Twist and Shout: Complications from Surgical Positioning

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Objectives

1. Describe four common complications of surgical positioning.
2. Discuss injuries related to specific surgical positions.
Positioning

“Perfect” positioning has 5 goals:

- Provide maximum exposure to the surgical area
- Maintain homeostasis
- Prevent injury
- Ensure anesthesia provider has adequate access to the patient for airway management, ventilation, medications, and monitoring
- Promote the enhancement of a satisfactory surgical result
Anesthesia Contributions to Positioning Complications

- Patient unable to report discomfort/pain

- Impaired reflexes prevent the patient from voluntarily repositioning

- Relaxation of the muscles may permit placement of body in ways not normally tolerated

- Decreased compensatory sympathetic nervous system reflexes that minimize systemic BP changes with abrupt position changes
Risk Factors

- Some are modifiable, some are not
  - Length (>4 hrs-increased risk)
  - Type of surgery
  - Position
  - Method of anesthesia
Risk Factors

– Patient’s history/status
  • Age->70 more susceptible
  • Weight-thinness and obesity
  • Co-morbidities/acute and chronic illnesses-diabetes, CV disease, respiratory disease-COPD, asthma, smoker
  • Medications-anticoagulants, steroids
  • Nutritional status
  • Neuromuscular status/physical limitations-arthritis
  • Implants
  • Alcohol/drug dependency
  • Skin fragility/Braden Scale < 20
Preoperative Considerations

- Position planned for type of surgery
- Length of surgery-padding, warming devices
- Type of pads on beds-Tempur-Pedic?
  - Type of bed pads influences type of padding required
- Type of anesthesia-regional vs MAC vs general
Surgical Positioning Injuries

- Nerves injuries are the most frequently reported injuries according to the ASA
- Most are nerve injuries due to overstretching and/or compression
- Ischemia ≥30 minutes result in nerve palsy
- 90% undergo complete recovery
- 10% are left with residual weakness or sensory loss
- Ulnar injuries are the most common
- Men 40-70 have higher risk
Upper Extremity Nerve Plexus

- Brachial Plexus
- Musculocutaneous Nerve
- Radial Nerve
- Deep Radial Nerve
- Pectoral Nerves
- Thoracodorsal Nerve
- Ulnar Nerve
- Median Nerve
Ulnar Nerve
Ulnar Nerve Injury

• On arm boards:
  – Caused by arms placed in pronation (palms down)
  – Ulnar nerve compressed at elbow between table and medial epicondyle
  – Prevented by positioning arms in supination

• Tucked at side-palms must face body

• Hypotension and hypoperfusion increase risk
Ulnar Nerve Injury

- 4th and 5th fingers affected
  - Pain
  - Weakness
  - Decreased function
  - Numbness

- Signs of ulnar nerve injury
  - Inability to abduct or oppose the 5th finger
  - Atrophy of the intrinsic muscles of the hand (claw hand)
Brachial Plexus Positioning

- In supine position, place arm more than 90° abduction
- In prone position, maintain abduction and anterior flexion of arms above head to no more than 90 degrees
- In lateral position, place chest roll under lateral thorax to minimize compression of humerus into axilla
Brachial Plexus

• Other causes of brachial plexus injury
  – Excessive arm abduction or external rotation
  – Arm falling off of table or arm board
Signs of Brachial Plexus Injury

• Shoulder and upper arm affected
  – Pain
  – Decreased sensation
  – Paresis of muscles in shoulder and upper limb
  – Paralysis

• Avulsion pain—burning, crushing pain along the distribution of the injured nerves
Pelvic/Lower Extremity Nerves

- Dorsal nerve of penis
- Pudendal nerve
- Inferior rectal nerve
- Perineal nerve
- Posterior scrotal nerves

Nerves of the Hip
- Femoral
- Obturator
- Sciatic
Femoral/Obturator/Pudendal Nerves

- Femoral nerve injury - angulation of the thigh stretches the inguinal ligament and compresses the nerve
- Obturator nerve injury - higher degree of thigh flexion stretches the nerve as it exits the obturator foramen
- Pudendal nerve - pressure from the perineal post on ortho tables
Saphenous Nerve

Lumbosacral Plexus Nerves—Anterior View

- Obturator n.
- Femoral n.
- Saphenous n.
Peroneal Nerve

- Superficial peroneal nerve
- Distal arborization
- Branch to peroneus brevis
- Deep peroneal nerve
- Point of fascial penetration
- Common peroneal nerve
- Branch to peroneus longus
Saphenous/Peroneal Nerves

• Associated with lithotomy/lateral positions

• Tibia’s medial condyle may compress saphenous nerve

• Head of fibula may compress peroneal nerve
Signs of Peroneal Nerve Injury

• Innervates muscles in leg that lift the ankle and toes upward

• Anterior and lateral part of leg and top of foot affected
  – Pain
  – Weak or no dorsiflexion of foot—”foot drop”
  – Numbness on top of foot
  – “High-stepping” gait
Other Injuries

• Pressure ulcers/skin necrosis

Positioning is CRUCIAL
Pressure Ulcers

- External pressure of 23-32 mmHg can interfere with normal tissue perfusion
- Stagnant blood flow increases acid by-products in the affected tissue
- Usually occurs over a bony prominence as a result of pressure or pressure in combination with shear and/or friction
- Can occur from pressure from staff leaning on patient, Mayo resting on toes/legs, straps
Pressure Ulcers

• Skin changes may appear as “burns”
  – Unique purple appearance or blood blister
  – Tend to progress outwardly
  – Origination at muscles over bony prominences

• May be painful, firm, mushy, boggy, warmer or cooler compared to adjacent area

• Changes in skin and tissue often do not appear until 72 hours after surgery

• May progress to Stage IV or Unstageable level
Compartment Syndrome

• Pressure on muscles causes:
  – Decrease in arterial capillary pressures and increase in venous capillary pressures leading to disruption of the microcapillary cell membrane
  – Disruption causes edema to develop within the compartment
  – Can lead to neuromuscular damage, tissue necrosis, and acute renal failure

• Can occur in any muscle!
Signs of Compartment Syndrome

• Primary signs:
  • Pain-out of proportion to expectations
    – Usually severe, deep, constant, and poorly localized
    – Aggravated by stretching the muscle group within the compartment
    – Is not relieved by analgesia up to and including morphine.
• Paresthesia-in nerves transversing the affected compartment
Other Signs of CS

- Pallor
- Paresis/Paralysis
- Pulselessness—late sign
- Poikilothermia—failure to thermoregulate
- Paralysis of the limb is usually a late finding
- Tense and firm compartment
- Feet and even legs may fall asleep
- Tense and swollen shiny skin
- Prolonged capillary refill time
Ophthalmic Injuries

- Incidence between 0.1% and 1%
  - Retinal and posterior ciliary artery compression by a face mask or improperly positioned head rest
  - Optic nerve injury and/or retinal damage

- Excessive pressure on eye causing
  - Arterial hemorrhage
  - Ischemia to retina

- Corneal abrasions

- Highest risk in prone and beach chair positions-occurs in extreme trendelenburg position
Other Injuries

• Respiratory compromise
• Cardiovascular compromise
• Bruises, skin tears, abrasions
• Damage to breasts and genitalia
• Iatrogenic fracture
• Stroke-occlusion and thrombosis of the vertebral artery from extreme rotation of the head
• Back pain-relaxation of the paraspinous muscles and flattening of the normal lumbar convexity
• Chemical burns from prep solutions pooling
Injury Effects

• Injuries can produce lasting disabilities
• Some injuries can lead to death
• Many injuries lead to litigation

• Recognition of risks and prevention is essential!!!!
Incidence of Injury

- ASA Committee on Professional Liability
- ASA Closed Claims Database from 35 insurance carriers
  - Nerve injuries second most common injury behind respiratory events (21% of all claims)
    - Ulnar nerve most common
    - Brachial plexus next most common
  - Eye injuries (5% of all claims)
  - Backache (5% of all claims)

Four Basic Positions

• Supine
  – Trendelenburg
  – Reverse Trendelenburg
  – Beach chair/Semi-Fowler/Semi-Recumbent/
    Fowler/Sitting

• Prone
  – Jackknife/Kraske/Knee-Chest

• Lateral
  – Lateral Tilt/Sims Position/Lateral Oblique

• Lithotomy
OR Table Attachments
OR Table
Supine

Figure 2: Pressure points in the supine position

- occiput
- olecranon
- scapulae
- thoracic vertebrae
- sacrum coccyx
- calcaneae
- calves
Supine
Supine Positioning

• Legs are uncrossed, slightly apart, knee pillow
• If arm boards are used, hands should be “palms up” (supination) to avoid compression of the ulnar nerve
• If arm boards not used, palms should face the body
• Minimal effects on circulation
• Functional Residual Capacity (FRC) decreases 25-30% from upright
• Total Lung Capacity (TLC) decreases
Supine

Hana Table

Total Hip Arthroplasty
Supine

OSI Trauma Table
Supine

Knee support
Supine Position Use

• Used
  – During the induction of general anesthesia
  – Abdominal surgeries, gynecological, open bladder procedures
  – Open-heart /abdominal /femoral vascular surgeries
  – Neck, face and oral surgeries
  – Anterior extremity procedures
  – Orthopedic surgeries-hip nailing, femur rodding, total hips, knee surgeries
Supine Injuries

• Arm injuries
  – Pressure injuries (leaning on the patient)
  – Brachial plexus/elbow nerve injuries (abduction)
  – Tucked arms tucked tightly at sides may cause tissue damage and pressure areas/compartment syndrome
  – Draws sheet for tucking arms tucked under mattress pulls shoulders down (tuck under patient!)

• Leg injuries
  – Knee strain
  – Lying on cords (e.g., SCD cords)
  – Heel resting on bed or foam pads
Supine Injuries

- Skin breakdown-pressure ulcers
- Lumbar strains/coccyx/boney prominences
- Circulatory compromise
- Hana Bed/Fracture table:
  - Scrotal/perineal bruising/necrosis
  - Pudendal nerve injury
- Injury from leg straps
- Alopecia from lengthy surgery
- Respiratory compromise-obesity/pregnancy
WHAT’S WRONG WITH THIS PICTURE?
Trendelenburg Position

• **Uses**
  – Laparoscopic abdominal and pelvic surgeries
  – Robotic abdominal and pelvic surgeries
• Lower extremity surgery to aid in hemostasis
• Facilitate central venous catheter insertion
  – Improves the exposure of pelvic and abdominal organs

• **Effects**
  – Increases venous return after spinal anesthesia
  – Minimizes aspiration during regurgitation
Trendelenburg Complications

• Cardiac-increases myocardial work
  – Activation of baroreceptors
  – Decreased CO, PVR, HR, and BP
  – Does not improve CO caused by hypotension or hypovolemia

• Respiratory
  – Decreased FRC, total lung capacity and pulmonary compliance
  – Increased V/Q mismatching
  – Atelectasis
  – Increased likelihood of aspiration
Trendelenburg Injuries

• Arms injury
  – Brachial plexus injuries/shoulder injuries from shoulder braces
• Swelling of face, eyelids, conjunctiva, & tongue
• Increase Intraocular pressure
• Eye erythema-extreme trendelenburg, e.g., da Vinci procedures
• Shoulder injury from shoulder braces
Reverse Trendelenberg

WHAT’S WRONG WITH THIS PICTURE?
Reverse Trendelenburg Position

• Used for:
  – Head and neck procedures to reduce blood flow
  – Open and laparoscopic abdominal surgery (e.g., liver or gallbladder operations, gastric banding)
  – May benefit patients who are obese or have respiratory conditions
Reverse Trendelenburg Injuries

- Usually well tolerated

- Cardiac
  - Decrease in CO, preload, and arterial pressure

- DVT from venous pooling in lower limbs—DVT prevention is crucial!
Beach Chair/Semi-Fowler/Semi-recumbent Position
Beach Chair/Semi-Fowler/Semi-recumbent Position

• Used for:
  – Shoulder surgeries
  – ENT surgeries
  – Facial plastic surgeries
  – Dental procedures
  – Neck dissections
Sitting/Fowler Position
Sitting/Fowler Position

- Used for
  - Posterior fossa craniotomy
  - Shoulder procedures

- Full sitting position is uncommon
- Better surgical exposure
- Facilitates venous drainage
- Less bleeding
Sitting Position Injuries

• Postural hypotension-CO decreases 20-40%
• DVT from peripheral blood pooling
• Brachial plexus stretching
• Ocular compression
• Edema of face, head, and neck due to prolonged neck flexion
• Sciatic nerve injury
  – Bended knees without flexion of the hips
  – Foot drop is clinical manifestation
Pneumocephalus

• **Symptoms**
  – Intense headache
  – Paresthesia
  – Restlessness/apprehension
  – Vegetative symptoms
  – BP changes

• **Treatment**
  – Supplemental O2 through a nonrebreather mask significantly increases the absorption rate of post craniotomy pneumocephalus as compared with breathing room air

Venous Air Emboli

- Venous air emboli - patients with patent foramen ovale
  - Potentially lethal
  - Chances increase with degree of elevation of operative site
  - Dx: change in heart rate, murmur, decreased EtCO2, cardiac dysrhythmias, change in heart sounds (Doppler)
  - TEE most sensitive for detection
  - Gasp breath may be first indicator
  - Decreased PaO2, EtCO2, increased EtN

Air in ventricle
Venous Air Emboli

Monitoring/Interventions

• Monitoring
  – EKG, BP
  – SpO2, EtCO2
  – Precordial Doppler
  – CVP, Pulmonary artery catheter

• Interventions
  – Place in left lateral trendelenburg position immediately!
  – If CPR required, place in Trendelenburg position
  – May try CVP into right atrium to extract air
  – Supportive respiratory and CV therapies may be needed
Prone

Figure 10: Pressure points in prone position

- ears
- acromion processes
- iliac crest
- toes
- eyes
- cheeks
- breasts
- male genitalia
- patellae

Image of a person in a prone position.
Prone Position

• Used for
  – Spine surgery
  – Posterior neck surgery
  – Back of leg surgery
  – Pilonidal sinus excision
  – Buttock surgery
Prone Positioning

- Positioned initially in supine; then log-rolled onto abdomen after intubation
- Positioning devices used to maintain alignment & protect breasts and genitalia
- Arms - either on the side or at the arm boards
- Frames to elevate spine-used to increase exposure
Prone Complications

- Skin breakdown
- Eye or ear damage
- Damage to breasts or male genitals
- Abdominal compression
- Respiratory compromise
- Cardiovascular compromise
- Brachial plexus injury
- Foot/toe compression
- Arm injury during turning supine to prone
Prone Complications

• **Cardiac**
  - Decrease preload, c.o., and blood pressure
  - Increased SVR and PVR
  - Decreased stroke volume and cardiac index

• **Respiratory**
  - Decreased lung compliance

• **Thoracic Outlet Syndrome-secondary to thoracic nerve compression**
  - Agonizing, debilitating, and unremitting pain post-operatively following overhead arm placement
Prone Complications

- Visual loss
  - Visual loss due to direct pressure on orbit
  - Corneal abrasion
  - Capillary bed stasis/decreased perfusion from head lower than heart
  - Increased risk with horseshoe headrest, prolonged procedures, substantial blood loss
Jackknife (Kraske)/Knee-Chest Position
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Jackknife (Kraske)/Knee-Chest Position

• **Kraske used for:**
  – Anal surgeries
  – Pilonidal sinus excision

• **Knee-Chest used for**
  – Sigmoidoscopy
  – Lumbar laminectomies
Jackknife (Kraske)/Knee-Chest Position Injuries

- Pooling of blood in legs
  - Severe hypotension
  - Increased DVT risk
  - Knee injury
Figure 8: Pressure points in the lateral position

- Olecranon
- Acromion process
- Iliac crest
- Greater trochanter
- Medial and lateral malleoli
- Downside ear
- Ribs
- Medial and lateral condyles
Lateral Decubitus
Ortho Trauma Table

Hip Nailing
Lateral with Kidney Bridge
Lateral Tilt
Sims Position

- Distraction tape
- Pillow between legs
- Pillow
- Roll under axilla
- Pad ankle and foot
Lateral Oblique Position
Lateral Positions Use

• Used for:
  – Chest
  – Lung
  – Kidney
  – Hip

• Lateral with kidney bridge (kidney horn)-used for kidney and ureter surgery

• Lateral oblique-posterior cranial fossa procedures
Lateral Decubitus Position

• Bean bag or position supports lateral position
• Head-aligned to support the spinal column
• Upper arm-on a pillow or over arm rest
• Lower arm-forward and padded to prevent pressure on brachial plexus
• Axillary rolls- placed at scapula near the axillary space to relieve pressure on the arm
• Bottom leg-flexed to provide stability
• Pillows placed between legs and feet
• Chest surgery- upper arm flexed at elbow and raised above head
Lateral Position Injuries

- Peroneal/saphenous nerves
- Radial artery injuries due to arm compression
- Respiratory
  - Decreased volume and increased perfusion of dependant lung, V/Q mismatch potential
- Lateral oblique positioning
  - Considerable weight on humeral head/acromion
  - Lower breast compression
  - Extreme neck flexion causing cervical spinal cord hypoperfusion
  - EKG electrode pressure necrosis
Lithotomy

Figure 6: Pressure points in the lithotomy position

- femoral epicondyles
- medial and lateral malleoli
- calcaneae
- sacrum
- occiput
- scapulae
- thoracic vertebrae
- olecranon processes
- medial and lateral epicondyles
Lithotomy
Lithotomy

Yellow Fins
Lithotomy

Candy Cane Stirrups
Lithotomy

• Types of lithotomy devices
  – Knee supports
  – Yellow Fins
  – Candy Canes

• Risk factors
  – Length of surgery
  – Age
  – Obesity
  – HX-arthritis-related symptoms
Lithotomy Position Injuries

- Heel pressure ulcers
- Coccyx pressure area
- Increased risk for DVTs-blood pooling in calf
- Safety strap injuries
- Hip discomfort from positioning (foot and knee align with opposite shoulder)
- Lumbosacral strain during the positioning
- Compartment syndrome in legs and back
- Shearing on the patient’s back
Lithotomy Position Injuries

• Patient’s hands caught when table bottom is lowered and raised

• Changes in central vascular volumes with elevation of legs

• Nerve injuries:
  – Peroneal nerve
  – Saphenous nerve
  – Femoral nerve
  – Obturator nerve
Morbid Obesity Considerations

• Bed must be able to accommodate patient’s weight
• Padding must not allow patient to “bottom out”
• Hard to assess if arms positioned at <90°
  – Padding/cradles must accommodate weight
  – Arms need to be supported to be level with body
Morbid Obesity Considerations

• Neck may hyperextend if not padded properly
• SCDs imperative!
• Supine, prone, and trendelenburg may not be tolerated; lithotomy may require special leg holders
• Lateral or sitting may be necessary
Morbidly Obese PACU Patient

- Airway, airway, airway!!
- Positioning in bed to facilitate breathing
- Medicating for pain
- Checking incision sites

- Assessing for injuries related to positioning
Assessments, planning, and communication are CRITICAL!