Anesthesia for joint replacement surgery: Issues with coexisting diseases

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Abstract

The first joint replacement surgery was performed in 1919. Since then, joint replacement surgery has undergone tremendous development in terms of surgical technique and anesthetic management. In this era of nuclear family and independent survival, physical mobility is of paramount importance. In recent years, with an increase in life expectancy, advances in geriatric medicine and better insurance coverage, the scenario of joint replacement surgery has changed significantly. Increasing number of young patients are undergoing joint replacement for pathologies like rheumatoid arthritis and ankylosing spondylitis. The diverse pathologies and wide range of patient population brings unique challenges for the anesthesiologist. This article deals with anesthetic issues in joint replacement surgery in patients with comorbidities.

Key words: Joint replacement surgery, low molecular weight heparin, thromboembolism

Introduction

In 17th century, surgical treatment of arthritis was limited to excision of the joint and surgeons trying joint interposition with adipose tissue, muscle, rubber and even glass in 18th century. The first Food and Drug Administration (FDA) approved hip replacement surgery was performed in 1969 at Methodist Hospital, United States. With the developments in surgical/anesthetic techniques and availability of new prosthetic material, joint replacement surgery has come a long way.

Epidemiology

In the US, over 600,000 total hip and knee replacements are performed annually. The projected growth in arthroplasties by 2030 is shown as Table 1.

Preoperative issues

Preoperative optimization is mandatory as the chances of serious complications within 30 days of joint replacement surgery is as high as 2.2%. In addition to established protocol for age and co morbidities, an elaborate pre-anesthetic check up should include the following:

Assessment of exercise tolerance
Assessment of the patient’s exercise tolerance is difficult because of involvement of joints. In the presence of clinical predictors like history of ischemic heart disease, congestive heart failure, cerebrovascular disease, diabetes mellitus, and serum creatinine >2.0 mg/dL, patient should undergo detailed cardiac evaluation, including stress testing. Patients with no clinical predictors can proceed for surgery without the need of stress testing.

Screening for methicillin resistant Staphylococcus aureus
Hypotension
Cardiovascular collapse requiring cardiopulmonary resuscitation (CPR) 

Moderate Level of hypoxia
Severe (SpO2 < 88%)

Loss of consciousness

Table 2: Classification of BCIS

| Grade | Hypoxia | Hypotension | Level of consciousness |
|-------|--------|-------------|-----------------------|
| 1     | Moderate (SpO2 < 94%) | Fall in systolic blood pressure (SBP) > 20% | Conscious |
| 2     | Severe (SpO2 < 88%) | Fall in SBP > 40% | Loss of consciousness |
| 3     | Cardiovascular collapse requiring cardiopulmonary resuscitation (CPR) | | |

Table 3: Risk factors of BCIS

| Patient related risk factors | Surgery related risk factors |
|------------------------------|------------------------------|
| Body mass index (BMI) > 30 kg/m² | Previously un-instrumented femoral canal |
| Poor physical reserve | Long-stem femoral component |
| Impaired cardiopulmonary function | |
| Pre-existing pulmonary hypertension | |
| Osteoporosis | |
| Pathological fractures | |
Tourniquets
The 2009 Perioperative Standards and Recommended Practices Guidelines\(^{[19]}\) states the use of widest cuff possible, based on appropriate tourniquet length with an overlap of 3-6 inches. The ideal pressure to which a tourniquet should be inflated is determined by adding a safety margin to the limb occlusion pressure (LOP) as shown in Table 4.

One hour is the recommended inflation time limit for upper limb and 1½ hours for lower limb. For long surgeries needing prolonged tourniquet time, a 15 minutes period of reperfusion is recommended before re-inflation of the tourniquet. Simultaneous use of bilateral extremity tourniquet at best avoided and individual tourniquets should be deflated 30 to 45 minutes apart. The patient should be monitored for at least 15 minutes after deflation of the tourniquet.\(^{[19]}\)

Postoperative issues
Pain management
Worldwide, the trend of postoperative pain relief is in favor of multimodal approach. It clubs the benefits of multiple drug delivery systems tailored to the patient’s needs with minimal individual side effects. A realistic expectation of surgical outcomes and postoperative issues may have a positive effect on postoperative pain management and overall patient satisfaction.\(^{[20]}\) Drugs used for pain relief are anxiolytics,\(^{[21]}\) acetaminophen, nonsteroidal anti-inflammatory drugs (NSAIDs), cyclooxygenase-2 (COX-2) inhibitors, opioids (tramadol, fentanyl, remifentanil, and morphine), and gabapentin. Clonidine, dexmedetomidine, fentanyl, and local anesthetics (LA) are some of the drugs commonly used with epidural route. Patient controlled analgesia (PCA) is an efficacious and safe method of providing postoperative pain relief. It is programmed for demand dose, lockout interval, and background infusion with involvement of patient in the pain management giving him the sense of autonomy.

LA agents can be used as epidural infusion, PNB, periaricular injection and continuous infusion into the surgical wound for postoperative pain relief. Analgesic effect of LA may be related to both reduced nociceptive inputs and local anti-inflammatory effect.\(^{[22]}\) Analysis of peripheral nerve blocks in arthroplasty is shown as Table 5.\(^{[23-25]}\)

Postoperative delirium
Incidence of postoperative delirium in THA and TKA is as high as 14.7 and 11%, respectively.\(^{[26]}\) Low-dose haloperidol (1.5 mg/day) given prophylactically to elderly hip surgery patients decreases the severity and duration of the delirium episodes.\(^{[27]}\) Low dose atypical antipsychotic, quetiapine (12.5-25 mg) is also effective.\(^{[28]}\)

Postoperative urinary retention (POUR)
The incidence of POUR in arthroplasty varies widely (10.7-84%).\(^{[29,30]}\) Routine preoperative catheterization is not recommended. Ultrasound may be used to guide catheterization (urine volume > 600 ml) with in-out catheterization as the technique of choice.\(^{[31]}\) We have found preoperative catheterization in male patients with prostatic symptoms more useful.

Popliteal vascular injury
This is a rare complication of TKA, incidence being 0.03 to 0.17%.\(^{[32,33]}\) Preexisting arteriosclerotic disease, correction of extensive flexion contractures, and redo arthroplasty have been identified as risk factors. Vascular complications commonly seen are thrombosis, atherosclerotic occlusion, or direct sharp trauma.\(^{[34]}\) Excellent limb salvage can be achieved with close postoperative surveillance to achieve early detection and repair of injuries. Color doppler flow ultrasound is a safe and accurate method to confirm the diagnosis.

Deep vein thrombosis
Hip and knee arthroplasty has been categorized as the highest risk for venous thromboembolism (VTE) by American College of Cardiology Foundation/American Heart Association with an incidence of 10-20% for proximal DVT and 40-80% for distal (calf) DVT without prophylaxis. The incidence of pulmonary embolism is 4-10% with fatality rate of 0.2-5%.\(^{[35]}\)

Prophylaxis
a. Ambulation as early as possible after surgery is recommended.
b. Aggressive mechanical prophylactic measures like intermittent pneumatic compression (IPC) may be the only suitable option for patients at high risk for bleeding. It has been found that graduated compression stockings combined with early ambulation in patients with DVT

| Table 4: LOP and safety margin |
|-------------------------------|
| LOP  | Safety margin |
|<130 mm Hg | 40 mm Hg |
|131-190 mm Hg | 60 mm Hg |
|>190 mm Hg | 80 mm Hg |

Table 5: Benefits and drawbacks of peripheral nerve blocks

| Benefits | Drawbacks |
|----------|-----------|
| Quality of analgesia equivalent to epidural and superior to opioids | Nerve injury |
| Less chance of hemodynamic instability and urinary retention | Post block paresthesia |
| Preservation of contralateral limb strength may facilitate postoperative rehabilitation | Falls and injuries |
| Toxicity of local anesthetic | Retroperitoneal hematoma |


Specific situations

Patients with diabetes
Preoperative evaluation includes assessment of metabolic control and any diabetes-associated complications, including cardiovascular disease, autonomic neuropathy, and nephropathy. Stress test is mandatory to know about the functional status of heart.

Patients with hypertension
Adequate blood pressure control is essential preoperatively as this reduces perioperative ischemia and consequent cardiac morbidity. Antihypertensive should be continued throughout the perioperative period except diuretics and angiotensin converting enzyme (ACE) inhibitors. Abrupt withdrawal of beta-blockers may precipitate myocardial ischemia by adversely affecting the heart rate and blood pressure.

Patients on implanted cardiac device
Adenosine radionucleotide imaging is used in a patient with pacemaker, as dobutamine stress testing is not possible. This technique uses the vasodilatory properties of adenosine and uptake of the radioisotope by viable myocardium. In preanaesthesia check up, device details including indication for implantation and present status should be noted which may be available by patient’s usual follow-up clinic. Patients with permanent pacemakers, who are pacemaker dependent, should have their device evaluated within 3 to 6 months before significant surgical procedures, and also after surgery. A 10% decrease in the rate from the time of implantation indicates power source depletion.

American College of Cardiology/American Heart Association (ACC/AHA) guidelines advice that implanted cardioverter defibrillator (ICD) should be reprogrammed to a ‘monitor only’ mode to prevent inappropriate shock delivery caused by electrical interference. Temporary external/transvenous pacing equipment and cardiologist along with a magnet should be available intraoperatively. Cables attached to electrocautery equipment should be kept away from the site of implant. When detectable pacemaker inhibition occurs, the surgeon should be informed immediately and diathermy either used intermittently or discontinued. Bipolar cautery creates less interference and hence preferable. Normothermia should be maintained during the perioperative period except diuretics that may interfere with the functioning of the device. If emergency cardioversion is required, the paddles should be placed as far from the implanted device as possible and in a orientation likely to be perpendicular to the orientation of the device leads (anterior-posterior paddle position is preferred).

Specific considerations with neuroaxial anesthesia

Neuroaxial anesthesia, when used concomitantly with anticoagulation increases the risk of epidural hematomas and subsequent spinal cord injury. American Society of Regional Anaesthesia and Pain medicine recommends waiting 24 hours after a full dose and 12 hours after a prophylactic dose of LMWH before CNB. LMWH should be withheld for at least 2 hours after removal of epidural catheter.

Special considerations in the elderly
Prophylactic doses of enoxaparin should be reduced to 30 mg subcutaneous daily in patients with creatinine clearance less than 30 ml/min. Caution is also advised when using fixed-dose LMWHs in frail elderly patients weighing less than 45 kgs. Factor Xa levels should be monitored in patients with renal insufficiency and over- or under-weight patients receiving LMWH. Dalteparin does not require dose adjustment in patients with renal insufficiency.

Inferior vena cava filters
Prophylactic placement of inferior vena cava filters is only recommend in patients with documented VTE in whom full-dose anticoagulation is contraindicated.

patients with coronary artery disease
Patient with history of recent myocardial infarction (MI), unstable or severe angina, decompensated heart failure, severe
valvular disease (e.g., severe aortic stenosis), or significant arrhythmias (e.g., ventricular tachycardia or atrial fibrillation with a rapid rate) are not fit to undergo joint replacement surgery. Patients taking statins and β-blockers need to continue these drugs. In patients who have undergone percutaneous coronary intervention, arthroplasties should be delayed for a period of 14 days for balloon angioplasty, 4-6 weeks for bare metal stent and 1 year for drug eluting stent. Clotidogrel, ticlopidine, glycoprotein (GP) IIIb/IIIa inhibitors should be discontinued 7 days, 14 days and 8-48 hours, respectively, before scheduled surgery. Patient should be assessed for the risk of stent thrombosis before stopping dual antiplatelet (DAP) therapy. Risk factors for stent thrombosis are shown as Table 6.

In selected cases, bridging therapy with heparin/tirofiban or heparin/epitifibatide may be considered. Perioperative anticoagulation with LMWH provide incomplete protection against stent thrombosis, therefore, DAP therapy should be restarted as soon as possible.

Patients on anticoagulation
Patients on oral anticoagulation may require bridging therapy perioperatively depending on risk of thromboembolism. Conditions with high risk for thromboembolism where bridging is advised include patients with thrombophilia, recurrent (2 or more)/recent (within 3 months) thromboembolic events, atrial fibrillation with risk factor for embolism, recently placed mechanical valve (<3 months). Bridging decision may be individualized in patients with intermediate risk for thromboembolism e.g., VTE more than 3 to 6 months ago. Elective surgery should be postponed for a minimum of 1 month from the VTE event.

Bridging therapy - Warfarin should be stopped 5 days before the surgery if international normalized ratio (INR) is 2-3, and 6 days before the surgery if INR is 3-4.5. LMWH should be started 36 hours after last warfarin dose. Choice of LMWH may include enoxaparin 1 mg/kg twice daily or 1.5 mg/kg once daily. Last dose of LMW should be given 24 hours before the planned surgery. Preoperative INR should be <1.5. Postoperatively, warfarin is started on the evening of surgery and LMWH should be restarted after 24 hours. LMWH is discontinued when INR is therapeutic for 2 consecutive days. Platelet count should be checked on 3rd and 7th days for the possibility of thrombocytopenia.

Patients with chronic kidney disease
Patients with elevated body mass index, elevated preoperative serum creatinine, history of chronic obstructive pulmonary disease, liver disease, congestive heart failure, hypertension and underlying heart disease are high risk for developing postoperative derangement of renal functions. Patients with chronic kidney disease (CKD) have normochromic normocytic anemia, therefore, preoperative correction should be done. Platelet count is within normal limit, but platelet activity is abnormal which can be improved by dialysis. Dobutamine stress echocardiography should be done in CKD patients for assessment of cardiac status. Adenosine stress testing is not reliable in view of maximum vasodilatory state. Blood pressure cuff should not be placed on the side of arteriovenous (AV) fistula for the risk of occlusion. Optimal fluid therapy can be guided by CVP monitoring and lactate containing fluids should be avoided. Perioperative cover with broad spectrum antibiotics is essential in view of impaired immunity. Patients on renal replacement therapy should have their dialysis scheduled 24 hours before surgery.

Patients with chronic obstructive pulmonary disease
American Thoracic Society and the European Respiratory Society in 2004 have provided guidelines for perioperative management of Patients with chronic obstructive pulmonary disease (COPD). Patients with a diagnosis of COPD have a 2.7-4.7 fold increased risk of post-operative pulmonary complications. Smoking cessation at least 4-8 weeks preoperatively and optimization of lung function can decrease postoperative complications. In patients with COPD, preoperative spirometry should be performed. Arterial blood gas analysis should be done for patients with moderate-to-severe COPD. Bronchodilators, inhaled or oral steroids, and antibiotics need to be continued on the day of surgery. Beta (β)-agonists are the most useful prophylactic intervention to lower the risk for bronchospasm on induction. Early mobilization, deep breathing, incentive spirometry, and effective analgesia are recommended in the postoperative period.

Patients with rheumatoid arthritis
Considerations for this group of patients include difficult airway (limited mouth opening and narrow glottic opening) and instability of atlantoaxial joint. Preoperative cervical flexion-extension X-rays should be evaluated in patients with limited neck movement and neurological symptoms. Awake fiberoptic tracheal intubation is ideal if the distance from the anterior arch of the atlas to the odontoid process exceeds 3 mm, while the cervical spine is protected with a cervical collar. Patients will need evaluation to rule
out pericardial effusion, pulmonary fibrosis, and renal insufficiency.

Patients with ankylosing spondylitis
Reduced movement of the cervical spine and reduced mouth opening may result in difficult intubation. Awake fibreoptic endotracheal intubation is required in most cases. Ossification of interspinous ligament and formation of syndesmophytes (resulting in classic “bamboo spine” appearance) makes CNB difficult. CNB by paramedian approach can be a useful technique in these patients. Access to caudal canal can be gained by sacral hiatus even in severe disease. Strict attention to intraoperative positioning is needed to avoid fracture of the fused spine with concomitant spinal cord trauma. Patients have narrowed epidural spaces and hence unusual delay in the recovery of sensory or motor blockade was observed when epidural infusion was used for postoperative analgesia. GA and PCA pump (for post operative analgesia) is generally preferred.

Patients with spinal pathology
Problems encountered with CNB in a patient who has undergone spinal surgery are:

a. Tactile landmarks are obliterated.

b. Abnormal vertebral anatomy.

c. Unpredictable local anesthetic spread.

d. Inadvertent dural puncture.

Ultrasoundography can be used to aid in insertion of epidural catheter as it can provide information about the depth and midline in patient with distorted surface anatomy. Taylor’s approach (para median approach via L5-S1 interspace) has been recommended by some studies.

Patients with lumbar canal stenosis
Patients with lumbar canal stenosis (LCS) presents with spectrum ranging from asymptomatic to neurogenic claudication. It increases intra-canal pressure leading to reduced local blood circulation during CNBs. The presence of a narrow canal could theoretically contribute to direct lesions of cord during lumbar puncture. Preoperative spine imaging and general anesthesia should be considered in symptomatic LCS.

Parkinsonism
Anti-parkinsonism drugs should be continued and deep brain stimulator should be switched off preoperatively.

Redo surgery
With younger patients coming for joint replacement surgery and a change in the age profile, the incidence of revision arthroplasty is on a rise. Massive blood losses, long surgical hours leading to increased chances of infections are some of the issues to be addressed in redo surgery.

Conclusions
Arthroplasty is a diverse field that demands highest level of technical expertise in terms of regional blocks, maneuvering difficult CNBs and airways along with a vast knowledge of geriatric medicine and coexisting diseases. The field is ever growing and technology is advancing at a frantic pace. With the introduction of day care surgery, robot assisted minimally invasive surgery, improved pain management techniques, newer rehabilitation protocols, and guidelines in joint replacement surgery, the onus is on the anesthesiologists to ensure a smooth sail for everyone.

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