# K-Wire Techniques

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## Problem Identification and Needs Assessment

### Identification of targeted learners

The target learner audience is the PGY-1 resident in Orthopaedic Surgery.

### Identification of need or problem for targeted learners

K-wire placement often proves difficult for residents because of the need to visualize in three dimensions and extrapolate without actually seeing. Another problem is learning how to direct the wire within the bone.

### Current educational approach to address need or problem

Residents receive K-wire instruction in the operating room setting, and this often depends on the quality of educational materials derived from patient characteristics. There is little standardization to teaching K-wire placement.

### Ideal educational approach to address need or problem

Dedicated space and equipment should incorporate fluoroscopy practice and wire handling practice with faculty guidance.

## Goals and Objectives

### Specific educational goals

- Learn how to use the wire driver, in forward, reverse, and oscillate modes
- Learn to maintain reduction of simple fractures
- Place the K-wire under direct visualization
- Manipulate the K-wire and change direction under direct visualization
- Place the K-wire with fluoroscopy
- Manipulate the K-wire under fluoroscopy
- Learn to distinguish cortical and cancellous bone penetration
- Manipulate and reduce fractures using the wire

## Syllabus Development

### Assumptions

Residents are assumed to have had little or no experience with K-wire placement, since this is not a routine part of medical school education.

### Description of laboratory module

This lab consists of skill building exercises focusing first on learning the equipment, hitting simple targets, and then learning to hold fractures under visualization. After that, techniques will progress to blinded placement with fluoroscopic verification.

### Description of techniques and procedures

**Part 1: Driver and wires/pins—learning how to grip the wire, spin, and control speed**

Pins and wires are versatile orthopaedic implants for fixation, and their advantage is that they are of low cost. Steinmann pins and Kirschner wires mainly differ in terms of diameters. Common K-wire sizes are 0.035, 0.045, and 0.062 inches in diameter, whereas pins are larger, varying between a sixteenth and quarter inch. For distal radius and more proximal, 0.062 inch wires are most commonly used, and 0.035 and 0.045 inch sizes are used in the hand and fingertips. Also, common lengths are four and nine inches. In terms of the tip, trocar tips have three sides, and chisel tips have two sides. Trocar tips are better for penetrating cortical bone, whereas chisel tips can be used to lodge into cancellous bone or to skive along the endosteal cortex. Implants may be single or double pointed. Double-pointed long pins may be cut, and the other end can be used; however, care needs to be taken to prevent personal injury in double-pointed pins. Most of the time, unthread wires are used; these are...
stronger and are more easily removed. Threaded implants are used when pin or wire migration is a concern.

The wire driver is composed of several parts: the pistol-grip handpiece with forward, reverse, and oscillating features; the wire collet, and the battery housing (which is usually part of the handpiece grip). There are usually two collet sizes, one for wires, and one with larger diameter for Steinmann pins. The collet snaps onto and releases from the handpiece. The wire or pin must be inserted straight into the collet so as to not bind the bearings. The handle grip tightens the collet chuck, which securely holds the implant for drilling.

Part 2: Driving a wire through a 10 cc syringe, using numbers as targets, transverse and oblique drilling

A syringe can be used to practice K-wire placement. Simple placement would be transverse K-wire passage, and a number marking on the syringe can be selected as a target. Further practice would involve placing the wire starting from an oblique surface. Various obliquities can be selected to increase difficulty. Then, further practice should involve blinding, such as drilling toward a number target in an oblique fashion under a simulated soft tissue envelope (towel wrapped around the syringe).

Part 3: Fracture model fixation

Distal radius model reduction model will be pinned with direct fracture visualization, and then this will progress to placement under simulated soft tissue envelope.

When placing wires, the surgeon should be aware of anatomic structures, both on the near and the far side. For example, for the distal radius, insertion into the radial styloid puts the superficial radial nerve and lateral antebrachial nerves at risk; at the metaphyseal side, interosseous structures should be considered.

Another consideration is fracture obliquity. Crossing the fracture site as perpendicular as possible will give the most stability; conversely, passing nearly parallel with the fracture line with give little stability.

In this example, a Sawbones distal radius model is used. Wires are placed from the styloid across the fracture and into the metaphyseal area. The video provides more detail.

After placement, wires are cut and left outside the skin. There are several options for bending or capping to protect the cut end. When bending, the wire should be stabilized with a needle driver to avoid pin migration and loss of fixation.

Common errors and prevention strategies

Error 1

Spinning the wire too slowly, or starting and stopping the spinning too often, will prevent the surgeon from proprioceptively assess where the tip of the wire is.

Error 2

When advancing too quickly, the surgeon may punch through cortex and not realize this.

Error 3

Bending the wire the wrong way, or not picking the correct starting direction, will prevent accurate wire placement. Changing directions can be achieved by maintaining wire spin, back out the pin while spinning and with slight deflection in the wire, and the surgeon can advance in a new direction after feeling for the give in the wire deflection.

Error 4

When under a soft tissue envelope, it is easy to miss the bone complete, either being completely in soft tissue only or skiving along the periosteum. It is helpful to position the point of the K-wire on the surface of bone before starting, and this will help ensure cortex penetration. Also, the learner should practice in order to develop proprioceptive feedback of what wire advancement in bone is like.

Error 5

Spinning wires can wrap up important structures. Nerves and vessels that are dissected free are especially prone. The surgeon should pay attention to surrounding structures, and when near an at-risk structure, the oscillate mode may be used to avoid wrapping up structures.

Recommendations for motor skills practice

Fast spin on the wire, but advance slowly, but avoid plunging. Feel the bone and each type of bone that the wire is going through, noting the difference between cancellous and cortical bone. Practice oblique and straight drilling, and practice direction change.
**Supplies and station setup**

- K-wire driver
- 0.0625" K-wires
- 10 cc syringes
- Sawbones distal radius model 1511-40-1
- Mini C-arm (the learner should review fluoroscopy technique and safety)

**Suggested duration for completion of module**

- Introduction to the equipment, wire driver and fluoroscopy: 30 minutes
- Practice on drilling 10 cc syringes: 30 minutes
- Practice on Sawbones radius, visualized: 30 minutes
- Practice on distal radius under fluoroscopy: 30 minutes
- Assessment: 30 minutes

**Estimated budget**

If using simulation materials, such as syringes and PVC pipes, this model will be several dollars per resident. Including Sawbone radius fracture model may increase the cost to $250.

**Learner Evaluation and Feedback**

**Methods of performance assessment**

**Part 1**

The learner should demonstrate the ability to assemble the wire driver, including the collet and battery. Wire insertion should be demonstrated as well.

**Part 2**

The learner should place wires in a syringe and hit a number target. An additional wire should be placed at a different angle/obliquity, ideally at least 45 degrees apart to test ability to navigate the wire against a more oblique surface.

**Part 3**

Blinded, distal radius under fluoro, place two pins from the styloid into the intact metaphysis in divergent fashion while maintaining fracture reduction, and an additional pin subchondrally, but without going through the distal radioulnar joint.

**Suggested proficiency benchmarks**

Checklist: picked starting point, good drill speed, appropriate advancement, use of proprioception, good directional control, appropriate penetration of far cortex

**Methods for learner debriefing and feedback**

The resident is given opportunity to provide feedback about this module and suggest process improvement.

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

Programs should use resident feedback to validate this curriculum, add and refine proficiency benchmarks, and develop program-specific objective criteria.