Joint replacement surgery is a common and effective procedure for the relief of disability due to severe joint pain and loss of function. The most common joints replaced are the hip, knee and shoulder, but with advances in technology and surgical techniques the range of joints that may be replaced is increasing. Most patients for joint replacement surgery have degenerative joint disease, commonly osteoarthritis. Other conditions necessitating joint replacement surgery include:

- rheumatoid arthritis
- osteoporosis and fracture
- metastatic lesions and pathological fractures
- avascular necrosis of the femoral head.

Most patients are elderly, and commonly have associated problems such as hypertension, ischaemic heart disease, chronic obstructive pulmonary disease (COPD) or renal disease. Younger people presenting for joint replacement surgery often suffer from rheumatoid arthritis, severe osteoporosis or obesity. Presentation for revision of previous replacement surgery is increasingly common.

### Preoperative assessment

Problems in multiple systems are common because most patients are elderly. The problems of disease processes associated with orthopaedic conditions should also be considered; the most common is rheumatoid arthritis (Figure 1).

#### Assessment of co-morbidities

**Cardiopulmonary reserve** is most commonly estimated by assessment of exercise tolerance. However, this may be impossible or inaccurate because joint disease may limit exercise. In these circumstances the following may be used:

- lung function tests, arterial blood gases and oxygen saturation in air
- resting ECG for silent ischaemia or previous myocardial infarction
- echocardiography for left ventricular function, wall movement and valvular abnormality.

These tests are of limited relevance because they provide information only about the function of rested, rather than stressed, cardiopulmonary systems. Dobutamine stress tests provide information about cardiac function under stress but they are not readily available and have associated risks.

### Problems associated with rheumatoid arthritis

#### Skeletal

- Instability of odontoid peg and atlanto-axial subluxation
- Restricted mouth opening due to temporomandibular joint involvement

#### Respiratory

- Rheumatoid lung nodules
- Pleural effusions
- Pulmonary fibrosis

#### Drugs

- Corticosteroids, non-steroidal anti-inflammatory drugs, gold and methotrexate may have significant systemic effects

#### Other

- Anaemia of chronic disease, pericarditis and amyloid deposits causing renal dysfunction

1

### Hip and knee replacement

#### Preoperative preparation

- Preoperative assessment should be carried out as above.
- Optimization of co-morbidities is required.
- Cross-matched blood must be available.
- Deep vein thrombosis (DVT) prophylaxis is required. If a regional technique is planned, ensure appropriate timing of low-molecular-weight heparin.
• Antibiotic prophylaxis (usually cephalosporin or aminoglycoside) is required.
• Invasive monitoring is seldom indicated unless there is significant cardiac disease or large blood loss is anticipated.
• Large bore intravenous access is required (sited in the non-dependent arm for laterally positioned patients).

Anaesthetic technique

Regional anaesthesia is probably the technique of choice because it:
• reduces blood loss, leading to a decreased need for blood and associated transfusion risks
• decreases bleeding at the operative site, improves cement bonding and decreases surgical time
• decreases the incidence of DVT and pulmonary embolus in hip and knee arthroplasty.

The reduction in blood loss seen with spinal anaesthesia, compared with general anaesthesia, is thought to be due to a combination of perioperative hypotension and a comparatively lower haematocrit level. There is a perception that regional anaesthesia reduces the incidence of postoperative confusion and cognitive dysfunction compared with general anaesthesia, but studies have failed to demonstrate this.

The decision to use neuraxial opiates usually depends on the presence of a resident anaesthetist, owing to the potential risk of delayed respiratory depression postoperatively.

Sedation is often desirable because of the duration of the operation, intraoperative noise and patient request. Patients positioned laterally for hip replacement may become restless and uncomfortable because of pain arising from the dependent shoulder. Intermittent midazolam, titrated in 1 mg increments, may be used but often causes intraoperative disorientation and confusion, resulting in patient movement. Increasingly popular is a target-controlled infusion of propofol, 0.5–2 µg/ml, which gives smoother, more titratable sedation. Oxygen should be administered throughout the operative period.

As sedation deepens, airway obstruction or snoring may occur. This is seldom a problem in the lateral position, but some supine patients may require a nasopharyngeal airway.

General anaesthesia: if general anaesthesia is indicated, bleeding may be reduced by modest hypotension in carefully selected patients, using volatile agents. Unless there is a risk of aspiration, spontaneous ventilation with a laryngeal mask airway is usually appropriate.

For hip arthroplasty, analgesia may be supplemented by the use of a 3-in-1 (femoral/obturator/lateral cutaneous of thigh) block. Some anaesthetists favour a lumbar plexus block because this also blocks the sciatic nerve, which has a component supplying the hip. For knee replacement a 3-in-1 block combined with a sciatic nerve block can be effective.

Intraoperative problems

Patient position: in the lateral position, there is a risk of excessive lateral neck flexion and pressure on the dependent limbs.

Hypothermia: orthopaedic theatres are often colder than other theatres, with a higher velocity airflow leading to more rapid patient cooling. Hypothermia may cause poor wound healing, infection, coagulopathy and cardiovascular dysfunction. Some surgeons are opposed to hot air warming devices because of the theoretical risk of increased wound infection, and a discussion of the balance of risks may be indicated. Fluid warmers, blankets and patient hats should be used routinely.

Blood loss: average blood loss in total hip replacement ranges from 300 to 1500 ml and may double in the first 24 hours postoperatively. During knee replacement surgery with an intraoperative tourniquet, most blood loss occurs in the recovery area. Careful fluid balance is essential because compensation for hypovolaemia is poor in the elderly. Provided normovolaemia has been maintained a haemocue can be used to guide blood transfusion requirements.

Cement reactions: prostheses may be cemented in place. At the time of cementing, a drop in blood pressure and oxygen saturation is often seen. This was originally thought to be caused by a directly toxic effect of the methyl methacrylate monomer component of the cement, but it is now known to be caused by a shower of microemboli of blood, fat or platelets forced into the circulation by high intramedullary pressure during cement packing and prosthesis insertion. Subsequent embolization to the lungs produces a raised pulmonary vascular resistance and reduction in left ventricular return, resulting in hypotension. The microemboli are toxic to the lung parenchyma causing haemorrhage, alveolar collapse and hypoxia. This may be severe enough to cause cardiovascular collapse, cardiac arrest and death. Reactions are more common and more severe in bilateral joint replacements and also in under-resuscitated patients; therefore it is vital to ensure that the patient is not hypovolaemic before cementing. Fractional inspired oxygen concentration may have to be increased. Cement reactions tend to be less common in knee replacement.

Thromboembolism is common after joint replacement. DVTs are more common following knee replacements than hip replacements. Following knee replacement, most DVTs are distal calf thromboses with a low risk of pulmonary embolus. In hip replacement surgery, extremes of movement at the hip and kinking of vessels lead to endothelial damage and blood stagnation. These thromboses tend to be proximal veins with a higher risk of pulmonary embolus.

The use of a regional technique, low-molecular-weight heparin, graduated compression stockings or pneumatic compression boots decreases the risk of DVT. Intraoperative low-dose intravenous heparin reduces the incidence of DVT without increased bleeding but is not commonly used. A combination of the above techniques provides the best protection and the anaesthetist should ensure that the local thromboprophylaxis protocol has been followed.

Tourniquet: in some patients with cardiac disease the increase in systemic vascular resistance when the tourniquet is inflated has precipitated left ventricular failure. However, more of a problem occurs on releasing the tourniquet, when the acidic byproducts of metabolism are washed out of the limb causing hypotension secondary to vasodilatation and the effects of acidosis on cardiac contractility. In knee replacement surgery, as the duration of the...
operation increases, tourniquet pain can become a problem. Additional analgesia or epidural top-up may be required.

**Postoperative management**

**Analgesia**

- **Epidural analgesia** is excellent, particularly in reducing quadriceps muscle spasm following knee replacements. However, there is an increased risk of urinary retention and the resulting catheterization may cause a bacteraemia, increasing the risk of prosthesis infection.

- **Patient-controlled analgesia** is the choice in many institutions. Intramuscular opiates may also be considered.

- **Regular paracetamol**, 1 g/6 hours, should be given orally or rectally.

- **NSAIDs** should be used with caution especially in the elderly owing to the increased risk of renal impairment.

- **Midazolam** infusions or baclofen are sometimes required to ease quadriceps muscle spasm.

**Fluid balance:** stringent fluid balance monitoring is mandatory because blood loss may double in the first 24 hours. Nausea may reduce the patient’s oral intake.

**Oxygen:** perioperative ischaemia is common and generally silent. Oxygen should be given for the first 72 hours postoperatively.

**Shoulder replacement**

**Monitoring and intravenous access**

Standard full patient monitoring is required. Large bore intravenous access is made on the non-operative side. Non-invasive blood pressure monitoring is instituted either on the non-operative side with a non-return valve on the intravenous line, or on the lower leg.

**Anaesthetic technique**

The most common technique is general anaesthesia using an armoured tracheal tube and positive-pressure ventilation. Selected patients may be managed satisfactorily using a spontaneous ventilation technique through an armoured laryngeal mask. Access to the patient’s head intra-operatively is extremely restricted. The interscalene approach to brachial plexus blockade provides excellent intraoperative and postoperative analgesia and improves the operative conditions with decreased blood loss and good muscle relaxation. It commonly gives a unilateral phrenic nerve palsy, but this seldom causes alveolar hypoventilation even in spontaneously ventilating patients.

**Patient position**

The patient is placed in a sitting position, with a bolster behind the shoulder blades to improve surgical access (Figure 2). Care should be taken to ensure there is no excess strain on the lumbar spine. The torso should be securely strapped. Many tables are specially adapted with a built-in extension for the head ring, the height and angle of which may be adjusted. The head must be securely fastened because there will be considerable pull and movement at the shoulder. Access to the airway intra-operatively is difficult owing to the sitting position and the presence of surgical drapes; the tracheal tube must therefore be securely taped in place. The eyes should be taped and well padded.

**Intraoperative problems**

Elderly patients often have poor cardiovascular compensatory mechanisms while under general anaesthesia. At the start of the operation, while positioning the patient, a large drop in blood pressure may accompany the change from supine to sitting and vasopressors and a temporary return to a flatter position may be required. Patients are at risk of air embolism from open veins at the operative site.

**Postoperative management**

Shoulder replacements are extremely painful and, if possible, interscalene block should be used, supplemented with patient-controlled opiate analgesia. Regular paracetamol and NSAIDs (in those in whom they are not contraindicated) should also be prescribed.

**Revision arthroplasty**

As the number of active elderly people increases, more patients are returning for revision of earlier replacements. As well as the problems of hip or knee replacement, revision arthroplasties have added complications associated with prolonged surgery and high blood loss.

**Preoperative preparation**

Discuss the anticipated blood loss with the surgeon; this depends on the type of previous prosthesis and the number of components being revised. Pre-donation of autologous blood with acute normovolaemic haemodilution and the use of a cell saver should be considered. Platelets (often not immediately available) and clotting factors may be required.

**Monitoring and intravenous access**

Invasive blood pressure and central venous pressure monitoring should be considered in view of the long duration of surgery and the likelihood of significant blood loss. A urinary catheter should be inserted with the facility for hourly urine output measurements.

**Anaesthetic technique**

The technique of choice is probably general anaesthesia, com-
combined with insertion of a lumbar epidural catheter and positive-pressure ventilation. An epidural reduces intraoperative blood loss and improves operating conditions as well as reducing the risk of DVT. Spinal anaesthesia is generally unsuitable because the length of the operation outlasts its effects.

**Intraoperative problems**

**Temperature:** it can be difficult to prevent perioperative hypothermia. These operations are long and considerable volumes of intravenous fluid are transfused. Fluid warmers, hot air blowers, humidification systems and patient hats are important because intraoperative hypothermia can contribute significantly to coagulopathy and perioperative blood loss.

**Blood loss** is often considerable. Pre-donation of 1 unit of blood in the anaesthetic room, using acute normovolaemic haemodilution, is useful if the patient has an adequate starting haemoglobin. Intraoperative use of a cell saver can reduce the need for bank blood and reduce the associated transfusion risks, but once cement is in use, cell salvage must stop. The use of a cell saver is contraindicated in patients in whom joint replacement is for metastatic disease or infection. Platelets and fresh frozen plasma are often required. Transfusion of pre-donated blood should wait until surgical haemostasis is obtained. Fluid balance should be guided by surgical blood loss, central venous pressure trends (where available), pulse, blood pressure and urine output, with the aim of maintaining normovolaemia. The haemoglobin concentration should be assessed often, either from blood gases or by using a haemocue device.

**Postoperative management**

Should be in a high dependency unit. Oxygen should be prescribed for at least 72 hours. Analgesia should be provided by epidural infusion with regular enteral paracetamol. Close control of fluid balance is aided by the use of central venous pressure monitoring and hourly urine output measurement. Coagulopathies should be treated, but the threshold to transfuse red cells depends, in part, on the presence of co-morbid medical conditions, especially ischaemic heart disease.

---

**FURTHER READING**


