Problem Identification and Needs Assessment

Identification of targeted learners

The targeted learning population consists of PGY-1 orthopaedic surgery residents and other residents entering orthopaedic surgery residency educational programs without significant experience in handling bone, saws, drills, reamers and bone cutting jigs. Other learners could include residents from other surgical subspecialties with the need for experience in these areas and also other midlevel providers who will be functioning in the orthopaedic operating room setting.

Identification of need or problem for targeted learners

Bone handling techniques involving the use of saws, drills, reamers and cutting jigs are critical for use in arthroplasty and trauma surgery. Treating long bone fractures and performing joint replacement surgery requires the proper use of these tools and techniques. The skills that will be taught in this module are basic to bone handling and are critical to the targeted population for performing and assisting in the orthopaedic operating room setting.

Current educational approach to address need or problem

The current educational approach for learners needing skills in bone handling is based on previous experience and master surgeon-novice surgeon apprenticeship experiences. These techniques are generally demonstrated by faculty or senior level residents in ‘live’ operating room experiences. Once the learner has watched and indicated understanding of the skills involved, they are given the opportunity to participate under direct observation with immediate feedback.

Ideal educational approach to address need or problem

The ideal educational approach would consist of a didactic teaching session to cover bone anatomy, saw and drill handling, utilization of jigs, and proper bone cutting techniques. The didactic session would be followed by a skills acquisition session involving sawbones and the use of those instruments. The learner would obtain hands-on experience in properly placing jigs on saw bone tibias/femurs and performing bone cuts. The implications and applications of freehand cutting of the bone would also be taught. The cuts and possible damage to surrounding soft tissues would be evaluated. This exercise would involve the use of slotted and non-slotted jigs for bone cuts.

Goals and Objectives

Specific educational goals

The learner will:

- Understand bone anatomy of the knee and hip with respect to arthroplasty and how it affects drill/saw usage.
- Understand the operation of battery powered saws/drills.
- Understand how bone cutting jigs are attached to bone and used to perform bone cuts, involving both slotted and open jigs.
- Understand the use of bone saws and various blades to perform bone cuts.
- Understand the use of femoral and acetabular reamers to accurately and safely perform bone preparation for arthroplasty.
- Understand how to protect surrounding soft tissues while using the described instrumentation.
- Understand the preparation and curing process of bone cement and the appropriate use of a mixer.
Specific cognitive, affective, psychomotor task objectives

The learner will:

- Demonstrate knowledge concerning bone anatomy of the hip and knee and how that affects the use of drills/saws to cut bone.
- Demonstrate the ability to utilize battery powered saws and drills.
- Demonstrate the ability to properly place jigs and prepare to make bone cuts.
- Demonstrate the ability to perform and evaluate a bone cut using both a slotted and open jig.
- Demonstrate the ability to make freehand bone cuts.
- Demonstrate the ability to use femoral reamers (hand reamers and/or powered reamers).
- Demonstrate the ability to use acetabular reamers with proper orientation and technique.
- Demonstrate the ability to protect surrounding soft tissues while performing bone cuts and evaluate any soft tissue damage.
- Demonstrate the ability to prepare bone cement using a mixer and properly handle the cement as it cures.

Syllabus Development

Assumptions

The learner will be assumed to have little knowledge and experience in the use of power tools and the placement of jigs to perform bone cuts. It will be assumed that the learner has little or no knowledge about bone anatomy as it relates to drilling/cutting. Basic anatomic knowledge about the extremities will be expected.

Suggested readings

- Kenneth A. Krackow: The Technique of Total Knee Arthroplasty.

Description of laboratory module

Prior to the laboratory module, the learner will be expected to review the suggested readings. The didactic portion of the module would include a short talk covering the pertinent bone anatomy and an introduction to the power tools involved. Video or PowerPoint demonstrations will be used to illustrate the correct techniques for the various skills, and then the learners will practice the skills on sawbones models. The skills will include techniques for TKA and THA. For TKA these include: placement of a bone cutting jig, fixation of the jig to bone using drill/pins, creation of a saw cut (with and without simulated soft tissues), and evaluation of the bone cuts and surrounding soft tissues. For THA the skills include: proper positioning of the pelvis, cutting of the femoral neck, preparation of the proximal femur using reamers and broaches, positioning and reaming of the acetabulum. For the Cement Handling, these skills include: proper mixing, proper venting, and proper handling through the curing process.

Description of techniques and procedures

Total Knee Arthroplasty (TKA)

- Task 1 - Femoral cutting jig
  - Placement of a cutting jig on the distal femur
  - Fixation with pins using a drill, drill bit, mallet, and pins
  - Check alignment and position

- Task 2 - Femoral Cuts
  - Perform a distal femoral cuts using the guide, cutting block and oscillating saw in freehand fashion
  - Check the accuracy of the saw cut using the guide

- Task 3 - Femoral Cuts with “tissue”
  - Repeat Tasks 1 and 2 with foam or a bag covering of the medial, lateral, and posterior aspects of the bone
  - Check the accuracy of the bone cut and the condition of the soft tissues
- **Task 4 – Tibial Jigs**
  - Placement of a cutting jig on the proximal tibia
  - Fixation with bicortical pins using a drill, drill bit, mallet, and pins
  - Check alignment and placement

- **Task 5 - Tibial Cut**
  - Perform a tibial bone cut with an oscillating saw using a slotted jig
  - Check the accuracy of the bone cut
  - Perform a tibial bone cut with an oscillating saw using an unslotted jig
  - Check the accuracy of the bone cut

- **Task 6 - Tibia with “tissue”**
  - Repeat Task 1+ 2 with foam or bag covering of the medial, lateral, and posterior aspects of the bone
  - Check alignment, placement, and soft tissue violation

- **Task 7 – Cadaver (optional)**
  - Repeat tasks 1-4 in the setting of a cadaver with an intact knee joint
  - Check alignment, pin placement, and the accuracy of the bone cuts
  - Check the condition of the soft tissues

**Total Hip Arthroplasty (THA)**

- **Task 1 – Femoral Neck Cut**
  - Position the femur on holder according to selected surgical approach
  - Perform a femoral neck osteotomy with oscillating saw using guides as per implant selected

- **Task 2 – Proximal Femur prep**
  - Using hand or power reamers, prepare femur for implant
  - Finish preparation with femoral broaches

  - Assess accuracy of femoral preparation

- **Task 3 – Acetabular reaming**
  - Orient the pelvis using patient positioner (or simulated positioner)
  - Using acetabular reamers, progressively ream acetabulum for implant insertion
  - Assess appropriate depth and orientation of reaming

- **Task 4 Acetabular orientation**
  - Insert acetabular component with proper orientation
  - Demonstrate changes in position with regard to antversion/retroversion and horizontal/vertical positioning.
  - Demonstrate acceptable range of positions

- **Task 5 - Acetabulum with “tissue”**
  - Repeat tasks 3 and 4 with pelvis covered in bag (or other covering)

- **Task 6 – Cadaver (optional)**
  - Repeat tasks 1-4 in a cadaver with native hip joint
  - Assess accuracy of implant positioning

**Bone Cement**

- Prepare bone cement using a mixer
- Demonstrate cleaning and drying surfaces to be cemented (including long bone canal)
- Demonstrate proper cement handling during the curing process

**Common errors and prevention strategies**

**TKA**

- Poor planning of bone cut (evaluate alignment, bone loss)
- Poor placement of jig (evaluate landmarks)
- Poor fixation of jig (evaluate pin placement)
- Poor bone cut (evaluate saw position, control)
• Damage to soft tissues (drill control, saw control)

THA
• Poor positioning of femoral component (evaluate anteversion/retroversion)
• Inadequate fixation of femoral component (evaluate stability)
• Fracture of femur (assess for)
• Poor positioning of the acetabular component
• Inappropriate sizing of acetabular component (too large/too small)
• Damage to soft tissues

Bone Cement
• Incomplete mixing
• Improper venting of mixing bowl
• Lack of compression during curing
• Inappropriate application (too much or too little)

Demonstrate expert performance
Videos of each Task will demonstrate proper usage of the equipment and offer tips and techniques to achieve the proper results.

Recommendations for motor skills practice
• Assembly of the drill/reamer and saw with drill bits, reamers and saw blades
• Repetitive placement of drill bits through one cortex, then through two cortices
• Repetitive performance of saw cuts using slotted and unslotted jigs
• Repetitive performance of saw cuts using a simulated soft tissue envelope
• Repetitive performance of femoral neck saw cuts
• Repetitive use of reamer (hand and power)

Supplies and station setup

TKA
• Twist Drills
  o Drill bits - assorted
• Oscillating saws
  o Saw blades – assorted
• Bone cutting jigs
• Sawbones (alternative: PVC pipe/wood block)
  o Tibia
  o Femur
  o Securing clamps or frames
• Foam insulation or bag to cover femur/tibia

THA
• Power reamer
  o Drill bits per implant used
• Oscillating saw
  o Saw blade
• TKA equipment
  o Femoral reamers and broaches
  o Trial or representative implants
  o Acetabular reamers
• Sawbones
  o Pelvis
  o Femur
  o Clamps or frames to secure sawbones
• Plastic garbage bag or other for obscuring pelvis

Suggested duration for completion of module
The preparation will include suggested readings and review of videos for the tasks – the time required for this will be variable, but can be estimated at 2 hours. The module will involve a short didactic session followed by task station practice and attainment of proficiency. This hands-on portion should be completed within 3-4 hours.

Estimated budget
• Drills/Bits:
• Saws/Blades:
• Sawbones/PVC pipe:
• Bone cutting jigs
• Insulation:
• Table Clamps/Bone Holders:
• Bone cement kit (with mixing bowl):
• Cadaver (optional):
Learner Evaluation and Feedback

**Total Knee Arthroplasty**

**Methods of Performance Assessment**

The learners will be assessed in their ability to properly place and effectively secure a bone cutting jig to a long bone. This assessment will include the proper use and control of a power drill and appropriate placement of pins to secure bone cutting jigs to bone. Once the jigs are properly placed, assessments will be made on how the power oscillating saw is handled and on the accuracy of the bone cuts. The fit of the trial component can be assessed for stability, gapping, notching. Finally, the ability of the learner to protect surrounding soft tissues will be judged by damage to the foam insulation. Further assessments of performance can be made by timing the activities once the moves are mastered.

**Suggested Proficiency Benchmarks**

The learner should be able to place and secure the jig within 2 mm of the appropriate position and within 3 degrees in flexion/extension and varus/valgus. The bone cuts should be smooth with minimal soft tissue damage. The power instruments should be handled with excellent control. Timing of the jig placement and creation of a tibial bone cut should yield a time not to exceed 10 minutes. The trial component should fit securely with minimal gaping (no more than 2 mm).

**Methods for Learner De-briefing and Feedback**

Feedback will be obtained through open discussion and a questionnaire to assess course utility, usefulness, and effectiveness.

**Total Hip Arthroplasty**

**Methods of Performance Assessment**

Learners of this exercise will be assessed but their ability to accurately and properly prepare the femur and acetabulum for insertion of a total hip arthroplasty. This assessment includes that proper use of a saw, reamers and broaches. They will also be assessed for the orientation of their instrumentation.

**Suggested Proficiency Benchmarks**

Preparation of the femur will require that the prosthesis be stable to rotational torque, be positioned in an acceptable range of anteversion and at an appropriate length of femoral neck (relative to the greater trochanter). Acetabular preparation requires a stable component (rim fit), orientation within an acceptable range.

**Methods for Learner De-briefing and Feedback**

Feedback will be obtained through open discussion and a questionnaire to assess course utility, usefulness, and effectiveness.

**Periodic Curriculum Review, Evaluation, Validation, and Refinement**

The module will be reviewed by faculty and learners on an annual basis and this will include evaluation for improvements in either the didactic or technical skill portions. The learners will be observed in operating room settings and the utility of the module in improving performance will be evaluated by questioning senior supervising surgeons.