

Knot tying

Overview

Any description makes knot tying sound more difficult than it actually is. Do not be discouraged if you find it difficult at first - almost everybody does. The best way to develop a dependable technique for tying safe, reliable knots is repeated practice of the processes covered in this module.

You will learn how to tie a reef knot, surgeon's knot and Aberdeen knot, as well as how to tie at depth and in a confined space.

1 The Reef Knot

The standard knot used in routine surgery is the reef knot (sometimes called a square knot).

The reef knot is ideal for most purposes. It is symmetrical, lies flat and gets tighter when the ends are pulled.

An instrument tied reef knot is generally recommended when closing a skin wound with sutures. This allows you to control suture tension with great precision without wasting suture material.

The knot has two components - a direction of throw and a direction of pull. Both components must be changed as you make the knot. Otherwise you will form a granny knot which will slip.

A single reef knot is not sufficient. Build up at least three throws, each forming a reef knot with the one before. Five throws are enough, even for smooth monofilament which is springy and can be difficult to tie.

Although this method consumes more suture material, there will be occasions when you will need to tie your knot by hand to achieve the best result.

2 Instrument tied reef knot

An instrument tied reef knot is recommended when closing a skin wound with sutures, provided that the wound is not subjected to strong tension.

Using a needle-holder for tying allows you to place the sutures precisely and control the tightness of the knot.

2.1 Principles

Making your reef knot involves two stages. Each stage has two components - a direction of throw and a direction of pull. Both components must be changed as you make the knot.

After looping the suture end once forward around the needle holder, the jaws pick up the free suture end and the throw is pulled flat. The suture is then looped once around the needle holder in the opposite direction, and the direction of pull is also reversed to ensure that the whole knot lies flat when tightened.

2.2 Instrument tie on knot tying trainer

In this demonstration, the white end of the thread represents the free end of the suture and the red represents the end attached to the needle.

For the first throw, the red suture end is looped once forward around the needle holder. The needle holder then picks up the white suture end and brings it back through the loop. The hands pull apart to make the knot lie flat. This completes the first throw.

For the second throw, the red end is looped once around the needle holder in the opposite direction to the first throw, and the hands also pull apart in opposite directions.

For the third throw, again the direction of throw and pull are reversed.

The whole knot lies flat when tightened.

2.3 Assembling your knot tying kit

You will use the sucker feet from the skin pad jig as the anchor points for this kit, so remove them from the underside of it. Make sure that the sucker feet will be properly oriented and comfortably positioned in front of you before you secure them in place.

Lightly moisten the sucker feet and place them 12 to 13cm apart (measuring from the middle of each foot).

Attach the red knot tying band to the top of the sucker feet. Place the two-coloured knot tying cord under the knot tying band.

You are now ready to start practising.

2.4 Practise tying

Start by placing your practice thread under the knot trainer strings, with the white end furthest away from you. Hold the red end between your left thumb and index finger and hold your needle holder in your right hand.

Wrap the red thread over the needle holder and away from you to form a loop. Pick up the white end with the needle holder and bring it through the loop towards you, whilst simultaneously pushing the red thread in your left hand away from you. Pull your hands apart to tighten. This completes the first throw.

For the second throw, bring the red thread in your left hand back towards you and place the needle holder under it. Wrap the red thread around the needle holder in the opposite direction to last time, i.e. by bringing it towards you. Pick up the white end with the needle holder, take it through the loop and away from you, whilst simultaneously bringing the red thread in your left hand towards you. Pull your hands apart to tighten. This completes the second throw.

Make a third throw in exactly the same way as the first. Wrap the red thread over the needle holder and away from you to form a loop. Pick up the white end with the needle holder and bring it through the loop towards you, whilst simultaneously pushing the red thread in your left hand away from you. Pull your hands apart to tighten. Ensure that the whole knot lies flat when tightened.

3 The hand tied reef knot

Although this is more wasteful of suture material, a hand tied reef knot can be useful when you are tying under a lot of tension, for example when inserting sutures deep to the skin and when tying ligatures. It allows you to hold both suture strands under tension and to control slippage.

3.1 Principles

The knot is predominantly constructed with one hand, which forms a loop through which the free suture end is passed. The throws are made with the index finger and middle finger alternately. The other hand is used to hold the free suture end.

In this video we show the right hand forming the knots, but it is equally acceptable to use the left.

Just as with an instrument tied reef knot, in order to form a safe and correct knot you must change the direction of throw and pull at each stage.

If, as shown here, you throw the knot and pull the hands apart without crossing them over, the knot does not lie flat and is incorrect. To make it lie flat, your hands should cross over, so that they are diametrically opposite where they started, and then pull away from each other. The knot is now flat and correct.

However, when operating it is awkward and impractical to cross the hands and by doing so you will impede the view of the site you are working on.

For your first throw, a way to avoid this is to cross the threads before you begin. Now, when making the first throw, the hands can stay on the sides where they started and pull apart to make a flat, safe knot.

This method should only be used for the first throw.

For subsequent throws, however, you still want to avoid impeding the view of the operative site when

you cross your hands over. A compromise is still to alternate the position of your hands but just to move them at right angles rather than fully crossing them over. The resulting throws will be more or less flat and the finished knot will be safe because the first throw was correctly formed.

In our practice video we show the right hand forming the knots. Once you have mastered this technique, you may want to try using your left hand as this will allow you to keep hold of the needle holder in your right and improve suturing efficiency.

3.2 Practise

Place the practise thread under the knot trainer strings with the white end to the left, then cross the two ends over the top of the trainer strings so that the red end is on the left and the white on the right. This will avoid you having to cross your hands over when tightening the first throw.

Hold the white end between your right thumb and middle finger and the red end between your left thumb and index finger. Use your extended right index finger to push the white thread over and across the red thread, creating some tension. Take the tip of your right index finger down through the loop then bring it back towards you to hook the white thread around it. Rotate your finger tip to bring the white end back up through the loop and pull it through. Tighten the throw by pulling your hands apart, applying horizontal tension on both strands. This completes the first throw.

For the second throw, hold the white end between your right thumb and index finger and use your middle finger to make the throw.

To tighten, rotate your hands by 90 degrees so that you are pulling the left (red) thread towards you and the right (white) away from you.

In a surgical setting you would snug the throw down tightly with your finger, but to make it easy to unpick your knot and practise again we advise you to do this gently.

For the third throw, repeat what you did for the first. Holding the white end between your right thumb and middle finger, use your extended right index finger to make the throw.

To tighten, rotate your hands by 90 degrees in the opposite direction to the last throw, and pull the left (red) thread away from you and the right (white) thread towards you.

Snug the knot down with your finger to tighten.

4 The surgeon's knot

The surgeon's knot is a simple modification to the reef knot and is used to achieve extra security. It can be tied with an instrument, or by hand. We recommend it is always used when tying with an instrument, rather than a standard reef knot.

It is particularly useful when using synthetic monofilament sutures such as Prolene, which can be very springy due to their inherent memory. It is also useful where slippage could be a major issue, for example when tying a vessel at depth.

The knot may look cumbersome, but it is very secure.

4.1 Principles

With an instrument tie, the thread is looped twice around the needle holder for the first throw only. This adds friction which will give extra grip and prevent the knot from coming undone.

With a hand tied knot, the extra friction is achieved by making an additional twist in the first throw only.

When using monofilament sutures such as Prolene which are difficult to tie, many surgeons use more than two throws to avoid slippage. In this example, the surgeon uses three throws. Some surgeons even use a surgeon's knot for their final throw, rather than the first, to achieve the friction that they need.

4.2. Practise instrument tie

To practise an instrument tied Surgeon's knot, you won't need to use the whole length of your practice thread.

Start by placing the white end of your practice thread under the knot trainer strings, with the free end furthest away from you. Hold the long end of the thread between your left thumb and index finger, approximately 6 cm into the red section.

With your needle holder in your right hand, twist the thread in a forward direction twice around it so that a loop is formed. Pick up the free end of the suture with the needle holder and bring it back through the loop towards you, simultaneously pushing the long end in your left hand away from you. Pull until the knot lies flat on the trainer. Release the free end of the suture.

For the second throw, loop the thread round the needle holder once in a backward direction, i.e. towards you. Tighten by pushing the free end with the needle holder away from you and pulling the long end in your left hand towards you. Release the free end of the suture.

For the third throw, loop the thread once forward around the needle holder. Tighten by pulling the free end in the needle holder towards you and pushing the long end in your left hand away.

4.3. Practise hand tie

Place the practise thread under the knot trainer strings with the white end to the left, then cross the two ends over the top of the trainer strings so that the red end is on the left and the white on the

right. This will avoid you having to cross your hands over when tightening the first throw.

Hold the white end between your right thumb and middle finger and the red end between your left thumb and index finger. Using your extended right index finger push the white thread over and across the red thread. Take your right index finger down through the loop that has now formed and grasp the red thread. Rotate your index finger to loop the white thread round the red. Hold the loop open with your left thumb and index finger and take the white thread round the red a second time with your right index finger. Now pull the thread through and pull your hands apart to apply horizontal tension and tighten. This completes the first throw.

The second throw is made with your middle finger in exactly the same way as for a standard hand tied reef knot. There is no additional twist. To tighten, rotate your hands by 90 degrees so that you are pulling the left (red) thread towards you and the right (white) away from you.

The third throw is made with your index finger and tightened in the opposite direction to the second, by pulling the left (red thread) away from you and the right (white) thread towards you.

5 The Aberdeen knot

The Aberdeen knot is useful when, having finished a continuous suture, you are left with a loop and a free end. It is usually tied by hand. It has been found to be stronger and more secure than a surgeon's knot.

Although it is not feasible to practise this type of knot using your knot tying kit, you will have the opportunity to practise it on your skin pad when you reach the chapter on Continuous Sutures in the Suturing Techniques module.

5.1 Principles

When completing your last continuous suture, rather than pulling it all the way through a loop of suture should be left. The loop is then displayed between the index finger and thumb of one hand and the free end is held between the index finger and thumb of the other.

The free end is grasped through the loop and pulled so that a new loop forms. The new loop and the free end are pulled in opposite directions so that the old loop is flattened and eliminated.

This process is repeated up to a maximum of seven throws. Finally the free end is passed through the loop, tightened down and cut to complete your Aberdeen knot.

5.2. Practise

It is not feasible to practise this type of knot on your knot tying trainer, but you can practise it on your skin pad after completing a run of continuous sutures, when you will be left with a loop and the free

end of the suture.

Display the loop between your right index finger and thumb and hold the free end of the suture with your left index finger and thumb.

Use your right index finger and thumb to grasp the free end through the loop. Pull it through and form a new loop, keeping the free end in your left hand so that the old loop is flattened and eliminated.

Repeat this process until you have completed four throws. Finally pass the free end through the loop, tighten down and then cut the suture thread to complete your Aberdeen knot.

6 Tying at depth

There will be occasions when you will need to tie a knot at depth and in a confined space, for example when tying off a blood vessel deep in the pelvis. This is best achieved using a hand-tied knot. To practise this technique you will need to assemble the cylinder and hook that are part of the knot tying kit in your Hands-on Kit using the skin pad jig as your base.

- Moisten both sucker feet with a little water. Place the jig on the work surface and push down along the centre of it. Make sure the feet have stuck securely by trying to move the jig.
- Slide the base plate (with the magnet facing upwards) under the long sides of the skin pad jig.
- Insert the long edge of the top plate (with the hole) under the one edge of the skin pad jig.
- Gently push the other edge of the top plate into the skin pad jig so that it 'pops' under it and forms a convex shape with the hole at the apex.
- Curve round the long flat sheet and insert the tab through the double slits to start forming the depth tying cylinder. Hold this tab in place.
- Insert the other tab into the remaining slit.
- Push the cylinder into the hole in the top plate.
- Attach the magnetic hook to the base plate. The hook represents an object to be ligated.
- There are 2 strength levels for the magnetic hook:
 - for maximum 'strength', the hook attaches directly to the base plate. This represents tough tissue and is good for your first attempts at tying within a confined space: it takes quite a lot of force to separate the hook from the base.
 - for less 'strength' place the spacer (circular plastic disc) over the magnet on the base plate and then attach the magnetic hook. This represents more delicate tissue and the hook will come away from the base plate with little force. You will need to remove the cylinder from the top plate in order to put the spacer in.
- Now take the two coloured knot tying cord from the basic knot tying kit to represent your suture material. You are now ready to start practising!

Pass the suture material around the hook, either using artery forceps or your right index finger. Be careful not to exert any tension on the hook.

Bring the suture material out of the cavity, and make a standard reef knot throw on the surface. Again, try to avoid exerting any tension on the hook, as this will cause it to lift up from the base.

Snug the knot down into the cavity using your right index or middle finger, keeping tension on the strand in your left hand. Make sure there is no traction or pull on the structure being ligated.

Tie a further throw outside the cavity. Push it into the cavity and snug it down, again using your right index or middle finger. Tighten it by counter traction against the finger.

Tie a third throw for security and snug it down into the cavity.

7 Things to avoid

7.1. Granny knot

As well as knowing how to tie a reliable knot, it is equally important to be able to recognize and avoid unreliable knots. A granny knot is asymmetrical and insecure. It becomes twisted as it is tightened. This increases the risk of the suture material breaking when tying the knot, particularly when using monofilament sutures.

A granny knot is caused by failing to change the direction of throw in the second stage. In this example, the thread is looped forward around the needle holder for both the first and second throw.

7.2. Slip knot

Never use a slip knot for suturing. It is dangerously insecure and will tend to come undone on its own. A slip knot is caused by failing to change the direction of pull in the second stage in spite of correctly changing the direction of throw.

7.3 Insufficient throws

A single reef knot is never sufficient when you are suturing. Build up several throws, each forming a reef knot with the one before. The minimum is three throws, and more are required for springy sutures like monofilament. Five throws are usually enough.

7.4 First throw coming undone

Monofilament synthetic sutures are springy and can be difficult to tie. The first throw tends to come undone. To avoid this problem, use a surgeon's knot, with an extra twist in the first throw, rather than a standard reef knot.

An alternative is to try 'tweaking' the throw. Pull firmly on the suture end in your non-dominant hand

while giving a sharp tug towards it with your dominant hand. This secures the knot temporarily while you make the second throw.

7.5 Damaging the suture

The simple structure of monofilament sutures means they must be handled very carefully to avoid damage and weakening of the strand. When tying with an instrument, only the ends of the sutures should be handled with your instrument.