



RESEARCH ARTICLE

ANAESTHETIC CHALLENGES & MANAGEMENT IN ORTHOPAEDICS REPLACEMENT SURGERIES.
STRATEGIES REVISITED

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ABSTRACT

Patients undergoing orthopaedics Procedure especially in the era of fast tract anesthesia are major concern for anaesthesiologist. These patients have range of comorbidities with associated injuries that can be a major challenge to anaesthetic. Also the intraoperative issues of cementation syndrome & VTE are of concern. This review article relates to all the major issues related to orthopaedic surgeries especially replacement.

Key words:

Replacement, Post operative cognitive.

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INTRODUCTION

Patients undergoing orthopedic procedures can be particularly challenging for anesthesiologists. These patient have low haematocrit because of significant blood loss, difficulty in airway management, and other comorbid conditions. These patients represent a broad scope of problems, ranging from an elderly patient with multiple comorbid conditions to a young, deceptively healthy trauma patient who may have associated injuries that can have a significant impact on the type of anesthetic administered. It is imperative that the anesthesiologist examine the entire patient and not just focus on the area of surgery. In this regard, a complete preanaesthetic checkup is important because it may reveal chronic connective tissue diseases that may alter the anesthetic plan. 68 Year old male with history of fall 2 days back, past history of controlled hypertension for last 10 years taking Atenolol 25mg BD, Ecospirin 75 mg, Rosuvastatin 20 mg OD presents to Emergency department. Trauma was sustained by slipping in the bathroom which resulted in swelling of Right. Hip area with excruciating pain, he was rushed to the casualty by his son within 1 hour of fall. On examination-Patient is conscious with B.P-170/100 mmHg, Pulse.Rate-94/min, swelling in right lower extremity, Respiratory & cardiovascular systems-are normal, Investigations-Hb-10gm/dl, TLC-10,400cell/mm³ Platelet count -1.8 Lakh/ μ L, RBS-130mg/dl, Urea-60 mg/dl, creatinine-1.8mg/dl, Na⁺-134 Meq/L, K⁺-4.2 Meq/L, S. Albumin-3.9 mg/dl, ECG-LVH(T-inversion v1-v4), 2D ECHO -diastolic dysfunction, Ejection fraction-58%.

- The Goals of management is-Immobilization at fracture site & prompt surgical fixation
- Two types of surgeries proposed- head conserving & replacement
- Joint replacement - effective procedure for relief of disability due to loss of function
- It is a growing demand , now performed as ambulatory surgery-'FAST TRACK SYSTEM'
- Imperative to manage in a streamlined way for early intervention & discharge
- Pre-operative assessment-Patient is posted for orthopedics with broad spectrum of problems like elderly with co-morbidities & young with associated trauma. Age is not a deterrent factor for surgery. There is limited end organ reserve in elderly.

Age related osteoporosis-is due to high circulating paratharmon & low vitamin D, growth hormone, there is disproportionate loss of trabecular bone leading high risk for stress fracture- (Minimal impact trauma) Bones at risk are spine, knee, foot, hand, hip. osteoarthritis is most commonly associated with geriatric age group. There is loss of articular with cartilage, inflammation & characterized by pain, reduced mobility, deformed joints. In Hands there is swelling of -DIP (Heberden's nodes), PIP (Bouchard's nodes). No systemic manifestations are there but it is important for surgical positioning of painful joints.

Rheumatoid Arthritis- There is Joint synovitis - bone erosion & loss of joint integrity. Systemic manifestation of disease are present with exacerbations & remissions. Clinical feature are pain&stiffness in multiple joints lasting >1 hour after initiating activity with Boggy & tender joint. Patients on NSAID's are then assess for gastrointestinal &renal complications. Glucocorticoids - in low doses are given (due to side effects-osteoporosis, cataracts, hyperglycemia) as they need 'stress-dose' for their operations. DMARD'S are started early but increases risk of infection. In Ankylosing spondylitis there is fusion of the axial skeleton- with loss of spinal mobility. The airway is challenging because of reduced movement of cervicalspines & TMJs, awake fibreoptic intubation may be required TMJ synovitis – limited mallampatti grading, damaged cricoarytenoid joints &narrow glottis- interferes with passage of Endo Tracheal Tube.Cervicalspine arthritis with the flexion of head the Odontoid process is displaced into cervical spine that leads to Quadripareisis. Pre-operative cervical flexion-extension radiographs are required to plan for awake fiber-optic intubation (AFOI).

Cardiovascular changes

There vascular – atherosclerosis which leads to increase in systemic vascular resistance, fibrotic myocytes are decreased which leads to decrease contractility. Decrease β -adrenergic responsiveness (Priebe, 2000) causes conduction delays, arrhythmias & ectopics.

LV systolic/diastolic- dysfunction co-exist heart failure with preserved ejection fraction (HFpEF).There is decrease in left ventricular compliance with increase in LVDP.The non compliant heart & blood vessels can neither tolerate hypovolemia nor exaggerated transfusion so**consider fluid administration carefully!**

Respiratory changes- There is loss of elastic recoil & loss of height of the vertebrae &rib cage leads to barrel shaped chest (Lung compliance increases that leads to early collapse of small airways causes air trapping). Chest wall compliance decreases causing increase in work of breathing.Ventilatory responses to hypoxia, hypercapnia areimpaired. Lung volume changes–Diffusing capacity, Vital Capacity, FEV1- decreases. Total Lung Capacity&Functional Residual Capacityare unchanged. Residual Volume increases by 5% -10% / decade. Closing capacity- increases with age & encroaches on FRC leads to V/Q mismatch (Sprung *et al.*, 2006).

Renal changes-There is structural-nephrosclerosis& functional decreases in GFR (Rule *et al.*, 2010). Sodium handling, concentrating & diluting capacity decreases which predisposes to dehydration & fluid overload.

Hepatic changes-structurally there is decrease in liver size &hepatic blood flow with10%/decadefunctionally-Phase I / Phase II metabolism slows down.

Nervous system changes-Aging causes memory decline to affect activity of daily living.The mechanism of NEURONAL Shrinkage & Neurotransmitters are involved.

The COGNITIVE ISSUES are -a) DEMENTIA (Lee *et al.*, 2004)- with incidence 5-8% >65 years Cause- ALZHEIMER'S with Agitation, Depression & sleep changes. b) DELIRIUM-10%, >65 years in fluctuating changes in level of consciousness

accompanied by other mental symptoms. DEPRESSION-8-16%, >65 years.

Ethical issues & consent-Diagnosis & screening is not easy in these patients for that use AD8 Questionnaire. Informed consent is a must either through surrogate or advanced directives.

Technique related-Patient co-operation is an issue for regional anesthesia & there is Post operative cognitive dysfunction, pain management with longer hospital stay.

Post operative cognitive dysfunction

It is short term deterioration of intellectual function as impaired memory or concentration detected days to weeks after surgery. Duration is of several weeks to permanent 25-50% of patients undergoing cardiac or orthopedic surgery. It is not affected by type of anesthesia-general or regional. Diagnosed by neuropsychological testing.

Risk factors are-Age & other comorbidities, alcohol use, psychotropic medication, preoperative cognitive impairment, Perioperative (hypoxemia, hypotension, abnormal electrolytes, infection, sleep deprivation, administration of BZD's anticholinergic medications). It can be prevented by prophylactic continuation of medications.

- Identifying at risk patients
- Maintaining proper sleep cycle
- IV Fluids & electrolytes correction
- Decrease exposure to- Antihistaminic, opioids, BZD,
- Maintain Hct >30%,
- Maintain O₂ saturation > 90%
- Pain control-Nerve Blocks, Gabapentin, opioids by rotation
- Early rehabilitation

FRAILTY- Refers to a loss of physiologic reserve that makes a person more vulnerable to disability during & after stress. The components are-weakness, fatigue, weight loss (Fried *et al.*, 2001).

Criteria- 1-Weight loss, 2-Exhaustion, 3-Physical activity on, 4-Walk time, 5-Grip strength

Investigations-for assessment of co-morbidities includes CBC- Hb / TLC / DLC / ESR/ Platelet count RBS, Cardiopulmonary – Chest x-ray, pulmonary function tests, ABG, SPO₂, resting ECG - 2DEcho / Dobutamine stress tests, Renal– S.creatinine, Blood urea, S.Electrolytes, Musculoskeletal, Airway/Spine-Range of limb & neck movements leads to assessment for positioning on table & for regional blockade should be made.

Risk assessment-done on factors like age, comorbidity, type of surgery whether it is elective or urgent, amount of blood loss & fluid shift & Risk are more related with the presence of comorbidities than with the age of the patient! Abnormal noninvasive cardiac testing pre-operatively rarely changes management in orthopedic surgery. Morbidity is not decreased by coronary interventions. Restenosis is an added risk factor if anticoagulants are discontinued before surgery & peri-operatively bleeding increases if they are not stopped.

Ideal time for surgery-It should be performed within 48 hours of admission. Optimization of co-morbidities should be done as early as possible, as delays increase morbidity so haemodynamic stress reduction is to be done with the use of beta-blockers/or it should be continued in high risk patient.

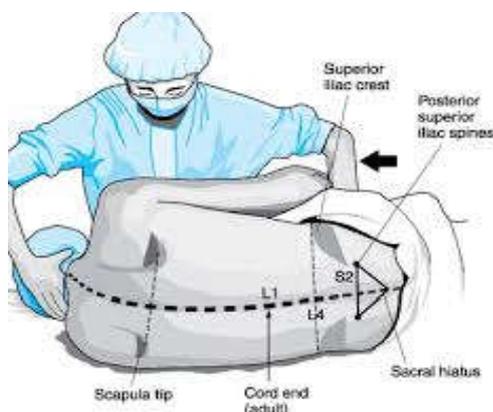
Pre-operative preparation- Traction should be given & O₂ therapy for first 48 hours is given to prevent hypoxemia, with 2 large bore I/V access in a non-dependant arm for laterally positioned patients. Cross matched blood must be available. DVT & antibiotic prophylaxis is required with prevention of bed sores.

INTRA OPERATIVE MANAGEMENT FOR Total Hip Replacement-Surgeons prefer lateral posterior approach with patients in lateral decubitus position, which compromises oxygenation owing to V/Q mismatch & also prevents pressure on axillary artery/brachial plexus by dependent shoulder hence, place a roll/pad beneath the upper thorax.

Techniques of anesthesia-REGIONAL ANESTHESIA-In old age epidural space area decreases & permeability of duramater increases. CSF volume decreases so there is decrease in dose requirement & for a given volume of drug there is more cephalad spread, resulting in shorter duration of block. Advantages of R.A is that we can assess mental status, there is increase in vascular flow, decrease in DVT (decrease in fibrinolysis), decrease in blood loss, decrease in POCD, NO AIRWAY INSTRUMENTATION IS REQUIRED, increase in post operative analgesia with early mobilization.

DISADVANTAGE- Patient can refuse it, sedation may be required, there is haemodynamic instability, with delayed onset & early wearing off & multiple body region surgery cannot be done.

Types of R.A-1-Sub arachnoid block, 2-Epidural anesthesia, 3-CSE & 4-Peripheral nerve block. for hip arthroplasty, 3-in-1 block can be given which includes femoral/obturator/lateral cutaneous nerve of thigh block. A lumbar plexus block also blocks the sciatic nerve, which has a component supplying the hip.



SPINAL ANESTHESIA-produces Profound block upto T-10 which is achieved by small amount of Local anesthetics. Main challenge is to control the intrathecal spread of drug. Hyperbaric LA "sink" while hypobaric LA "swim" in away that level of spread depends on interaction of density of LA with patient's posture with a midline approach & sitting position, At L2-L3 interspace 3.5ml of 0.5% hyperbaric bupivacaine is injected. When patient operated in lateral position spinal

anesthesia given with patient lying on their side in L2-L3 space (hip schedule for surgery is upwards) then hypobaric solution is created by adding 3.5ml isobaric bupivacaine + 1.5ml distilled water.

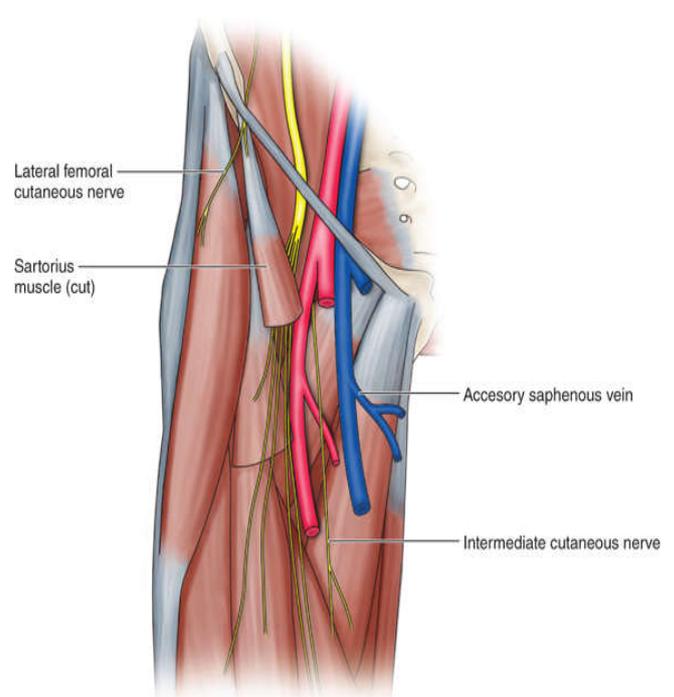
EPIDURAL ANESTHESIA-For EA, sudden Loss of resistance occurs as the needle passes through ligamentum flavum & enters the epidural space, then introduce the epidural catheter with marked end in front through the Tuohy needle until the desired depth. Catheter marking in cm-5.5-16.5 (10.5cm- 2 ring, 15.5cm-3 ring, 20.5cm-4 rings) & then remove Tuohy needle holding catheter tightly.

Femoral nerve blocks- Nerve supply to hip joint is by- obturator nerve, inferior & superior gluteal nerves. It can be given by various techniques-

- 1- Nerve stimulation in which mark the inguinal ligament, Palpate Femoral artery about 2 to 3 cms below it & then Insert a 22 G, 3 inch needle perpendicular to skin lateral to FA & elicit paresthesias, Inject 10ml of L.A.
- 2- USG GUIDED -USG transducer placed over inguinal crease, FA & FV visualized in Cross section, Just lateral to artery & deep to fascia iliaca femoral nerve appears as spindle shaped

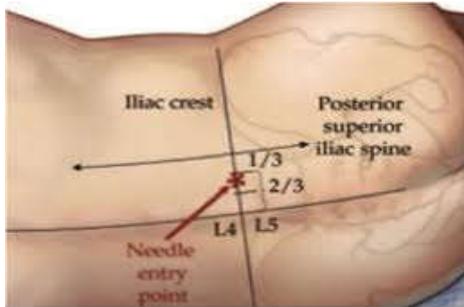
HONEY COMB texture. Needle inserted lateral & cephalad to an angle of 45° then after careful aspiration 30-40 ml of L.A is injected.

- 3- Fascia iliaca technique-once inguinal ligament & FA identified, inguinal Ligament is divided into thirds, 2 cm distal to the junction of the M2/3 & L1/3rd, needle inserted in cephalad direction & 2 "pops" felt. After careful aspiration 30-40 ml of L.A is given.



Lateral femoral cutaneous nerve block-Patient positioned supine & a point 2 cm medial & 2 cm distal to anterior superior iliac spine is identified. A short 22 G needle inserted & directed laterally, observing for a "pop" as it passes through fascia lata. A field block is performed with 10-15 ml of L.A.

Lumbar plexus block-In Lateral decubitus position palpate midline. Draw a line through lumbar spinous processes & both intercrystal line identified & connected with a line at level of L4. posterior superior iliac spine is then palpated & line is drawn cephalad parallel to 1st line. A 10-15 cm needle is inserted at the point of intersection between the transverse line & intersection of the lateral & middle 3rd of the 2nd sagittal lines. Needle advanced (<3 cm past the depth at which transverse process contacted) in an anterior direction until a femoral motor response elicited (quadriceps contraction) & inject L.A.



General anesthesia issues-Advantage is that early in onset, multiple surgery can be performed at a time, PPV can be given, there is greater acceptance & it can be given as long as needed. Disadvantage is that airway instrumentation is there, which causes haemodynamic alteration & there is impairment of neurologic examination

Physiologic changes in elderly-Effect on pharmacokinetics

Absorption-There is increase in gastric pH with decrease in gastric emptying & decrease in absorption surface, decrease in splanchnic blood flow.

Distribution-increase in body fat lead to increase in volume of distribution of lipophilic drugs, increase in alpha-1 glycoprotein causes decrease in free fraction of basic drugs, decrease in albumin causes increase in free fraction of acidic drugs & decrease in body water leads to increase in concentration of polar drugs.

Metabolism-there is decrease in hepatic metabolism causes decrease in biotransformation.

Elimination-there is decrease in GFR causes decrease in elimination of drugs, pH & electrolyte disturbance is there. There is also decrease in renal tubular function.

Clinical Pharmacology of Anesthetic Agents in Elderly Patients

Drug	Brain Sensitivity	Pharmacokinetics	Dose
Inhaled agents	↑	—	↓
Thiopental	—	↓ Initial distribution volume	↓
Etomidate	—	↓ Initial distribution volume	↓
		↓ Clearance	
Propofol	↑	↓ Clearance	↓
Midazolam	↑	↓ Clearance	↓
Morphine	↑	↓ Clearance	↓
Sufentanil	↑	—	↓
Alfentanil	↑	—	↓
Fentanyl	↑	—	↓
Remifentanyl	↑	↓ Clearance	—
		↓ Central compartment volume	↓
Pancuronium	NA	↓ Clearance *	↓ *
Atracurium	NA	—	—
Cisatracurium	NA	—	—
Vecuronium	NA	↓ Clearance	↓

Intra operative monitoring-is to be done by SPO₂, EtCO₂, ECG, NIBP, Temperature, Invasive arterial B.P monitoring-in patient with limited LVF/with massive blood loss, CVP, Cardiac Output monitoring-is used to guide fluid therapy, Cerebral O₂ Saturation.

Intra operative problems

- 1- Patient position**-In lateral position, risk of excessive lateral flexion/pressure on the dependent limbs.
- 2- Hypothermia**-Orthopedic Operation Table is relatively colder, with a higher velocity of airflow, Hypothermia causes poor wound healing, infection, coagulopathy, Fluid warmers/blankets should be used routinely.
- 3- Blood loss**-Ranges from 300-1500 ml may double in the first 24 hours postop. During Total Knee Replacement with an intra-operative tourniquet, most blood loss occurs at recovery.
- 4- Bone cement implantation syndrome**-bone cement is composed of PMMA, clinical features are hypoxia, hypotension, unexpected loss of consciousness, cardiac arrest can occur at time of cementation, prosthesis insertion, joint reduction, tourniquet deflation in a patient undergoing cemented bone surgery.



Etiology-most commonly is monomer absorption & its systemic embolisation-in the circulation cement undergoes exothermic reaction (72-120 °C) expands increase in intramedullary pressure leads to debris being forced into circulation, Histamine release & type 1 hypersensitivity, complement factors cause release of anaphylatoxins. Risk factors are-old age, comorbidities, bony metastases, pathological fracture, intertrochanteric fracture.

Risk reduction & Management-In high risk cases discuss risks & benefits of uncemented /cemented arthroplasty, Avoid N₂O & increase O₂ concentration at the time of cementation, use PAC & TEE & maintain good haemostasis with medullary lavage & venting the bone which permits air to escape from the end of the cement plug. If BCIS is suspected, O₂ concentration should be increased to 100% & continued in postoperative period. Resuscitation with I/V fluids/Vasopressors & Inotropes.

4-FAT EMBOLISM- Fat embolization and Fat embolism syndrome are not synonymous, Fat embolism is due to complication of skeletal trauma & surgery involving instrumentation of medullary canal while fat embolism syndrome is due to physiological response to Fat emboli, a multi system dysfunction, Onset is within 24-72 hours, associated with long bone /pelvic fracture, > closed fracture. Mortality rate: 10-20%

Risk factors for FE-

- 1- General factor**-Males, 10-39 years, Post traumatic hypovolemic state with Reduced cardiopulmonary reserve.

- 2- Injury related factors-Multiple fracture, Bi-lateral femur fracture, lower extremity fracture.
- 3- Surgery related factors-Intramedullary reaming & nailing after femoral fracture, if a bi-lateral procedure is being operated Joint replacement with high volume prosthesis.

Clinical features are triad of dermatological sign (rash), pulmonary dysfunction (hypoxemia), neurological (nonspecific) symptoms.

DIAGNOSTIC criteria-GURD'S criteria (Gurd and Wilson, 1974)

Major Features (at least 1)

- * Respiratory insufficiency
- * Cerebral involvement
- * Petechial rash

Minor Features (at least 4)

- * Pyrexia, Tachycardia, Jaundice
- * Retinal, Renal changes

Laboratory Features

- * Fat Microglobulinemia (required)
- * Anaemia, Thrombocytopenia, High ESR

Schonfeld Fat Embolism Syndrome Index (Schonfeld et al., 1983)

Sign	Score
Petechial rash	5
Diffuse alveolar infiltrates	4
Hypoxemia -PaO ₂ < 70 mm Hg,	3
FiO ₂ 100% -Confusion	1
Fever >38°C (>100.4°F)	1
H.R >120 beats/min	1
R.R > 30 / min	1

Score > 5 required for diagnosis of FES

Treatment & Management

Prophylaxis

Immobilization - Early fixation

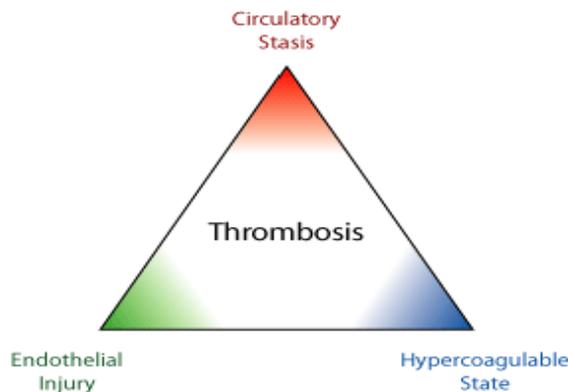
Supportive Medical Care

- Maintenance of adequate oxygenation & ventilation
- Maintenance of hemodynamic stability
- Administration of albumin & blood products
- Use of steroids is controversial!
- Prophylaxis of DVT
- Heparin, LMW dextran, Ethanol can be used

DEEP VEIN THROMBOSIS

What is DVT? It is clot in deep veins of the legs!
 Clinical features- pain, swelling, tenderness, discoloration of surface veins

Risk of DVT & PE: Increases by several factors



Factors intrinsic to the patient	Factors related to underlying disease or medical condition	Factors introduced by medical or surgical treatment
<ul style="list-style-type: none"> • Age • Obesity • Immobility • History of thrombosis • Thrombophilia 	<ul style="list-style-type: none"> • Varicose veins • Venous insufficiency • Pregnancy • Trauma • Heart failure/MI • Malignancy 	<ul style="list-style-type: none"> • Concomitant medication • Chemotherapy • Orthopaedic surgery • Major surgery • Caesarean section

Pulmonary embolism (Guyatt et al., 2012)

Occurs when the blood clot breaks loose & travels to the lungs. Clinical features-shortness of breath, sharp rib/chest pain, occasionally hemoptysis, light-headedness, or collapse. Patient with symptomatic PE have a 18-fold higher risk of death than with DVT alone.

Diagnosis

- HISTORY/EXAMINATION
- CHEST X-RAY/ECG/D-dimers
- DUPLEX ULTRASOUND/VENOGRAPHY
- Spiral CT chest/V:Q scan /Pulmonary Angiogram
- COMPLICATIONS OF DVT

Complications- short-term- Prolonged Hospitalization, Bleeding Clinical complication, Local extension, Long-term- Post-Thrombotic Syndrome, Pulmonary hypertension, Recurrent DVT

Risk of VTE in Hospitalized Patient

Patient Group	DVT Prevalence (%)
Medical Patients	10-20
General Surgery	15-40
Major Gynecologic Surgery	15-40
Major Urologic Surgery	15-40
Neurosurgery	15-40
Stroke	20-50
Hip and Knee Arthroplasty, Hip Fracture Surgery	40-60
Major Trauma	40-80
Spinal Cord Injury	60-80
Critical Care Patients	10-80

Prophylaxis

Must be given to all elderly patient under going orthopedic procedures confined to bed >more then a day.

Mechanical

- Compression stockings
- Intermittent pneumatic compression devices
- Inferior vena caval filters

Pharmacological

1. Antiplatelet (aspirin 50-100 mg/d)
2. Coumarins (Warfarin)- Adjusted-dose started preoperatively or evening after surgery (INR target-2.5)
3. UFH-5000 U S/C 8 hourly (monitor ApTT)
4. LMWH (Enoxaparin)- started 12 hour before surgery or 4-6 hour after surgery-40 mg S/C OD
5. Fondaparinux (Factor Xa Inh)-2.5 mg OD S/C
6. XIMELAGATRAN (DTI)-36 mg BD(oral)

NICE Guidelines - 2016

1-Anticoagulant -prophylaxis & treatment of DVT LMWH

- Recommended over UFH (IV/SC) for initial therapy
- Do not require monitoring of coagulation
- Efficient when started preoperatively but risk of bleeding are high
- Continued for at least 10 days in low risk & extended to 28to 35 days in high risk

2-Thrombolytics—in severe and possibly fatal PE

ASRA - recommendations regard to use of anticoagulants & RA (Horlocker *et al.*, 2010)

- Low dose aspirin -no restriction
- Clopidogrel stop 7-10 days prior & continue 2 hours after Epidural catheter removal
- An interval of 12 hours after administration of usual dose of LMWH and placement of CNB
- With larger doses of LMWH- delay should be extended to 24 hours
- Epidural catheter removal at least 8-12 hours after last LMWH dose, or 1 to 2 hours before the next dose.

Postoperative Complications

Decision to initiate rehabilitation, depends on whether there are or not any perioperative Complication

Cardiac Complications

- ACC/AHA guidelines recommend pre-operative cardiac testing in patient at increased risk on basis of clinical risk factors type of surgery
- Older patient have increased risk of myocardial morbidity/mortality after orthopedic surgery

Respiratory Complications

- Age related, exacerbated in arthritis
- Embolization of bone marrow debris to the lungs
- Neurologic Complications-post operative cognitive dysfunction

Post Operative Management

Oxygen: for the first 72 hours postoperatively.

Analgesia

- Epidural / Patient Controlled Analgesia / BLOCKS
- Intra articular inj. Of L.A with opioids
- Paracetamol- 1 g/6 hours, given orally/ rectally.
- NSAIDs used with caution, in elderly
- Midazolam infusions or baclofen are sometimes required to ease quadriceps muscle spasm

Fluid balance

Stringent monitoring is mandatory because blood loss, may double in the first 24 hours.

Total Knee Replacement-ISSUES

Technique

- Innervation of the knee –Tibial Nerve, common peroneal Nerve, Obturator Nerve, & Femoral Nerve
- RA- SAB / CSE / femoral & sciatic block
- Advantages of Single stage bilateral TKR - exposure to risks of one anesthetic, one postoperative course of pain, reduced rehabilitation & an earlier return to baseline function.
- SBTKA however, have higher incidence of perioperative complications, including MI, FES, & thromboembolic events

Patients Excluded for SBTKR (Loner *et al.*, 2007)

- Age \geq 75 year
- ASA class III
- Active ischemic heart disease (positive stress test)
- Poor ventricular function (LVEF < 40%)
- Oxygen-dependent pulmonary disease
- Patients considered at increased risk for morbidity and mortality
- IDDM
- Renal insufficiency
- Pulmonary hypertension
- Steroid-dependent asthma
- Morbid obesity (BMI > 40)
- Chronic liver disease
- Cerebrovascular disease

What is Tourniquet? (Horlocker *et al.*, 2006)

It is a compressing device applied over extremities to control circulation for a period of time to decrease intra operative bleeding & achieve a better operating condition "BLOOD LESS FIELD"



Depends on following variables

- Patient's age
- Skin condition
- Blood pressure
- Shape & size of extremity

Tourniquet cuff ?

Cuff applied over limited padding

Cuff dimensions

- large enough to comfortably encircle the limb for uniform pressure.
- width of the inflated cuff should be > half the limb diameter.
- Before inflation, limb should be elevated for approx. 1 min & tightly wrapped with an elastic bandage distally to proximally.

Optimal limb Occlusion Pressure (LOP)

- Determined by gradually increasing tourniquet pressure until arterial blood flow distal to cuff is interrupted
- 50-100 mmHg above Systolic B.P
- Upper limb-250 mmHg
- Lower limb-350 mmHg
- Occlusion time kept minimum-Safe limit of 1-3 hours
- Assess operative situation at 2 hours, if anticipated duration >2hour then deflate for 10 min & subsequently at 1 hour interval

Prerequisites for application

- Adequate hydration, Blood Volume, Normothermia
- Use in a patient of sickle cell anemia remains controversial

Contraindication

- Sickle Cell Disease
- Peripheral Vascular Disease
- CRUSH INJURY
- Diabetic Mono NEUROPATHY
- History of DVT, PE

Local Effects of Tourniquet Inflation

Problems

Muscle change-due to compression / ischemia of the tissue over time

Glycogen, ATP, NAD ↓
HYPOXIA → ACIDOSIS

Endothelial integrity disrupts
→ tissue edema
→ colder limbs

Haemodynamic response

Inflation- exsanguination of limb-increase in CVP/ arterial pressure (15%)

- increase in SVR, increase in HR, MAP, after 30-60 min of inflation
- increase in PAP can occur in poor ventricular compliance
- prolonged inflation-systemic hypertension develops
- reflecting cellular ischemia which cannot be reduced by deepening anesthesia -use vasodilators

Deflation- reperfusion of ischemic limb causes

- Sudden decrease central venous & arterial pressure
- Sudden decrease in SVR → Pooling of blood in the extremities

Metabolic responses

After deflation & reperfusion of extremity, a washout of acidic by products occurs from ischemic limb to systemic circulation. Transient metabolic acidosis leads to (increase in EtCO₂) the Changes reversed with in 30 min of deflation

↑ in Lactic Acid, K⁺, PaCO₂,
↓ in PO₂, ↓ in pH

Neurologic

Combination of nerve compression & ischemia

- Direct pressure of nerves beneath tourniquet (shear stress) leads to evidence of nerve injury
- Abolition of SSEP/Nerve Conduction Velocity occurs with in 30 min reflecting axonal hypoxia
- Upper limb- Radial>Ulnar>Median
- Lower limb-Common Peroneal Nerve-
- Implication in use of Central Neuroaxial Blockade-when tourniquet Inflation (> 2 hours) causes post operative neuropraxia

Tourniquet pain

- Poorly defined dull aching, burning sensation at the site of application about 1 hour after inflation
- Correlates with degree of cellular acidosis not relieved by narcotics & nerve blocks & EMLA Deflate the tourniquet for 10-15 min & reinflate
- Related to cutaneous neural mechanism, (A δ & C fiber) quality / intensity of somatic neural blockade.

Temperature/Haematological change

- Inflation- increase in core body temperature
- Deflation-increase in core body temperature (0.7 °C) Redistribution of body heat

- Inflation- hypercoagulable state (stimulation of
- coagulation factors caused by tissue damage)
- Deflation—increase fibrinolytic activity – anticoagulation (POST TOURNIQUET BLEEDING)

Shoulder replacement

Monitoring and I/V access

- Standard monitoring is required
- Large-bore I/V access on the non-operative side
- NIBP monitoring is instituted either on the non-operative side with a non-return valve on I/V line, or on the lower leg.

Anesthetic technique

- 1-G.A using an armoured tracheal tube and PPV
- 2-Interscalene approach to brachial plexus -improves operative conditions, increased blood loss, good muscle relaxation

Patient position

- Sitting / beach chair position
- No excess strain on lumbar spine
- Torso securely strapped/head ring
- Access to airway difficult, ETT must be taped

Intraoperative problems

- At start of operation, while positioning, drop in B.P accompany change from supine to sitting- vasopressors required
- At risk of air embolism from open veins at the operative site

Revision arthroplasty

Main intraoperative problem is

- Anticipated blood loss - depends on type of previous prosthesis and the number of components to be revised.
- Pre-donation of autologous blood with
- Acute Normovolaemic Haemodilution (ANH)
- Platelets & clotting factors may be required.
- Transfusion of pre-donated blood should wait until surgical homeostasis obtained
- Fluid balance should be guided by surgical blood loss,
- CVP, pulse, BP , urine output
- Temperature - prevent perioperative hypothermia
- Due to long hours of surgery, considerable fluid & blood are transfused.

Spine surgery

Indications

- Neurologic dysfunction
- Structural deformity / Pathologic lesions
- Essential to discuss preoperatively stability of the CERVICAL SPINE with the surgeon

Neurological assessment:- Should be documented

1. Avoid further deterioration during intubation, positioning / hypotensive anesthesia
2. Muscular dystrophies involve bulbar muscles, increase risk of aspiration
3. Level of injury & time elapsed since insult are predictors of physiological derangements which occur peri-operatively

Prone position

- Induction & intubation in supine position
- Turn prone as a single unit
- Neck in neutral position
- Head turned to the side / face on a cushioned holder
- Arms at the sides with the elbow flexed
- Chest should rest on parallel rolls to facilitate ventilation

Anesthetic problems of prone position *Monitor disconnects Airway:*

ETT kinking /dislodgement/Edema of upper airway

Head and Neck

Hyper flexion / hyper extension of neck
Excess cervical rotation - kinking of vertebral artery

Eyes: pressure over eyes:- retinal injury /corneal abrasion

Blood Vessels: Kinking of Femoral Vein with marked flexion of the hip

Abdominal—increase epidural venous pressure → bleeding increase

Nerves: Brachial plexus / Ulnar N/ CP/ LCNOT compression

Wake up test

Lightening anesthesia during the procedure and observing patient's ability to move to command, Evaluates functional motor integrity.

Anesthesia requirements:

- Easy, rapid to institute, quickly antagonized
- Awakening should be smooth
- No pain/recall during the test

Anesthetic techniques

Volatile/Midazolam/ Propofol /Remifentanyl -based anesthesia can be administered

Disadvantages

- Risks of falling from the table during extubation
- Provides information at the time of the wake-up only
- Does not assess sensory pathways

Conclusion

1. Orthopedic surgery is associated with high incidences of deep venous thrombosis and pulmonary embolism.

2. The need for anticoagulation results in anesthesia issues specifically related to the potential for neuroaxial hematomas.
3. Unique complications in orthopedic surgery are related to tourniquet use and fat embolism.
4. Regional anesthesia is associated with lower morbidity and mortality than is general anesthesia.
5. Prone spinal surgery cases have unique complications related to patient positioning, such as nerve injuries, ventilation problems, and blindness.

However, providing adequate analgesia using central neuraxial techniques can be challenging, especially when deep venous thrombosis (DVT) prophylaxis with low-molecular-weight heparin (LMWH) is needed. This challenge has led to the development of many peripheral nerve block techniques and advances in the equipment used for these techniques, including continuous nerve catheters and ultrasonography for identification of nerve plexuses. Recent literature has shown a benefit of regional anesthesia over general anesthesia with respect to mortality, morbidity, postoperative analgesia, and functional recovery. The use of ultrasonography to place nerve blocks may offer a significant advantage over peripheral nerve stimulation. A meta-analysis looking at the advantage of ultrasonography over nerve stimulation technique showed improved efficacy in respect to onset and quality of block. It also appears that the minimum amount of local anesthetic required to successfully perform the nerve block may be greatly reduced by using ultrasonography instead of the traditional nerve stimulation technique. This may be of great benefit in reducing the incidence of local anesthetic toxicity. This chapter considers the factors pertinent to anesthesia for orthopedic surgery and reviews the appropriate management.

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