

ANAESTHESIA FOR HIP REPLACEMENT

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Arthritis of the Hip

In the simplest terms, the hip is a ball and socket joint. The ball is formed by the upper end of the femur, and the socket by part of the pelvis called the acetabulum. The ends of the bones are covered with a smooth layer of cartilage, which allows nearly frictionless and painfree movement. When the cartilage is damaged by arthritis, joints become stiff and painful. Arthritis may affect 2% of the population and causes include:

- **Osteoarthritis (OA)** - A degenerative disease affecting the articular surface of one or more joints, usually due to aging or repetitive joint trauma. Some populations show an extremely high incidence of OA. An example of endemic OA includes Mseleni Joint Disease, found in the Tsonga people of East Africa, and in Mseleni, Northern Kwazulu-Natal, South Africa.

- **Inflammatory - rheumatoid arthritis** is characterized by an immune-mediated joint destruction with chronic and progressive inflammation of the synovial membranes

- Infective
- Congenital dislocated/shallow hip

Treatment of arthritis includes:

- Anti-inflammatory and analgesic treatment.
- Physiotherapy to maintain movement and flexibility.
- Joint replacement surgery if arthritis is severe and significantly affects activity.

Hip Replacement Surgery

Joint replacement is a common surgical procedure with a high success rate. Total hip replacement (THR) involves:

- dislocation and removal of the femoral head.
- reaming of the acetabulum and insertion of a prosthetic plastic or ceramic acetabular cup.
- reaming of the femur with insertion of a femoral component (metal or ceramic femoral head, and metal stem) into the femoral shaft (with or without cement). Metals used include stainless steel, alloys of cobalt and chrome, and titanium. Wear-resistant polyethylene (plastic) is used for socket replacement. Bone cement (with or without antibiotics) may be used to anchor the prosthesis into the bone. Joint replacements implanted without cement are designed to fit and lock into the bone directly.

Hip Replacement Options

- **THR, also called total hip arthroplasty (THA)**. The hip socket and ball of femur is replaced, with a metal or ceramic ball, on a stem fitted into a cup with a plastic liner.

- **Revision of Hip Replacement**. A re-operation on a previously performed hip replacement which has failed or become loose. Part or all of the previous implant is removed and replaced with a new one. This may be a prolonged operation with significant blood loss.

- **Bilateral Hip Replacement**. Both hips are replaced simultaneously. This operation has a longer recovery time and requires a higher level of fitness preoperatively.

- **Hip resurfacing (Birmingham hip resurfacing; BHR)**. The ball of the femur is 'resurfaced' with a metal shell rather than being removed and replaced. This preserves more of the patient's own bone and produces a more anatomical load bearing on the femur. The socket is replaced as in a traditional replacement procedure, without cement.

- **'Girdlestone' Procedure**. Usually if revision hip replacement is not an option, the loosened prosthesis is removed altogether. Scar tissue develops between the upper end of the femur and the hip bone and allows the person to move with little pain. However, the femur is shortened, the leg is weak, and walking with the aid of a stick or crutches is usually necessary.

Preoperative Assessment For Hip Replacement Surgery

There is no single standard anaesthetic. An anaesthetic plan should be formulated that will optimally accommodate all aspects of the patient and planned surgical procedure (primary THR versus complex revision THR). Assessing patients preoperatively includes a pertinent history, a physical examination, and any indicated laboratory tests.

Most patients presenting for hip surgery are elderly, and somewhat frail. A thorough preoperative assessment is necessary, but indiscriminate cancellation or delay is inappropriate.

History

- **Current problems and activity** - What type of patient are we dealing with? Young/old/active/inactive/lucid? Personality, activity and age often dictate the type of anaesthetic.

- **Underlying medical fitness, and review of organ systems** - especially in the elderly. Enquire about respiratory and cardiovascular problems. Debilitating and limited joint mobility prohibit assessment of exercise tolerance, potentially masking underlying coronary artery disease (CAD) and lung problems.

- **Drug history** - warfarin, aspirin, nonsteroidal anti-inflammatory drugs (NSAIDs - have side-effects of GIT bleeding, renal toxicity and platelet dysfunction) has implications for the anaesthetist with regard to neuraxial blocks, and also the surgeon. Some patients are on immunosuppressants and steroid supplementation may be required. A high proportion of elderly patients are on cardiovascular treatment, particularly beta-blockers and ACE-inhibitors.

- Allergies - enquire specifically about antibiotic allergies, and check the type of cement being used. Aseptic loosening of cemented THRs has been linked to allergies to some of the components of the cement.
- Surgical history, previous anaesthetics - anaesthetic records may detail difficulties in spinal/epidural insertion, airway assessment with intubation, and other problems encountered.
- Family history

Examination

- Ideally blood pressure should be optimised preoperatively. Although poorly controlled hypertension increases the likelihood of perioperative silent myocardial ischaemia, direct evidence of a worse outcome in these patients is lacking. However, if there are associated cardiac risk factors, these need to be investigated appropriately preoperatively.
- General - weight (Body Mass Index) and shape of back may determine type of anaesthetic used. Pallor, dehydration and oedema will guide investigations needed and necessary interventions required preoperatively.
- The cervical spine should be carefully assessed for pain during movement, and restricted movements. Under anaesthesia and particularly during intubation attempts, excessive movement of the abnormal neck must be avoided. In OA the spine may be involved causing nerve root compression. In RA the cervical spine and temporomandibular joint can be involved. Atlantoaxial subluxation, which can be diagnosed radiologically, may lead to protrusion of the odontoid process into the foramen magnum during intubation, compromising vertebral blood flow and compressing spinal cord or brainstem. Intubation should be performed with neck stabilization, and in some patients an awake intubation technique will be required. Involvement of the TM joint can limit jaw mobility. Regional anaesthesia may prove practical in these patients.
- Systemic review - Heart, lungs, extremities and neurological examination. In RA multiple joints including small joints of the hands, wrists and feet may be involved in patients with RA, therefore insertion of invasive catheters and even gaining IV access are a challenge. Make sure the patient can tolerate lying flat if a simple spinal is used. Neurological assessment is also important regarding confused patients (lying still).

Laboratory Evaluation

Most patients are elderly and should have as routine:

- Full blood count or haemoglobin level
- Creatinine and electrolytes (if available)
- ECG for symptomatic patients, and routinely over 60 years
- Group and save or two units packed cells crossmatched depending on the base-line Hb, type of hip procedure, size and weight of the patient. (Sometimes only 'O negative' blood available in a rural set-up)

Other tests may be indicated:

- Clotting studies (if on Warfarin)

- Blood gas/ lung function tests
- Chest x-ray
- Urinalysis
- Blood glucose

Choice of Anaesthetic

Hip replacement can be performed under general, spinal or epidural anaesthesia, and a combination of techniques is often used. An anaesthetic plan should be made for each patient taking account of the patient's physiological state, including any medical and surgical illnesses, the planned procedure, drug sensitivities, previous anaesthetic experiences, and psychological makeup.

Recent reviews show that anaesthetic technique makes no difference to operative mortality^{1,2,3}. In the recently published Cochrane Database Systemic Review, Choi et al⁴ reviewed the evidence comparing the efficacy of epidural analgesia with other postoperative modalities for pain relief following hip or knee replacement. The authors conclude that epidural analgesia may be useful for postoperative pain relief following major limb joint replacements, however, the benefit may be limited to the early (four to six hours) postoperative period. The current evidence is insufficient to draw conclusions on the frequency of rare complications from epidural analgesia, postoperative morbidity or mortality, functional outcome or length of hospital stay.

These reviews suggest that a variety of appropriate anaesthetic techniques can be used. The choice will depend on a number of factors including patient choice, the skills of the anaesthetist, the surgical procedure, the facilities, including postoperative care, funds available and location of the hospital.

The advantages of regional techniques include:

- Reduced blood loss, reducing the need for transfusion
- Avoids effects of general anaesthesia on pulmonary function
- May avoid intubation
- Good early postoperative analgesia
- Reduced incidence of postoperative venous thrombosis and pulmonary embolism (sympathectomy-mediated increase in blood flow, and amelioration of the hypercoagulable state associated with surgery)
- Lower cost
- Simple technique in rural set-up

Spinal and epidural anaesthesia have proved to be extremely safe when correctly managed; however, there is still a risk of complications. Adverse effects range from self-limiting back pain to debilitating permanent neurological deficits and even death. The anaesthetist must therefore have a good understanding of the anatomy involved, be thoroughly familiar with the pharmacology and toxic dosages of the agents used, diligently employ aseptic technique, and anticipate and quickly treat problems.

The advantages of general anaesthesia include:

- Easier for patients that cannot tolerate lying flat
- Safer in patients with fixed output states like aortic stenosis, where maintenance of normal sinus rhythm, heart rate and intravascular volume is critical. (Remember these patients need cardiology review preoperatively. Echocardiography can determine the size of the stenosed orifice, the transvalvular gradient and peak blood flow velocities distal to the obstruction.)
- May be safer for patients with ischaemic heart disease as stable cardiovascular conditions may be easier to maintain
- Patient preference

Anaesthesia

Anaesthesia should be planned depending on the surgery which may be Primary THR, revision THR, bilateral THR, resurfacing technique or 'girdlestone' procedure.

Premedication

Consider relevant premedication if necessary. Often explanation and reassurance is all that is needed. Pre-emptive analgesia (paracetamol or NSAIDS) if appropriate.

Monitoring

All patients should be fully monitored with blood pressure (NIBP usually, direct arterial is indicated in high risk patients undergoing difficult surgery), pulse oximetry and ECG. Capnography, inspired oxygen, volatile agent analysis and airway pressure monitoring are indicated for a general anaesthetic.

Intravenous lines

A reliable 14-16G cannula should be inserted. If a lateral position is anticipated, use the lower arm, as this leaves the upper arm free for a BP cuff or direct arterial pressure measurement. CVP is indicated in high risk patients undergoing revision surgery.

Warmth

Keep the patient warm with a forced air warmer or equivalent and remember to warm IV fluids. Maintaining normal body temperature during hip replacement surgery has been shown to reduce blood loss.⁵

Spinal anaesthesia

A simple THR is particularly amenable to spinal anaesthesia and this can be supplemented with sedation or general anaesthesia, a decision which may be partly influenced by the patient's request.⁶

- Check for any contraindications to SAB.
- Preload with IV fluids prior to performing a spinal. Monitor blood pressure closely.
- Single-shot spinal (2.5-3.5ml bupivacaine 0.5% plain) under sterile technique. In 'younger' patients diamorphine (0.25mg) may be added for more prolonged anaesthesia. 10-25mcg fentanyl is an alternative.
- Target-Controlled-Infusion (TCI) propofol with a target of 1.0-3mcg/ml is useful sedation for the lateral position, using facemask supplemental oxygen. However, some patients may be

uncomfortable due to pain from arthritic shoulders and other joints. Intermittent doses of midazolam, cautious opioids or O₂-N₂O/isoflurane via the face-mask may be useful. On occasions induction of GA is required, using a LMA.

- For the supine position in a patient who wishes to be asleep during surgery, consider an LMA with a light GA to maintain the airway.
- The addition of intrathecal opioid helps cover the longer duration of surgery necessary for a more complex primary hip replacement. It is a suitable technique for up to 3 hours of surgery. Alternatively, or for longer cases, a combined spinal/epidural technique can be used.

General Anaesthesia

● GA (rather than sedation) may be combined with an epidural for any complex primary operation because of the prolonged surgical time. An LMA, or endotracheal tube and IPPV, may be considered. The epidural should be topped up incrementally to avoid the combination of a high spinal block and IPPV resulting in reduced venous return and hypotension.

● Using an epidural postoperatively will necessitate inserting a urinary catheter (which also helps monitor fluid balance). This is best performed at the time of surgery.

● A femoral 3:1 block or a psoas lumbar plexus block plus lateral cutaneous nerve of thigh block can be used to supplement GA if central neuraxial blocks are contraindicated.

● Aim to maintain blood pressure at an adequate level based on preoperative readings. In elderly patients with vascular disease hypotension should be treated immediately.

● Intra-operative antibiotic prophylaxis will be required.

● Ensure adequate IV loading prior to cementing of femoral component. Hypotension can occur on pressurisation of the cement into the femur, usually due to vasodilatation and direct myocardial depression from the monomer. The transient hypotension does not correlate with the level of monomer in the circulation, but with deficit in blood volume.

Postoperative

● The surgeon usually prefers the patients to be placed on their bed in the supine position with the legs abducted using a pillow to prevent dislocation of the prosthesis. Anaesthesia techniques which lead to rapid recovery of airway control and patient cooperation is therefore an advantage.

● Patients are usually mobilized at 24-48 hours and simple IM/subcutaneous opioids with regular paracetamol or NSAIDs are usually sufficient for postoperative analgesia in a simple THR. If an epidural has been inserted, a postoperative infusion can be used but needs to cease prior to mobilization. PCA is a suitable alternative if pain relief is needed for an extended period.

Special considerations

● To some extent position (lateral or supine) dictates anaesthetic technique. Sedation with an oxygen facemask is much simpler in the lateral position where the airway is better maintained. If supine, then sedation should either be light enough to maintain airway reflexes or anaesthesia with an LMA should be considered.

● Blood loss varies with different types of bone structure and levels of inflammation. It is also affected by anaesthetic technique. The average loss in a simple THR is 300-500 ml. A similar amount may be lost in the drain and tissues postoperatively. Blood transfusion is relatively uncommon during surgery in patients with an adequate preoperative Hb. Group and saved serum is acceptable if cross-matched blood can be provided within 30 minutes. The Hb should be checked 24 hours postoperatively, and treated with either transfusion or iron supplements if indicated. The decision to transfuse is multifactorial and includes general fitness, continuing surgical losses, and local practice. In complex revision hip surgery perioperative blood transfusion is frequently required and blood loss can be substantial. Two units of cross-matched blood should be available in theatre with the ability to obtain more within 30 minutes. (Blood recovery and autologous transfusion using a ‘Bratt’ device or similar is often practical.) These complex hip procedures should not be done in a rural set-up. Oxygen therapy is advisable in most patients overnight and for those with cardiorespiratory disease 48 hours as nasal spectacles 2-3lpm.

Life-threatening intraoperative complications

Bone cement implantation syndrome - Methylmethacrylate (MMA) cement interdigitates within the interstices of cancellous bone, and strongly binds the prosthetic device to the patient’s bone. Mixing polymerized MMA (PMMA) powder with liquid MMA monomer causes polymerization and cross-linking of polymer chains. This exothermic reaction leads to cement hardening and expansion against prosthetic components. The resultant intramedullary hypertension can cause embolization of

fat, bone marrow, cement, and air into the femoral venous channels. The residual monomer can also cause vasodilatation and a decrease in systemic vascular resistance, thought to be the cause for the transient hypotension often seen with cement insertion. The release of tissue thromboplastin may trigger platelet aggregation, microthrombus formation in the lungs, and cardiovascular instability as a result of circulation of vasoactive substances.

The clinical manifestations of this syndrome include:

- Hypoxia (increased pulmonary shunt)
- Hypotension
- Dysrhythmias (including heart block and sinus arrest)
- Pulmonary hypertension
- Decreased cardiac output.

Strategies to minimize the effects of this complication include:

- Increase inspired oxygen concentration prior to cementing
- Maintaining normovolaemia, monitor blood loss carefully
- Surgeons vent the distal femur to relieve intramedullary pressure
- Use uncemented femoral component

Perioperative haemorrhage - a revision THR may be associated with significant blood loss. Blood loss depends on many factors including the experience and skill of the surgeon, the surgical technique used, and the type of prosthesis chosen. Some ways of decreasing intraoperative bleeding include:

Summary of hip replacement anaesthesia		
Procedure	THR Prosthetic replacement of femoral head and acetabulum	Revision of THR Revision of previous THR - may include one or both components
Time	2 hours	2-6 hours
Postoperative pain	+++	+++/++++
Position	lateral or supine	lateral or supine
Blood loss	300-500 ml, G&S	1 litre, occasionally considerably more, crossmatch 2 units
Practical techniques	Spinal, with or without sedation or GA +LMA; GA + ETT with nerve block or epidural or opioids	Epidural or combined spinal/epidural with sedation or GA/LMA, or IPPV + ETT + epidural or opioid Arterial line +/- CVP may be indicated for complex revision or high risk patient.

- Avoiding hypertension and tachycardia during anaesthesia
- Regional anaesthesia (may be due to vasodilatation of the venous and arterial vascular systems leading to redistribution of blood flow)
- Maintaining normal body temperature

Thromboembolism - Venous thromboembolism is a significant cause of morbidity and mortality following hip-replacement surgery. Strategies minimizing the risk:

- Regional anaesthesia (spinal or epidural)
- Intermittent leg-compression devices
- Low-dose anticoagulant prophylaxis - If central neuraxial blockade is planned, ensure that the final preoperative dose is timed appropriately. Bleeding and compression neuropraxia is a potential complication of regional anaesthesia in patients who are anticoagulated or with clotting abnormalities. The recommendations allow a 12 hour interval between low molecular weight heparin and epidural/spinal injection. Avoid any further dose for 4 hours post block. This also applies for removal of epidural/spinal catheters.

Reaction to the antibiotic in Antibiotic-loaded bone cement (ALBC)

Commonly used antibiotics in cement include:

Tobramycin	Cefazolin
Gentamycin	Cefotaxime
Vancomycin	Cefamandole
Ticarcillin	Erythromycin
Nafcillin	Clindamycin
Cefalothin	

ALBC is extremely rare and

- Adverse reactions are lower than those among patients receiving systemic antibiotics⁷
- Some surgeons believe that the primary reasons for avoiding the indiscriminate use of ALBC include the occurrence of an allergic or toxic reaction to the antimicrobial agent and emergence of antibiotic-resistant bacteria⁸

An example of THR surgery in rural South Africa

On 8 August 2003, Dr Victor Fredlund from Mseleni Hospital in Northern KwaZulu-Natal, RSA, received the Pierre Jacques Award, the Annual Rural Doctor of the Year Award. Dr Fredlund has been working at Mseleni Hospital since 1981 and has been Medical Superintendent there since 1985. A notable achievement has been the establishment of a programme of THR surgery for the local community.⁹

Mseleni Joint Disease (MJD) is a particularly disabling form of destructive OA which occurs in the Mseleni area, creating the necessity for hip replacements in many people. In view of the

impossibility of getting large numbers of patients into a programme for hip replacement surgery at the tertiary referral centre in Durban, 350 km away, Dr Fredlund established a programme for hip replacement surgery at his rural district hospital.

MJD affects 1 in 2 women, and by the age of 50, 50% of the 75,000 people who live in the area suffer from some form of arthritis, which usually begins causing pain in their twenties. In an area where mobility is essential, and walking is the only means of transport, it is vital that these patients have access to surgery.

There are almost 900 patients on the MJD clinic register, but Fredlund says there are probably about 2000 more people living in the community who could benefit from the operation. Fredlund has performed about 200 operations, and his postoperative results compare favourably to those from the most advanced hospitals worldwide, with only 1% developing post-operative complications. Because of the cost, and lack of resources, Mseleni does not offer revision therapy, but there is the option of a 'Girdlestone' procedure. Spinal anaesthesia is the safest and most affordable option of anaesthesia.

The Mseleni Hip Clinic is run jointly by the South African Red Cross and the Department of Health, and the hip replacement programme is supported and sponsored by various means. The SA Red Cross Air Mercy Service (AMS) facilitate travel for the dedicated and committed teams of volunteer orthopaedic surgeons and anaesthetists who regularly perform hip replacement operations for this impoverished community.

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