

**Wayne State University
Department of Surgery**

Knot Tying I Module

Syllabus

Knot Tying I Module

COGNITIVE OBJECTIVES

By the end of this laboratory session participants should be able to:

1. Understand the value of square knots in surgical procedures.
2. Understand the value of being able to use an instrument to tie square knots.
3. Understand the benefit of being proficient at being able to tie two-handed square knots.

TECHNICAL SKILLS OBJECTIVES

By the end of this laboratory session participants should:

- 1) Tie a series of instrument-tied square knots
- 2) Tie a series of two-handed square knots

Introduction, General Principles and Practical Tips of Knot Tying

- The overall goal of any knot tying skill is to efficiently and effectively produce a series of stable square knots of sufficient strength to securely ligate a structure or approximate the edges of a wound or incision.
- The proper performance and application of these techniques results in safer faster surgery, less wastage of costly surgical materials, decreased operating room time, and improved patient care.
- When practicing, always use a thick string or suture first to determine if you are placing your knots correctly.
- The student should be able breakdown each type of knot into its individual component steps, master them, and then practice each step until they can move through the sequence of steps smoothly.
- Always start with a crossed suture if you can. By doing so, initiating a knot is easier, avoids crossing your hands and does not obstruct yours or the assistants view.
- Students will perform all knots using monofilament or braided suture.
- The half-hitch is the first basic throw of the surgeon in creating a square, hybrid or granny knot. This is also referred to as a *simple knot*. A half-hitch is formed when the suture material is looped and one end is completely twisted around the other end.
- For a knot of any kind to be performed, placement of two half-hitches is required.
- The square knot is the basic knot used in surgery. In this knot, two half-hitches are placed in opposite directions (mirror images of each other). This knot once tied cannot be loosened, and is the most secure knot used in surgery. A square knot can tie two-handed, one-handed, or with an instrument.
- The hybrid knot is an intermediate type knot; not quite square knot but not granny knot either. This knot is generally secure. It is performed by alternating the direction of the half-hitches using the thumb and index finger as when performing a square knot, but in this instance the hands do not rotate 180° to form a square knot. In essence, it is a 'psuedosquare' knot.
- The granny knot is performed by placing two half-hitches in the same direction. This knot lacks security, is unstable, and will loosen with excess tension or motion.

- The surgeon's knot is performed when two twists are placed in the same direction in the first half-hitch (known as surgeon's half-hitch or throw, which is then followed by a second half-hitch (basic single throw) in the opposite direction to produce a secure squared surgeon's knot. When two surgeon's half-hitches are throw in opposite directions this is known as a double-double square knot.
- The slip knot is performed primarily when two half-hitches are thrown in the same direction and vertical tension is applied to one suture strand (similar to a granny knot except horizontal directed tension is applied for a granny knot). Similarly, a square knot can sometimes be secondarily converted into a slip knot by applying pressure on one end of the suture. A slip knot can tied two-handed, one-handed, or with an instrument.
- Placement of all final (end) knots is done with the suture strands in a horizontal direction to ensure proper sitting of the knot.
- Knots should be as small as possible to prevent an excessive amount of tissue reaction or minimize foreign body reaction.
- Avoid "sawing" or contact friction of the suture strands as this can weaken the integrity of the suture.
- Avoid excessive tension to suture during tying as this may break the suture and cut through tissue.
- Suture should approximate tissue, not strangulate
- Tie only the proper number of knots. Extra knots do not add to the strength of a properly tied knot. Bulk is not better!
- Avoid damage to suture material when handling. Avoid crimping or crushing of the suture strands.
- Students should be prepared to change stance or position in the OR in order to place a knot securely and flat. Do not be an immobile surgeon!

Instrument Tied Square Knot

- Instrument-tied knots are best used for wound closure or when one or both of ends of the suture are too short to be effectively tied with one or two hands. An easy set of rules to remember when tying this knot are as follows: 1) Try to keep the needle holder parallel to the wound, 2) Always roll the long suture strand over the needle holder toward the short end and tighten the knot in the opposite direction by pulling away from the short end of the suture, 3) Keep free suture tail about 2 to 3 cm in length.
- The benefits of instrument-tied square knots are suture conservation and speed. If performed properly, one can tie up to 10 instrument-tied square knots using an 18 inch suture. This compares to only 1-3 two- or one-handed-tied knots with the same length of suture.

Two-handed Square Knot (Reef Knot or Flat Knot)

- This is the primary knot used in surgery. This knot is composed of two half-hitches (ei. simple knots) thrown in opposite directions (i.e., mirror images of each other) and secured with horizontal directed tension.
- The two-handed square knot is the best method to use when the closure requires *firm and continuous pressure* during the process of tying.
- Always start with a crossed suture. In right-handed tying, the long or fixed segment of the suture is held in the left hand, whereas the right hand holds the short or free end of the suture and does most of the maneuvering by holding, letting go, and regrabbing the suture.

COMMON ERRORS and/or PREVENTION STRATEGIES

▪ Two Handed Knot Tying at Surface – 4 major errors

- *Excessive motion involving the right hand.* The instructor will emphasize that the majority of work for this knot is done with the left hand. The right hand is used primarily to manipulate the rope or suture material. If the student persists in this error the instructor will ask the resident to use only his right hand while he uses his left hand to cooperatively aid the student in tying the knot. This simple teaching method helps the student understand the secondary role of the right hand in tying this knot. The instructor should emphasize that excessive use of the right hand slows the performance of the completion of this skill.

- *Dropping the suture or failure to maintain tension on the suture.* Initial attempts at performing this knot will invariably result in dropping of the rope or suture and/or subsequent loss of tension as the first and second loops are formed. Furthermore, as the students gain speed and efficiency in this skill there is a tendency to relax their hold on the ends of the suture. These common yet preventable errors often results in loss of the first or second knot loops resulting in complete failure to tie this knot, and/or inadequate ligation of the structure due to formation of “air knots”. The students should understand that maintaining tension on the rope or suture is a more important goal than speeding carelessly through this skill. The students should be instructed to maintain tension on the sutures at the expense of speed at all times during this module.

- *Hands located too close to knots.* The result of this error is that it becomes difficult to pass the straight end of the suture, thumb or finger through the loop and the suture end is either dropped completely or tension is lost. The other error related to poor hand position is the inability to form a second loop. Either outcome results in a loss of knot tying efficiency. To prevent these errors the students should be instructed to grasp the sutures at a point along their length which allows for the formation of the first or second loop and prevents dropping of the suture or loss of tension to the suture.

- *Hands located too far away from the knots.* Here when the hands are too far away from the knots it is difficult to maintain tension on the suture. Coincidentally, it is difficult to gauge how much tension on the suture is required to successfully place the knots while avoiding excessive outward tension on the tissue being tied.

- *Failure to cross hands and suture.* Formation of a true square knot requires that the student crosses his/her hands and fingertips while performing the two half-hitches. Failure to do so will result in a non-squared knot, the so-called “Granny Knot”. This error can be avoided by demonstrating the difference between the two knots. Using the rope, the instructor can demonstrate the clinical result of performing a non-squared knot. The instructor will explain how the non-squared

knot will slip in almost all clinical scenarios and what the expected outcome will be if this knot failure occurs in an actual patient.

- **Two Handed Knot Tying at Depth.**

- The major error that occurs with this knot is the failure of the student to slide the knot completely down to the intended depth. This error results in the formation of gaps between each previous knot loop (e.i., air knots) resulting in an incomplete tissue ligation or closure. The instructor can show the student how to avoid this error by demonstrating how each loop should be slowly and deliberately slid down to the intended depth and secured with appropriate tension. Additionally, knots should be secured using opposite index fingers to avoid producing ‘granny knots’. Index finger should be placed on knots directly on the target tissue.

- Another common error is that the length of the suture tail (mobile hand) is too short in relation to the depth of the target tissue. This can result in loss of appropriate tension on suture during knot tying or dropping of the suture itself.

- **One Handed Knot Tying at Surface or Depth.**

- The same major errors that can occur with two handed knot tying can occur with one handed knot tying. In particular, residents will have difficulty maintaining tension as they manipulate the strands of the suture. In addition, the students will struggle with maintaining the proper size loop to allow the left index finger to bring the opposite suture strand through the loop. The key practice instruction for this skill is to proceed slowly enough to maintain tension on the suture strand while maintaining a large enough loop to manipulate the suture strand through the loop.

- **Instrument Tying.**

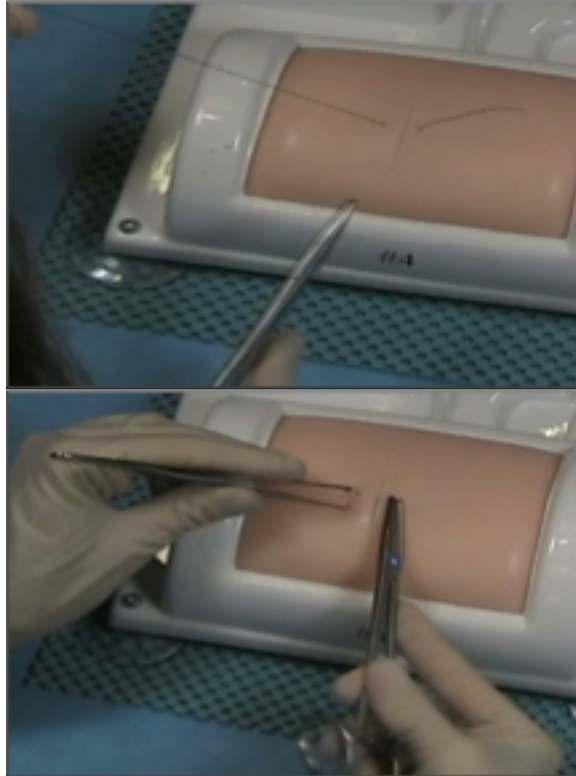
- The specific error that students tend to make with this knot tying skill relates to the length of the suture strand grasped by the instrument to secure the square knot. It tends to be either too long or too short. If this suture “tail” is left too long, it makes manipulation cumbersome particularly in deep closed spaces and thus creates inefficiencies. If the suture tail is left too short, it becomes difficult to grasp the suture strand and pull it through the loop. Again, creating inefficiencies and increasing the length of time for completion of the knot. The instructor can help the students avoid these errors by describing the optimal suture strand length, and demonstrating the differences between an optimal length of suture strand versus suture strands which are either too long or too short. Caution must be used when performing this knot tying technique with a monofilament suture. Repeated grasping and bending of the monofilament suture with a needle holder may cause the suture to weaken or break at a critical area.

- **Miscellaneous Issues.**

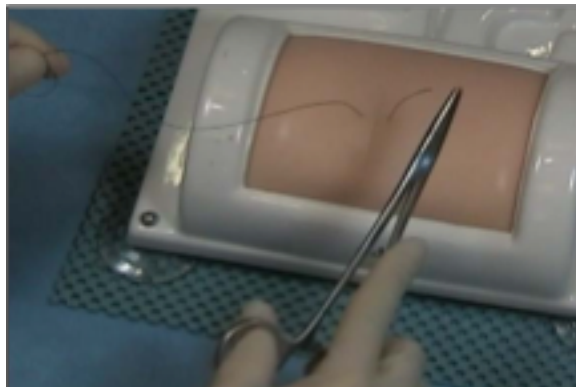
- Final end knots should be tied with the suture strands in a horizontal direction to ensure proper sitting of the knot.
- Knots should be as small as possible to prevent excessive amount of tissue reaction.
- Avoid “sawing” of the suture strands as this can weaken the integrity of the suture. Also avoid excessive tension as this may cut tissue and break the suture.
- Tie only the appropriate number of knots. Extra ties do not add to the strength of a properly tied knot. Bulk is not better!

Exercise - Instrument tie

1. Place a simple stitch through the skin pad. Pull the suture material through, until the tail is 2 – 3cm long.



2. Drop the needle. Hold the long end of the suture material in your left hand. Make a 'V' with the suture material, with the incision, or skin pad at the point of the 'V', and the tail of the suture material on the right hand side of the 'V'.



3. Using your right hand, place the needle driver in the middle of the 'V'. L
SEP



4. Loop the long end of the suture material twice over the top and around the tip of the needle driver.



5. Grab the short end of the suture material with the needle driver.



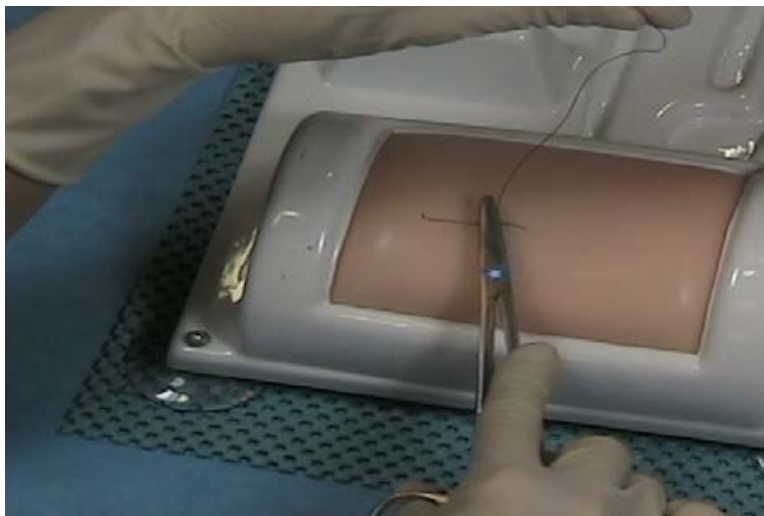
6. Cross your left hand over your right hand to lay the knot down flat.



7. This completes your first throw. Start the second throw, with the long end of the suture on the right side of the 'V' and the short end on the left side.



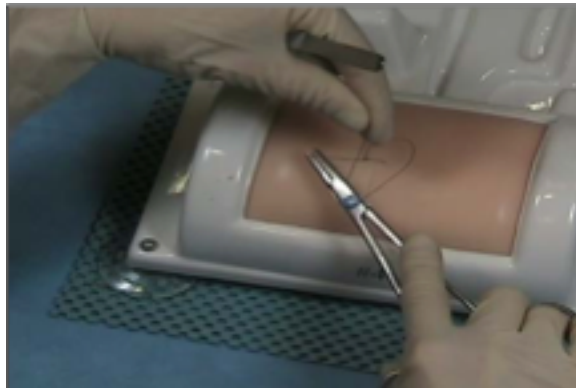
8. Holding the long end of suture in your left hand, and the needle driver still in your right hand, place the needle driver in the center of the 'V'.



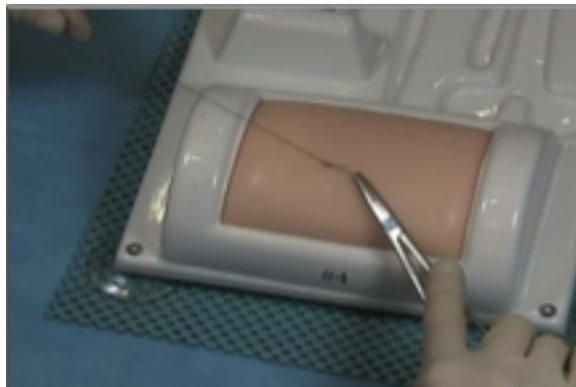
9. Loop the suture material around the needle driver (starting on top of the needle driver) once.



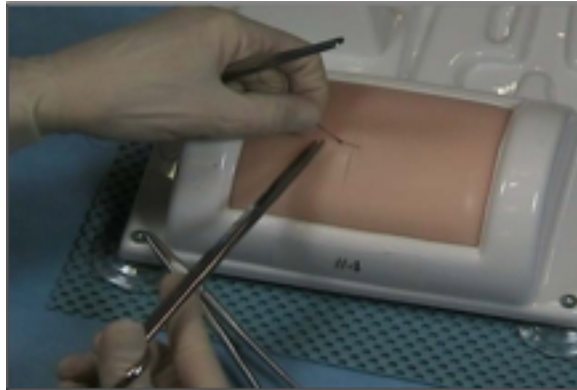
10. Grab the short end of the suture with the needle driver.



11. Lay the knot down flat by moving the needle driver to the right, and the long end of suture to the left.



12. This completes a square knot instrument tie.



Exercise – Two-handed knot tie, under tension

1. Start with strings crossed, darker string crossed over top of lighter string.



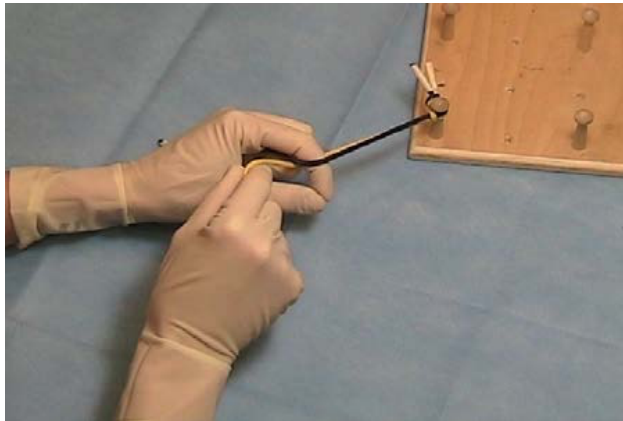
2. Hold darker string over top of index finger of left hand, with end of string stabilized by third finger onto left palm.



3. Hold lighter string in right hand. Make a loop of two strings by placing lighter string under tip of index finger.



4. Put tip of left thumb and index finger together.



5. Push thumb upwards, through the loop created by the two strings. ^[1]_{SEP}



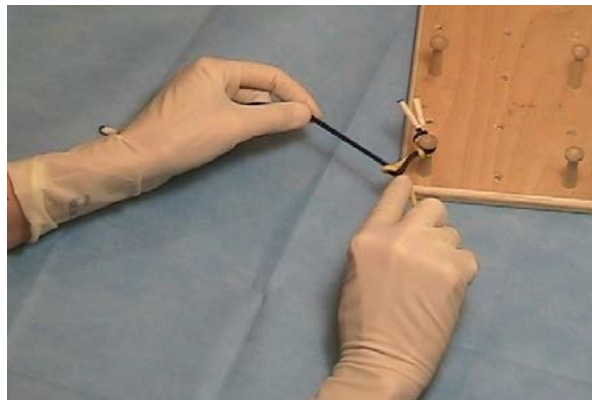
6. Put the end of lighter-colored loop between the tip of the index finger and thumb.



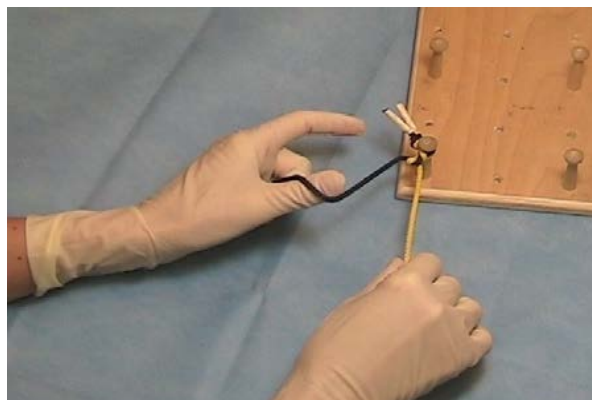
7. Push index finger back down, to deliver the end of the lighter-colored tie through the loop.



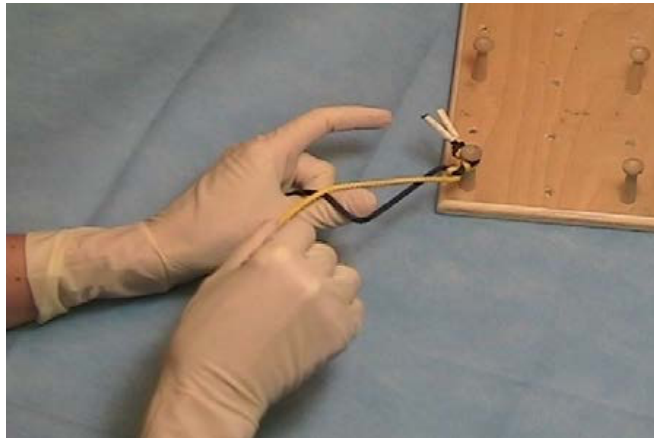
8. Lay the first knot down.



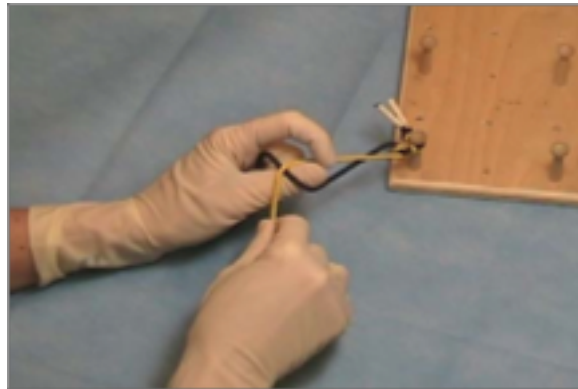
9. Put darker string over thumb.



10. Bring lighter-colored string under thumb.



11. Put the tip of the left thumb and index finger together.



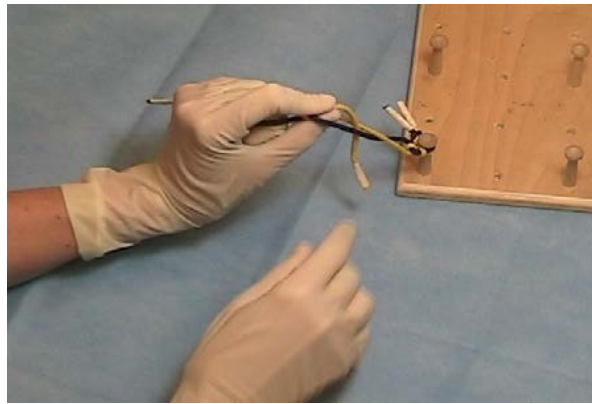
12. Push index finger down.



13. Put end of the lighter string between left thumb and index finger.



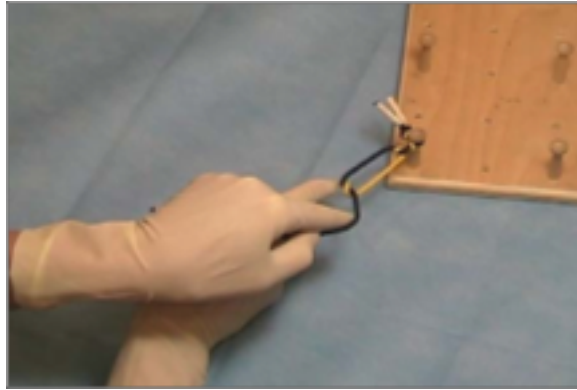
14. Push thumb up.



15. Grasp end of lighter-colored string.



16. Cross left hand over right to lay knot down flat.



Knot Tying OSAT ASSESSMENT

INSTRUCTIONS:

Place a knot (instrument tie; two-handed tie; one-handed tie) with 6 throws.

ITEM	Not done Or Incorrect	Done Correctly
1. Places square knots	0	1
2. 1 st throw down is square	0	1
3. 2 nd throw down is square	0	1
4. Maintains appropriate tension while tying	0	1
5. Maintains appropriate tension on knot	0	1
6. Conserves motion	0	1
7. Holds hands at an appropriate distance from the knot	0	1
8. Avoids air knots	0	1

Maximum Total Score

(8)

Total Score

Comments

Resident: _____

Date: _____ **Examiner:** _____