Suturing and Knot Tying

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Problem Identification and Needs Assessment

Identification of targeted learners
The target learner audience is the PGY-1 resident in a surgical specialty.

Identification of need or problem for targeted learners
Residents have been taught basic suturing and knot tying during medical school, but many of these courses are limited, with few opportunities for the student to apply techniques.

Current educational approach to address need or problem
During residency, learners receive instruction on suturing and knot tying through observations in the operating room. However, poor techniques are sometimes perpetuated, either from bad habits or from inadequate supervision. In many cases, the attending surgeon scrubs out during the closing, and residents then continue to practice erroneous techniques.

Ideal educational approach to address need or problem
A laboratory module with specific instruction on the basic suture techniques and knot tying basics is one approach. This would include video demonstrations to facilitate self-learning.

Goals and Objectives

Specific educational goals
- Tie two-handed square knots
- Tie one-handed square knots
- Instrument tie square knots
- Learn to load the needle driver
- Place sutures through tissue without undue stress on the needle or tearing through the tissue
- Place simple interrupted stitches
- Place simple running stitches
- Place horizontal and vertical mattress sutures
- Place inverted subcutaneous stitches
- Place running subcuticular sutures
- Cut sutures to the appropriate length

Specific cognitive, affective, psychomotor task objectives
- Manipulate needle driver with needle and suture using the dominant hand
- Assist with forceps in the non-dominant hand

Syllabus Development

Assumptions
Most residents should have received basic suturing and knot tying instruction during medical school.

Suggested readings

Description of laboratory module
The module first begins with knot tying, since the learner can incorporate the practice of tying knots into suture techniques. This may be best first practiced on a knot tying board.

The second part incorporates suturing. Pig's feet provide a realistic model and are usually easily obtained. The various suture techniques are practiced, and the learner continues to practice knot tying and suture cutting.

Description of techniques and procedures
Tying knots
The first part is to perform two-handed knots. An important skill to learn is to slide the first two half hitches down the single post to enhance loop security when tying tissue under tension. On top of this, reversing half-hitches must be thrown.
Second, the resident practices the same techniques using the one-handed knot technique. Again, the learner incorporates good practice for initial loop security, which can be enhanced by using a single post for the first two throws, while thereafter, additional reversing half-hitches add to knot security.

Third, the resident practices tying using an instrument tie technique. Instrument tying is then practiced, and care is taken to make sure the needle driver is placed in the correct configuration (inside the V) such that the knots end up square. The learner demonstrates uses the needle driver to tie square knots.

**Loading the needle driver**
The curved needle should be grasped using the driver tips at about \( \frac{2}{3} \) the way down from the point. The needle should make a right angle to the needle driver.

**Simple interrupted stitch**
For skin, toothed forceps should be used. Insert the needle into the skin edge, taking care to enter the skin perpendicular to its surface; or if erring, the needle should be directed slightly away from the wound, rather than skiving toward. The bite should include the epidermis and the dermis, with minimal subcutaneous fat. The opposite wound edge, if far away, may be sutured after regrasping the needle. Care is taken to exactly mirror the depth and distance, so that the two sides are symmetrical. Practice knot tying to approximate the skin edge without strangulation, making sure that the edges meet without overlap, stepoff, or edge inversion. Cut the suture, leaving a 5 mm tail.

**Simple running stitch**
Begin as in placing a simple interrupted stitch. Tie the suture and cut the short end, leaving a 5 mm tail. Using toothed forceps to facilitate skin edge eversion, place the needle into the skin, taking care to enter perpendicular to its surface. Continue evenly, maintaining the same distance. At the end, leave the last loop for tying.

**Mattress stitches**
For the horizontal mattress, enter the skin edge as if placing a simple interrupted stitch. This is continued to the opposite side. Without tying this interrupted simple suture, advance 5 mm along the wound and place another simple interrupted throw in the opposite direction. Tie the suture on the side of the wound, and the tension effective everts the skin edges. The vertical mattress is thrown in similar fashion, except that the two opposing bites are deep and then shallow. Think far-far, near-near. Again, tying this suture everts the skin edges.

**Inverted subcutaneous stitch**
Using toothed forceps, hook and lift the skin to expose the dermis layer. Enter at the junction of the deep dermis and subcutaneous fat, and curve the needle around to exit at the junction of the dermis and epidermis. Place the opposite wound edge in similar fashion, mirroring the depth and distance. On this opposite side, first enter at the epidermal junction, and then exit in the deep dermis. Tie, and cut the suture ends right at the knot, practicing sliding down and tilting the scissors to avoid cutting the knot.

**Running subcuticular stitch**
There are various ways to begin and end the running subcuticular stitch. One way is to anchor the suture at one end by first placing an inverted subcutaneous knot, as this places the knot deep within the wound. Cut the free end short. Then, the first bite drags the knot deep, and the strand exits at the wound apex. From here, insert the needle into the epidermis-dermis junction, being careful not to emerge onto the skin surface. Take horizontal bites, alternating from opposing sides, entering exactly directly across from the last bite’s exit point. End at the apex, and either exit the skin 1 cm away and anchor with Steristrips, or tie a deep knot.

**Common errors and prevention strategies**

**Error 1**
One common error is not achieving square knot placement. Multiple half-hitches down a single post do not offer the same amount of security as well-placed square knots. Take care to practice placing square knots by crossing the suture strands and by visually inspecting each throw.

**Error 2**
Placement of air knots can occur when there is sufficient tissue tension. The first strategy is to tie a surgeon’s knot. Do this by looping the first throw twice. The second strategy is to place the first two throws and slide them down a single straight post. To do this, place the first half hitch and the second one over it in square fashion. Then, maintain tension on the short loose end to bring this into a
straight post. Sufficient tension needs to be maintained so that the half-hitches can slide.

**Error 3**

Skin inversion is a common problem, especially when the needle enters the skin at a poor angle, skiving toward the wound edge. Instead, correct this by entering the skin surface at a perpendicular angle, or even angling slightly away from the skin edge.

**Error 4**

When placing inverted subcutaneous or subcuticular stitches, a common error happens when the needle inadvertently exits the skin surface. Careful placement involves paying attention and avoiding penetration of the epidermis layer.

**Recommendations for motor skills practice**

Suturing and knot tying skills can be practiced with smaller and smaller suture on pig’s feet. Further practice will increase speed of needle placement and knot tying.

**Supplies and station setup**

- Knot tying board
- 2-0 suture, and smaller for more practice, such as 4-0 and 5-0
- Other options include fishing line and string with reusable free needle to decrease cost
- Needle driver
- Toothed forceps
- Suture scissors
- Pig’s foot

**www.sawbones.com** offers a Suture Trainer with complete tools, suture packs, and suture skin pad for $350.00

**Suggested duration for completion of module**

Introduction to the station, with orientation and readings: 30 minutes

Knot board practice: 30 minutes

Suture placements with knots: 90 minutes

Assessment: 30 minutes

**Estimated budget**

The cost should be minimal, and most likely less than $20 per resident session.

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**Learner Evaluation and Feedback**

**Methods of performance assessment**

Instructor may observe all steps of this station, which includes knot tying, needle and suture handling, and placement of sutures.

**Suggested proficiency benchmarks**

The resident should be able to demonstrate the following:

- Place simple interrupted stitch, reapproximate tissue under tension, and tie a series of square knots.
- Demonstrate vertical and horizontal mattress sutures.
- Place inverted subcutaneous sutures followed by subcuticular stitch.
- Suggested checklist:
  - Proper forceps selection for type of tissue
  - Correct needle loading
  - Suture bites taken at right angles
  - Curve of the needle followed
  - Appropriate needle handling and protection
  - Knots correctly tensioned with tissue approximation
  - Square throws
  - Skin everted, and not inverted
  - No dog ears with closure
  - Good tissue handling without creating excessive trauma from forceps or needle cut-out
- Additional assessments can include closing wounds that are in different orientations than an ideal flat surface, such as placing tissue on a near vertical or oblique surface. Also, learners may practice performing a z-plasty with closure for advanced assessment.

**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.