analgesic regimen [35].

d. Pericapsular nerve group block (PENG block)

The PENG block is a USG-guided interfascial plane block, first described by Girón-Arango et al for the blockade of articular branches of the femoral, obturator and accessory obturator that provide sensory innervation to the anterior hip capsule [36]. The local anaesthetic is injected in the plane between the iliopsoas tendon and periosteum, between the anterior inferior iliac spine and iliopubic eminence (Figure 3). In a randomised controlled trial by Pascarella et al, the patients receiving PENG block in THA had lower pain scores up to 48 hours post-surgery, compared to patients who did not receive the block. There was a significant reduction in opioid consumption, a better range of hip motion and a shorter time to ambulation [37]. It is a motor sparing block,

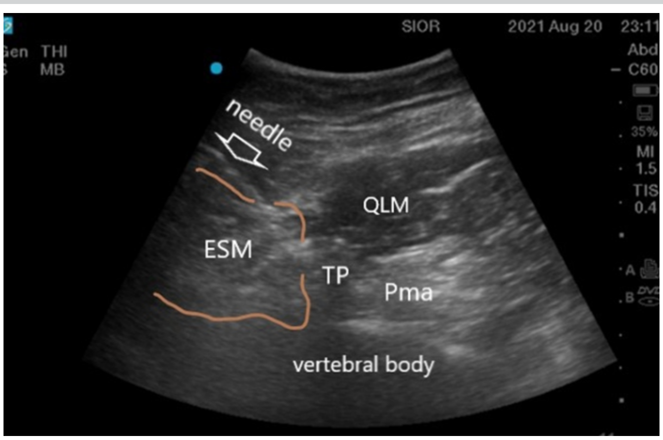

Figure 2: Lumbar Erector Spinae Plane Block
ESM-erector spinae muscle; TP-transverse process; Pma-psoas major; QLM- quadratus lumborum

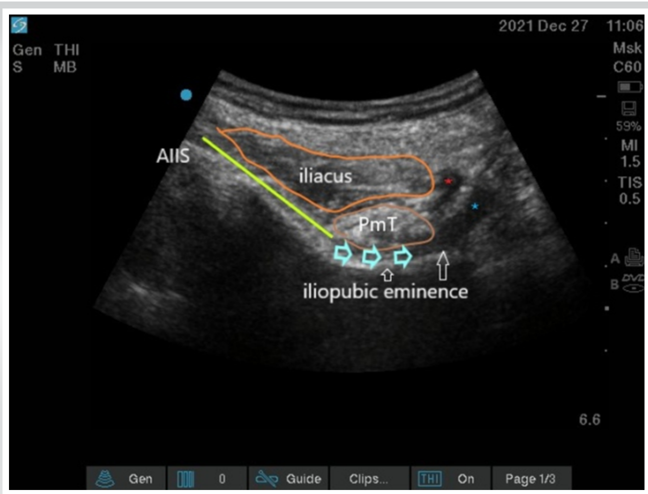

Figure 3: PENC block

Table 5: Comparison of novel peripheral nerve blocks for hip surgery

Nerve block	Advantages	Disadvantages
Suprainguinal fascia iliaca compartment block	● Excellent analgesia ● Technically easy ● Fewer complications ● Minimal motor block	Does not provide complete analgesia for hip
Lumbar erector spinae plane block	● Extensive sensorial coverage for hip ● Technically easy ● Fewer complications	Incidence of motor block
Quadratus lumborum block	Excellent analgesia	● Deep block ● Technically difficult ● Not consistent performance with all approaches
PENG block	● Excellent analgesia ● Patient positioning for procedure ● Motor sparing effect ● Technically easy ● Fewer complications	Cannot be used as a sole anaesthetic block for the hip surgery

easy to perform and has a low rate of complications [38]. The main disadvantage is that it cannot be used as a sole peripheral nerve block for hip surgery and needs an additional modality to cover pain at the incision site.

AIIS-anterior inferior iliac spine; PmT-psoas tendon; local anaesthetic flow-blue hollow arrows; white hollow arrows-iliopubic eminence; red asterix-femoral artery; blue asterix-femoral vein.

Conclusion

The goal of hip arthroplasty is to restore a painless hip joint and provide early functional recovery. Multimodal pain management has become a crucial part of perioperative care of these patients. Peripheral nerve blocks are an increasingly popular technique for pain management in hip surgeries. They are especially useful in patients on thromboprophylaxis, and also reduce the incidence of adverse effects associated with parenteral opioids and central neuraxial blocks. Although adverse effects are rare, vigilant practice and monitoring are essential. Institutional protocols should be developed to make these peripheral nerve blocks a routine component of multimodal analgesia in hip surgeries. This should include skill development as well as awareness about the safety and efficacy of these blocks.

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Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his/her consent for his/her images and other clinical information to be reported in the Journal. The patient understands that his/her name and initials will not be published, and due efforts will be made to conceal his/her identity, but anonymity cannot be guaranteed.

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