Basic Techniques in External Fixation

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Problem Identification and Needs Assessment

Targeted Learner
PGY1 orthopaedic residents are the learners targeted for this motor skills training exercise.

Identification of Need
Basic techniques in external fixation is an introduction to the skills necessary for the operative management of fractures. The learners must gain proficiency in the use of external fixation in the treatment of lower and upper extremity fractures. Most of the targeted learners do not possess these skills when they begin residency. These skills are not part of the previous training. These skills are fundamental to the management of fractures. The learners need to acquire the knowledge and skills necessary to perform these procedures.

Current Educational Approach
Currently, orthopaedic residents learn about external fixation by reading the relevant literature. They learn how to perform the operative technique during fracture surgery by a process that includes observation and hands-on experience with actual patients. Sometimes, these experiences in the operating room are preceded by training session with sawbones and/or cadavers, product demonstration videos and textbooks or other written instructional materials.

Ideal Educational Approach
The ideal approach entails the creation of a motor skills training curriculum that incorporates didactic lecture, live demonstration and instructional video. These components would demonstrate proper technique, illustrate relevant decision-making to achieve the desired result while avoiding pitfalls and provide strategies to resolve procedural difficulties. The learners would receive hands-on training with expert guidance and the opportunity for additional practice time. The achievement of skills proficiency would be confirmed through motor skills testing with performance metrics.

Goals and Objectives

Educational Goals of Skills Module
• The learner will obtain the pertinent cognitive knowledge and observe, practice and demonstrate a level of proficiency in the basic skills of treating fractures with external fixation.
• The learner will understand the common errors and pitfalls associated with the use and application of external fixation

Specific cognitive, affective, psychomotor task objectives
The learner will demonstrate proficiency in:
• Identifying a fracture of the upper and lower extremity appropriate for the use of external fixation
• Organizing a complete collection of equipment, instruments, and implants necessary to apply external fixation to a fracture
  ➢ Developing a pre-op planning checklist with contingencies
• Acquiring the ability to insert a half-pin into a long bone bicortically
  ➢ Pre-select the an appropriate size twist drill bit and set of half-pins
  ➢ Drill a bicortical hole perpendicular to long axis of the bone
  ➢ Insert half-pin to appropriate depth (no under- or over-penetration of far cortex)
  ➢ Insert subsequent half-pins aligned with initial pin in a configuration that is biomechanically advantageous and conforms with the fixation clamps
• Acquiring the ability to assemble a monolateral fixation construct
  ➢ Selecting appropriate rods, clamps and instruments for assembly
  ➢ Building the construct to the half-pins in preparation for reduction and stabilization

• Acquiring the ability to reduce the fracture while utilizing the construct as a reduction tool and maintaining the reduction with the construct

Syllabus Development

Assumptions
It is assumed that the learner will have little to no knowledge/experience/skill/training in the application of external fixation

Suggested readings


  • Bindra RR. Biomechanics and biology of external fixation of distal radius fractures. Hand Clin 21;363-373, 2005

Description of Laboratory Module
This laboratory module will consist of a series of exercises to apply an external fixation to a fracture and successfully perform reduction and stabilization in a displaced fracture model. It will include; background reading, review of a slide presentation, video review, dedicated practice in the skills lab and direct observation based assessments of proficiency.

Learners will learn how to use the equipment, instruments and implants necessary to apply and external fixator properly. Learners will practice on the PVC pipe-model with a surrogate soft tissue envelope. All exercises are illustrated by videos. The videos provide overall guidance for the exercise and are specifically designed to orient the learner to the targeted skills, exercises and related techniques.

Description of Techniques and Procedures
1. Tibial sawbone with soft tissue envelope surrogate
   In this exercise you will learn how to use a power drill, threaded half-pins, clamps and rods to construct a monolateral external fixation frame
     a. Make a stab incision over bone with subperisoteal elevation
     b. Create a drill hole that is bicortical and perpendicular to the long axis of the bone using a soft tissue protector and drill guide
     c. Insert the half pin to appropriate depth
     d. Create additional drill holes and insert half-pins aligned with the initial half-pin to establish a series of properly placed half pins in a biomechanical advantageous configuration amendable to the fixation clamps
     e. Assemble the external fixation construct

2. Fracture Reduction
   In this exercise you will learn how to manipulate a displaced fracture into an acceptable alignment* using the external fixation as a reduction tool and lock down the external fixation frame without loss of reduction (*no shortening, angulation or malrotation)
Common Errors and Prevention Strategies

- Inadequate incision and sub periosteal exposure
- Incorrect drill hole
  - unicortical
  - not perpendicular to long axis
  - unstable start point (drill slips/skives off bone)
  - appropriate spacing between half-pins
- Under or over penetrated half-pin
- Ineffective fracture reduction
  - not enough or excessive traction
  - failure to apply traction in-line

Expert Performance/Video

Videos demonstrating the exercises have been created by senior faculty members. They include discussion of the many common errors and techniques and how to avoid them. These videos will guide residents through the recommended exercises for this module.

Recommendations for Motor Skills Practice

- repeat as needed to enhance perception and assessment of
  - perpendicular drill hole placement
  - tactile feedback of bicortical half-pin placement
  - assembly of rods and clamps with accuracy and alacrity
  - effective in-line traction

Supplies and Station Setup

- Table with vise
- Tibial sawbone with pipe insulating foam
- Power drill with chuck
- External fixation system
  - drill bits and drill guides
  - half-pins
  - clamps and rods

Suggested Duration for Completion of Module

- Background reading and video review (2 hours) to be completed before the skills training session
- Lecture with slide presentation, Live demonstration and Instructional video (1 hour)
- Module stations and independent practice (2 hours)
- Video competency assessment (1 hour)

Estimated budget

- Tibial sawbones, PVC pipes ($75-125 per session)
- Power drills with chucks ($50-125 per item)
- External fixation system (variable depending on institution)

Learner Evaluation and Feedback

Method of Assessment

Learners are assessed in their ability to utilize the equipment, instruments and implants in a safe and efficient manner. In addition they will be assessed on their ability to utilize these materials effectively to construct a monolateral external fixator on a sawbones.

Suggested proficiency benchmarks

1. Quiz on anatomy of tibia, biomechanics of external fixation. Emphasis on ‘safe zones’ for drilling and pin insertion. 80% correct
2. Direct observation proficiency assessment. The learner must construct a monolateral external fixator that includes properly positioned half-pins, clamps and rods to construct a frame that applies the biomechanical principles outlined in the module. The fracture must be aligned anatomically and the frame must maintain the reduction to manual stress. The frame should be assembled, applied and the ‘fracture’ reduced within 20 minutes

Method for Learner Debriefing and Feedback

Learners will provide curriculum feedback using a web-based, anonymous tool assessing module didactic content, expert video quality and usefulness of skills training.
Curriculum faculty will annually review learner comments and assess potential improvements in the didactic and manual skills portion of the module. Educational validation will occur when the learner is observed and graded in the clinical setting.