7 Arthroscopic knot-tying techniques

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Introduction

One of the most important advances in the last two decades has been the development of devices that allow sutures to be passed and retrieved within joints. These devices have allowed arthroscopists to 'sew' within joints, and the need to tie knots arthroscopically has naturally followed.

Initially, knots used in open procedures such as the square knot were tried for arthroscopic applications. It became clear that these knots were not well suited to arthroscopic applications as it was very difficult to maintain tissue approximation tension when tying these knots arthroscopically. The search therefore began for knots that better lent themselves to arthroscopic techniques. Slip knots were found to be easily tied and to provide good tissue approximation tension, but they tended to loosen easily. Attention then turned to attempts to somehow 'lock' the slip knot so that it would not loosen so easily. Loutzenheiser et al[1] showed that the most effective way to secure a sliding arthroscopic knot was through a series of alternating post half-hitches applied after the sliding knot had been seated. The Duncan loop backed with alternating post half-hitches was shown to be the most secure arthroscopic knot of several tested in Loutzenheiser's paper and consequently has come to be one of the most commonly used arthroscopic knots. Several variations on the theme of placing locking knots behind a slip knot have since been described in search of a knot with the ideal qualities of ease of tying, tightness of tissue hold, and resistance to loosening.

Recently, attention has turned to 'locking' slip knots. 'Locking' slip knots are passed as slip knots, then the configuration of the knot is purposely changed once the knot is seated in order to convert the knot to a non-sliding configuration. This prevents the knot from loosening. Theoretically, this approach provides good tissue loop tension and knot security (resistance to loosening) with a small knot that can be rapidly tied. As discussed in greater detail below, locking slip knots do fulfill these objectives, but tying them can be difficult.

The development of arthroscopic implants has also influenced the evolution of arthroscopic knot tying. For example, as suture anchors have become more effective and easy to use, arthroscopists have been able to attempt more complicated procedures. With the advent of more complicated arthroscopic procedures, the need for and relevance on arthroscopic knot-tying skills has increased. Conversely, arthroscopic knot tying has also influenced the design of arthroscopic instrumentation. As manufacturers have recognized that arthroscopic knot tying may not be a skill that all arthroscopists can master, devices have been devised to eliminate the need for knot tying. These devices have to date fallen into two categories: knot substitute devices such as the Y-Knot (Innovasive, Malborough, MA, USA) and knot elimination devices such as 'knotless suture anchors' (Mitek, Norwood, MA, USA; Arthrex, Naples, FL, USA and others). Knot substitute devices eliminate the need to tie knots when the surgeon places standard sutures, and knot elimination devices change the techniques of reconstruction such that no free suture ends need to be tied.[2]

Arthroscopic knot tying is indicated when there is a need to secure a suture repair intra-articularly and the arthroscopist has the technical expertise to tie a secure arthroscopic knot for fixation of that repair. Although knot-substitute devices or knotless suture anchors are available, it would be unwise to undertake a procedure known to require securing of suture intra-articularly if the surgeon does not have the technical expertise to tie knots arthroscopically as a back-up. Knot-substitute devices or knotless anchors are useful adjuncts to arthroscopic knot tying, not substitutes for the ability to tie arthroscopic knots.[3]

Surgical principles

Arthroscopic knot tying is significantly more complex than open knot tying. Rather than simply memorizing knot configurations, a significant part of successfully tying knots arthroscopically is appropriate suture management.[4] It is critically important that the arthroscopist understand the path of the sutures within the tissues being approximated, within the joint, and within the cannulas. This understanding is a prerequisite to tying and passing knots without tangling the sutures with each other, getting the sutures stuck in soft tissue, or breaking the sutures while tying. Paradoxically, most published information on arthroscopic knot tying focuses on the configuration of specific knots rather than the important issue of suture handling. Focusing on the fine points of arthroscopic knot configuration is analogous to debating the most efficient way to pack bundles of money into duffel bags and overlooking the issue of how you're going to get the bags into the bank vault. Certainly there is merit in finding the most effective arthroscopic knots, but the literature largely overlooks the issue that presents the greatest challenge to the vast majority of arthroscopists—avoiding problems that can preclude a knot of *any* configuration from being tied.

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Surgical technique

In order to facilitate a more practical understanding of arthroscopic knot tying, we will consider the surgical technique as four distinct processes: preparation for arthroscopic knot tying; selection of the right arthroscopic knot; suture handling for arthroscopic knot tying; and configurations of specific arthroscopic knots.

Prior to developing the topic of arthroscopic knot tying, some knot terms should be clarified. The two free ends of any given suture are referred to as 'limbs'. A knot is made up of a series of loops passed around the 'post' limb. The limb that is not currently acting as the post is by default the 'non-post'. The post is not always the same limb and, in fact, it can be changed with every throw if desired—it is simply the limb the loops are being thrown around.

Preparation for knot tying

The basic foundation of learning to tie knots arthroscopically is practicing the techniques and knots involved. Materials for practice are inexpensive and readily available: a short segment of cord is really all that is needed to get started. When the surgeon is ready to progress on to tying with suture, the appropriate suture material, a knot pusher, and a cannula are needed. Either a commercially available or a makeshift knot-tying board is also required. The process of learning can be greatly accelerated by attending a teaching course that includes specific instruction in arthroscopic knot tying. Learning in a controlled environment with capable surgeons at hand to demonstrate the fine points is far more productive than on-the-job or at home trial and error learning. (Arthroscopic teaching courses are offered regularly in the United States by the Arthroscopy Association of North America (www.aana.org).)

Prior to tying knots arthroscopically in the operating room setting, it is critical to ensure that the necessary equipment and sutures are available. Being half way through an arthroscopic procedure and realizing that you don't have the piece of equipment you need to throw the knot is a very lonely feeling. Table 7.1 provides a general listing of the items needed.

What knot pusher is the best?

The answer is that it depends on what you're doing. In general, knot pushers are used for three purposes: (1) to check for suture twisting prior to knot tying; (2) to tie sliding knots; and (3) to tie non-sliding knots.

When checking for suture twisting prior to knot tying, a two-hole knot pusher is definitely the most reliable and easy to use.[5] There is no way for a suture twist to hide in the cannula when a two-hole knot pusher is used, whereas twists can occasionally remain undetected with a single-hole pusher. Any twisting detected can also be easily corrected with a two-hole pusher by simply rotating the pusher to untwist the suture under arthroscopic visualization. Once the suture has been untwisted, the two-hole pusher is withdrawn from the cannula without further rotation and the suture limbs are laid to the appropriate side of the cannula in their new, untwisted configuration. With regard to knot tying, two-hole pushers can be used to tie sliding knots but the increased bulk of the two-hole pusher is unnecessary and gives no advantage over the easier-to-use single-hole pusher. Using a two-hole knot pusher to tie non-sliding knots has been described, but there is no way to maintain tension on the tissue loop while subsequent throws are placed. This generally results in a loose and less effective knot. As a result, use of two-hole knot pushers to pass knots has now largely been abandoned.

For tying sliding knots, a single-hole knot pusher is the most commonly used and least complicated pusher. The single-hole design is relatively effective in checking for suture twists and allows easy passage of knots through cannulas and application of tension to seated knots. A modified one-hole knot pusher (Surgeon's 6th Finger, Arthrex) can also be used to check for suture twisting, pass knots through cannulas, and apply tension to seated knots. However, the modified one-hole pusher

Table 7.1 Arthroscopic knot-tying equipment

Quantity	*Description*	*Notes*
1 or more	Water-tight cannula(s)	Transparent cannulas are helpful[3,4] as are cannulas with differing inner diameters
1	Suture retriever	Suture graspers Crochet hook
1 or more	Knot pusher(s)	(see discussion in text)
N/A	Suture	27" for single or double-hole pusher 36" for modified one-hole pusher

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Table 7.2 A comparison of knot pusher types

Style	*Ease of detecting twisting*	*Usefulness for sliding knots*	*Usefulness for non-sliding*	*Cost*
One-hole	+/–	+	Don't use	One-time cost
Modified one-hole	+/–	+/–	+	Per-use charge
Two-hole	+	–	Don't use	One-time cost

is a bit bulkier than the standard one-hole pusher, requires use of a longer suture than the standard one-hole pusher, is associated with a per-use patient charge since it is disposable, and requires a certain technical expertise for proper use that can slow the inexperienced user. Proponents of the modified one-hole pusher cite greater 'loop security' than that obtained by a standard one-hole pusher by virtue of the pusher's ability to maintain tension in the initial knot loop while subsequent throws are placed.[6]

As discussed below, non-sliding arthroscopic knots are typically tied out of desperation rather than design. If one is forced to tie a non-sliding knot, the modified one-hole knot pusher is really the only good option since it is the only knot-tying device that can hold tension on the initial knot loop while subsequent throws are placed. Use of any other style of knot pusher relies on the friction of the suture against itself to hold the initial throw tight while another knot is thrown to secure the initial knot. This rarely results in a 'non-sliding' knot with satisfactory tissue loop tension.

To summarize, a one-hole knot pusher is the most commonly available and easiest pusher to use, a modified one-hole knot pusher should be available in case of the unexpected need to tie a non-sliding knot due to suture binding, and a two-hole knot pusher is the most effective when checking for suture twisting (Table 7.2).

Selecting the right arthroscopic knot

The basic objectives of tying an arthroscopic knot are to: (1) provide good tissue loop tension to approximate the desired tissues,[3,6] and (2) to maintain this tension as the tissues are loaded postoperatively.[3] The ideal knot is one that accomplishes these two objectives with the smallest bulk and greatest ease of tying.

Sliding versus non-sliding

Sliding knots inherently provide better tissue loop tension, but also inherently loosen more easily than non-sliding knots. As arthroscopic knot tying has evolved, it has proven easier to devise techniques to keep a sliding knot from loosening than to get good tissue loop tension from a non-sliding knot. Consequently, sliding knots are preferred to non-sliding knots for all arthroscopic knot tying.

Non-locking versus locking

Two fundamentally different approaches to the prevention of loosening have been developed for sliding knots: throwing additional loops on top of the sliding knot after it is seated, and changing the sliding knot into a non-sliding knot after it is seated.

As demonstrated by Loutzenheiser et al,[1] the addition of just a few simple suture throws on top of a sliding knot can be very effective in preventing loosening. This approach is both easy to accomplish from a technical standpoint and very reproducible or predictable. Because of these benefits, the Duncan loop knot backed by alternating post half-hitches has become the workhorse of arthroscopic knots. Securing other types of sliding knots with additional suture throws has been described,[7] and has been shown to be effective as well.[3]

An alternative method of preventing sliding knots from slipping is the locking sliding knot. A locking sliding knot is one whose configuration can be selectively changed by applying tension to the suture limbs in the appropriate sequence. Theoretically, this is accomplished after the knot has been seated and good tissue loop tension has been achieved. The problem with this approach however, is that the knot can be inadvertently locked at any point in the tying process. Locking a knot in the cannula is one thing on a knot-tying board and quite another thing after working for 10 or 20 minutes in the operating room to get an anchor properly placed, pass the suture through the correct location in the correct tissue, and get the suture limbs back through the cannula without tangling. Locking knots are very attractive in theory but can be very unforgiving in practice.

For the average arthroscopist, the best knot to learn is probably the Duncan loop backed by alternating post half-hitches in light of the Duncan loop's proven effectiveness, relative ease of tying, and predictability.

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Suture handling for arthroscopic knot tying

Tips and tricks: general

A good basic starting point when tying knots arthroscopically is to eliminate any distractions that may be present in the operating room.[4,8] Of course, a good view of the knot-tying field is also mandatory.[3,4,8,9] One should always check for twisting of the sutures prior to tying[4,10] (Figure 7.1) as a knot tied on twisted sutures will inevitably untwist after tying, thereby loosening the tissue loop.

It is a mistake to tie a sliding knot with a suture that does not slide freely.[4,10] At best, a knot with poor tissue loop tension results. At worst, the suture stops sliding altogether and the knot becomes firmly fixed about halfway down the cannula. If the knot does become stuck in the cannula you usually have to just cut the suture out and start over; such a knot can rarely be coaxed back up the cannula for untangling and retying. Which brings us to another important point—always have a back-up plan in case your arthroscopic knot tying is unsuccessful.[4,9,10]

Tips and tricks: the portals and cannulas

It is critical to ensure that both suture limbs being tied exit the joint through the same passage, with no soft-tissue bridge between the limbs. Clearly, it is not possible to seat a knot within the joint if a soft-tissue bridge blocks the knot's entry into the joint. Drawing the limbs to be tied through a cannula prior to tying ensures by default that there is no soft-tissue bridge.[4] Use of a cannula for tying also helps prevent interposition of stray soft tissue in the knot as it is seated. If the tip of the cannula is kept close to the area where the knot is to be seated the risk of soft tissue becoming entangled in the knot just prior to seating is minimized as well.[5] In effect, the less soft tissue the knot passes by the less likely the soft tissue is to become entangled in the knot.

Another approach that is very helpful is to use a third portal when tying knots arthroscopically.[4,9,10] Having a third portal allows the uninvolved sutures to be passed out of the joint clear of the tying process (Figure 7.2). This significantly reduces the likelihood of these other sutures becoming entangled within the knot. It is also generally easier to retrieve sutures from a third portal than from around the cannula in the tying portal, as is recommended by some authors (Figures 7.3 and 7.4).[11]

As discussed previously, an important part of successful arthroscopic knot tying is having an understanding of the suture's path within the tissues and cannulas. Having this understanding allows the surgeon to react appropriately and quickly when figuring out which limb to pull to tighten a knot, which limb to pull to draw the knot into the joint, and so on. One technique that is

Figure 7.1
Knot pusher advanced to knot, revealing twisting.

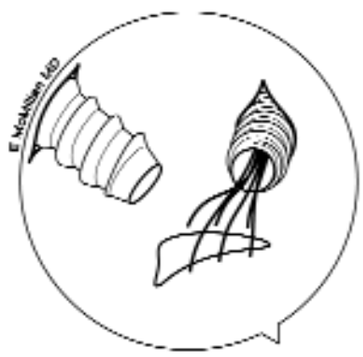

Figure 7.2
Uninvolved sutures passing out of accessory cannula, clear of the knot-tying process.

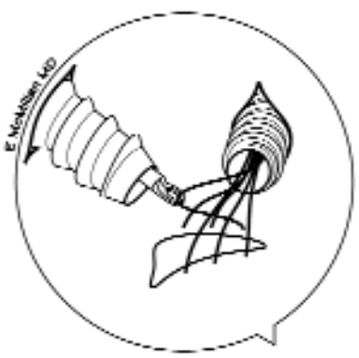

Figure 7.3
Suture being easily retrieved from accessory cannula.

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Figure 7.4

Suture binding at edge of cannula during retrieval when placed through tying portal adjacent to cannula.

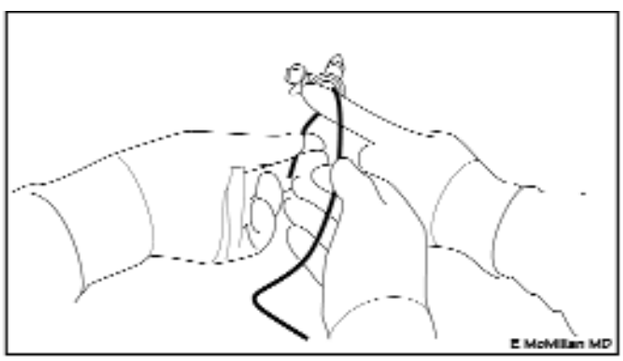

Figure 7.5

Assistant's finger placed between suture limb exiting cannula.

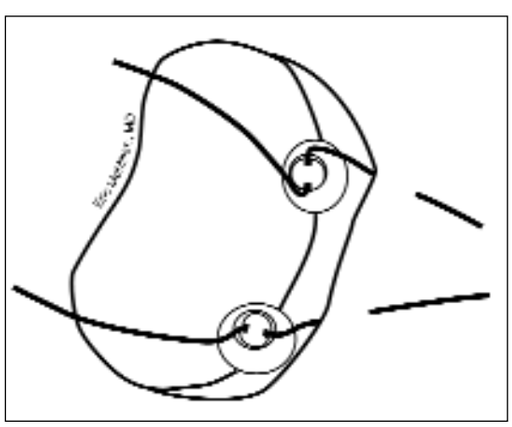

Figure 7.6

Top anchor has been placed such that suture must twist just to pass through desired tissue. Bottom anchor shows proper orientation to allow suture to slide freely.

very helpful in keeping the suture limb orientation straight is to classify the suture limbs in your own mind into two categories such as 'left' and 'right', 'anterior' and 'posterior', or similar. Once this informal classification has been assigned to the suture limbs, the limbs should be drawn out of the tying cannula without twisting and laid to the appropriate side of the cannula. In other words, the 'left' suture limb should be placed to the left side of the cannula, or the 'anterior' limb placed to the anterior side of the cannula and so on. Once the limbs have been separated in this fashion, the assistant or scrub nurse can place a finger between the limbs on top of the cannula (Figure 7.5).[4] This allows the surgeon to manipulate the suture limbs for knot tying while still maintaining the original orientation of the sutures within the cannula, thus preventing any suture twisting and maintaining a clear understanding as to which suture limb is the post. Knowing which suture limb is which and being able to access the desired suture limb without guessing will significantly speed and simplify your knot tying. Many surgeons also tag the post limb with a small hemostat in order to help themselves remember which limb is currently acting as the post.

Tips and tricks: the anchor

When using suture anchors, aligning the anchor such that the suture does not have to twist as it leaves the anchor will help ensure that the suture slides through the construct freely when it comes time to tie (Figure 7.6).[12] Also, be sure to avoid over-penetrating the anchor as sinking the anchor too far will introduce unwanted friction between the edge of the anchor hole and the suture. Above all, binding of the suture is to be avoided.

Tips and tricks: the suture—braided or monofilament?

Several factors deserve consideration when choosing a suture for arthroscopic knot tying—handling characteristics of the suture, initial strength of the suture, and changes in strength of the suture over time.

In terms of handling characteristics, monofilament sutures are generally easier to pass using currently available suturing instruments such as the Caspari Suture Punch (Linvatec, Largo, FL, USA) or the Spectrum Suturing System (Linvatec). Braided sutures tend to be easier to tie, and tend to loosen less than commonly used monofilament sutures.

If the surgeon prefers a non-absorbable suture but wants to use the Caspari suture punch or Spectrum Suturing System, two alternate methods are available: use of the Suture Shuttle Relay (Linvatec) or use of the Thal technique. The Suture Shuttle Relay is a twisted wire cable that is covered with plastic except at the center of its length where the wires can be separated. The Suture Shuttle is passed using the Caspari punch or Spectrum System, then once the Suture Shuttle has been removed

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Table 7.3 Suture strength as a function of time[3]

Suture	*Dissolve/non-dissolve*	*Mono/braided*	*Time (weeks)*	*Retained strength (%)*
Monocryl	Dissolving	Monofilament	3	0
PDS II	Dissolving	Monofilament	3	80
			6	40
Maxon	Dissolving	Monofilament	3	67
			6	9
Vicryl	Dissolving	Braided	3	<10
Panacryl	Dissolving	Braided	3	95
			6	90
			12	80
Ethibond	Non-dissolving	Braided	3	100
			6	100

Monocryl, PDS II, Vicryl, Panacryl, and Ethibond are products of Ethicon, Inc (Somerville, NJ, USA). Maxon is a product of the United States Surgical Corporation (Atlanta, GA, USA).

from the suturing device a braided suture is placed between the wire strands in the center of the Shuttle Relay. The braided suture is drawn through the desired tissue by pulling the Shuttle Relay in the appropriate direction, thereby passing the braided suture retrograde through the tissues. A more gentle pull will limit the braided suture from stripping the plastic coating.

The other technique for passing braided suture using the Caspari punch or the Spectrum Suturing System is the Thal technique (R. Caspari, personal communication). A 2-0 or 3-0 monofilament suture is folded in half and the two free ends fed into the Caspari punch. The two free ends feed roughly the same as a single larger monofilament in most cases. Once the doubled monofilament suture has been placed through the desired tissues and retrieved from a cannula a braided suture is passed through the loop at the end of the doubled monofilament suture and drawn down into the joint and through the desired tissue by pulling on the free ends of the doubled monofilament suture. Alternatively, a suture punch specifically designed to accommodate braided suture (Arthrotek, Warsaw, IN, USA) can be used.

With regard to the strength of various sutures, non-dissolving braided sutures such as Ethibond (Ethicon, Mitek) tend to have higher failure strength than monofilament dissolving sutures such as PDS II (Ethicon).

As expected, dissolving and non-dissolving sutures vary significantly in their strength as time passes (Table 7.3).

Based on these data, it would seem prudent to use either Panacryl or Ethibond in an application where the suture was expected to be under greater tension (e.g. rotator cuff repair under tension) and in other circumstances the suture of the surgeon's choice.

With sliding knots, a significant disparity in the length of the limbs can result after the knot is seated if the limbs are not adjusted properly prior to tying. This length disparity can make it very difficult to continue the knot tying process and in extreme cases can even leave the surgeon with only one very long suture limb protruding from the cannula. Without access to both limbs, additional loops can not be thrown to back up a non-locking sliding knot and a locking sliding knot cannot be locked. For a sliding knot, leaving the non-post limb protruding about half the overall suture length farther than the post limb from the cannula provides limbs of roughly equal length once the initial sliding knot is seated (Figure 7.7).[4] For non-sliding knots, the post and non-post limbs should be about equal.

Tips and tricks: the knot pusher

With sliding knots, the knot pusher should be placed on the post limb only when seating the initial knot. This initial knot should be 'pushed' into place, keeping tension on the post in order to fully seat the knot and prevent its loosening once seated. Subsequently, the knot pusher is best placed on the non-post limb in order to 'pull' additional throws down onto the initial sliding knot. With non-sliding knots, the knot pusher should be placed onto the non-post limb for all throws.

When choosing the limb that will act as the post, choose the limb that passes through the tissue in the most out-of-the-way location.[11,12] For example, when securing a Bankart repair using a glenoid suture anchor, make the suture limb farthest away from the glenoid the post. This will tuck the knot out of the way and minimize the chance of knot interference with joint function after the repair is completed.

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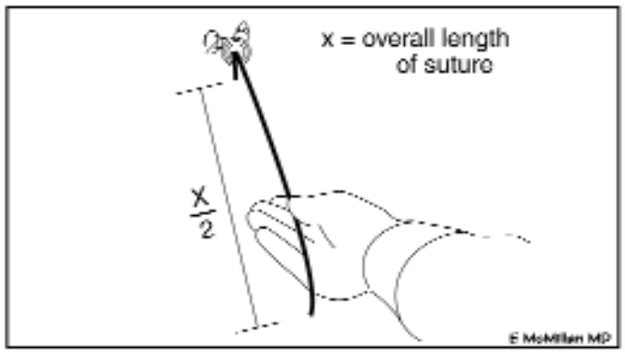

Figure 7.7
Non-post limb adjusted so it extends about half of overall suture length farther than post limb from cannula.

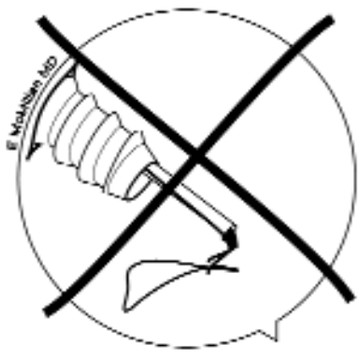

Figure 7.9
Knot pusher advanced obliquely, pulling suture.

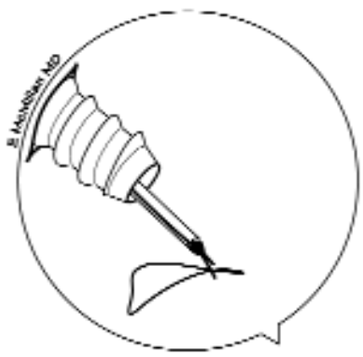

Figure 7.8
Knot pusher advanced directly toward knot.

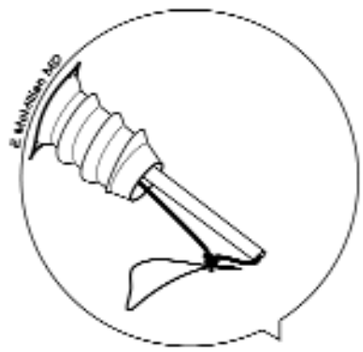

Figure 7.10
Past-pointing with the knot pusher to tighten the knot.

Even with the knot pusher correctly in place, it can be difficult to advance knots down the cannula and into the joint. The easiest way to facilitate advancement of knots is to gently alternate tension on the two limbs of suture in your hands.[4,5,10] Note that this technique should not be used on the throw immediately after the initial knot of a sliding knot because pulling on the non-post limb will usually loosen the initial suture loop. Advancing the pusher directly toward the knot (or the desired position of the knot if it is not already seated) relieves tension on the post limb and allows for easier passage of the knot (Figures 7.8 and 7.9).[4,5]

It is important to seat each knot fully under arthroscopic visualization prior to passing subsequent throws,[4,10,13] as the knot pusher can be inadvertently passed through the knot within the cannula. If the knot is left loose within the cannula and another knot is passed down, the two knots usually engage and lock. This can make for a long afternoon in the OR. Once a throw is seated, the knot pusher should be used to 'past-point' to gain additional tightness within the knot (Figure 7.10).[4,5,10,13] This is analogous to past-pointing commonly employed in open knot tying.

When holding the two suture limbs for knot tying, one easy technique to gain an 'extra' helping finger is to hold the two suture limbs slightly separated between the left thumb and middle finger. This leaves the left index finger free to help pass the non-post limb as it is thrown around the post to construct whatever knot is planned (Figure 7.11).

Arthroscopic knots

Sliding/non-locking

The Duncan loop (Figures 7.12–7.24) backed with alternating post half-hitches is a good basic sliding knot that is relatively easy to tie and provides good holding

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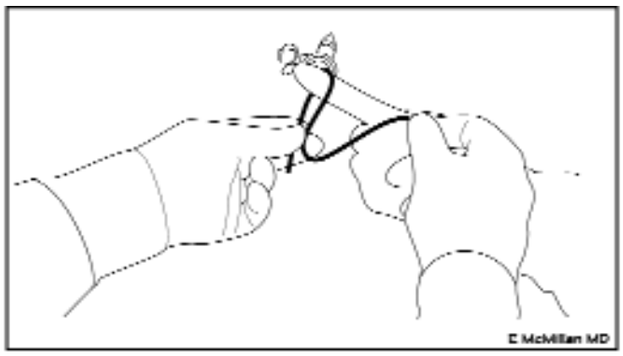

Figure 7.11
Suture being held between left thumb and middle finger, leaving the index finger free to help with knot tying.

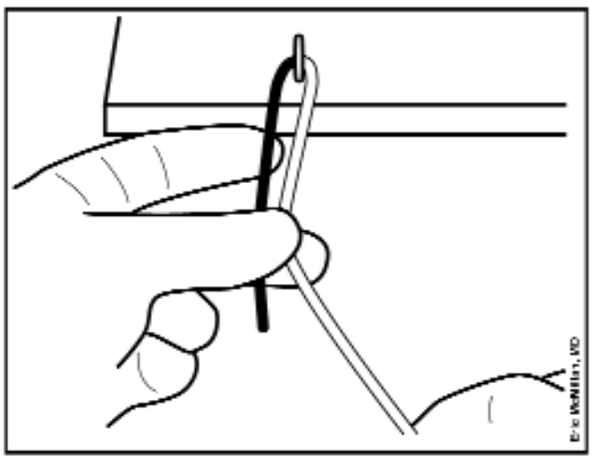

Figure 7.12
Adjust the suture limbs for a sliding knot and hold both limbs between the left thumb and middle finger.

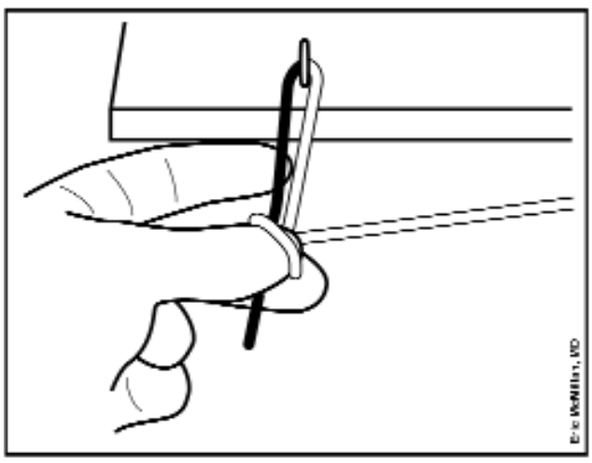

Figure 7.13
Throw an overhand loop over the tip of your thumb and subsequently over the post.

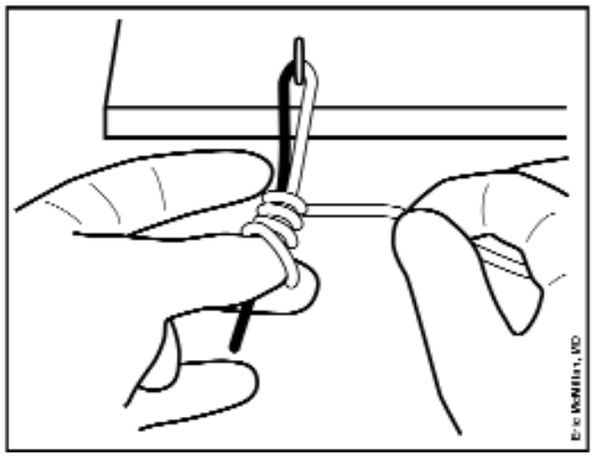

Figure 7.14
Throw three overhand loops on the post.

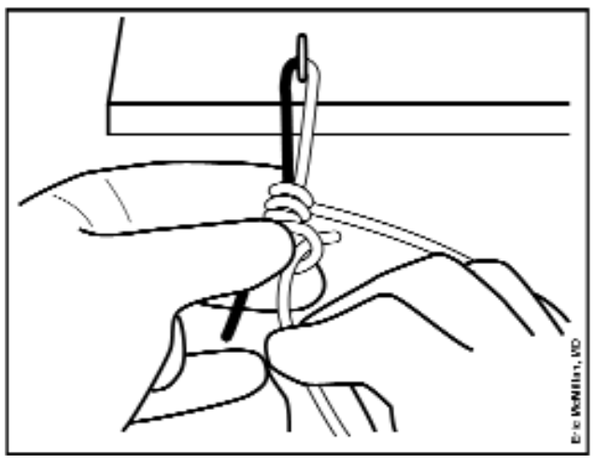

Figure 7.15
Move the loop that was over your thumb tip down and pass the end of the non-post limb through the loop in a downward direction.

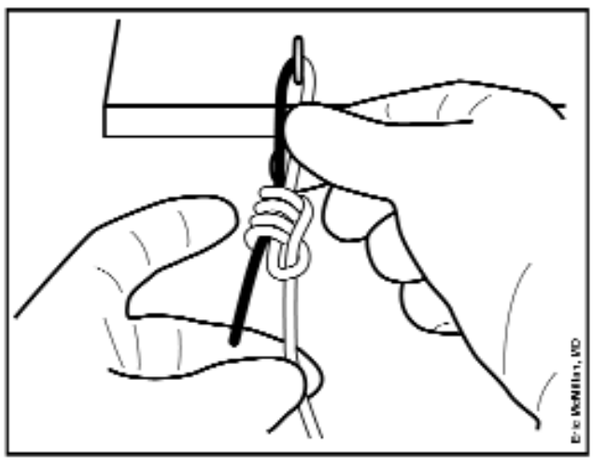

Figure 7.16
Apply tension to both ends of the non-post limb to snug the knot.

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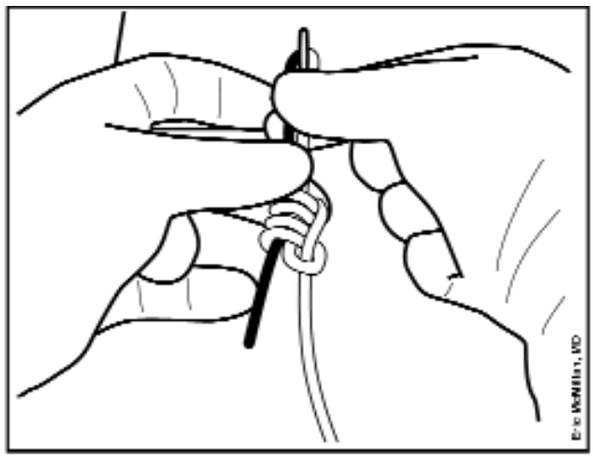

Figure 7.17

Hold both limbs with the right thumb and index finger, and apply a pull to the knot with the left thumb and middle finger to compact the knot. Use caution not to overtighten.

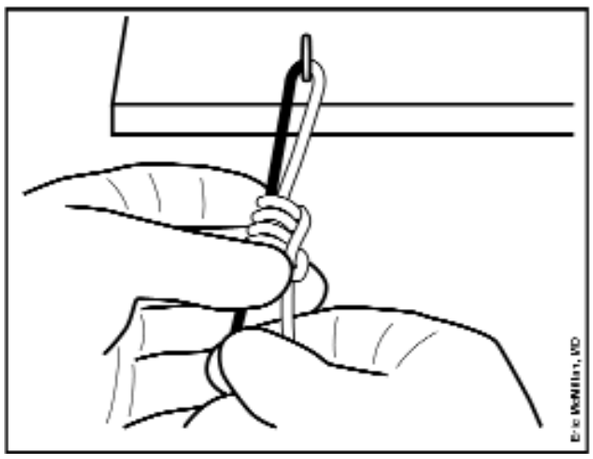

Figure 7.18

Apply a push to the knot to further compact it. Seat the knot by applying tension to the post and/or pushing the knot into the joint with a knot pusher on the post limb.

strength.[1] The only significant drawback to this knot is its relatively large size compared to other arthroscopic knots.

The Tennessee slider (Bunt-line hitch)[7] (Figures 7.25–7.29) is a knot that is easy to tie and has a comparatively low bulk. The Tennessee slider also has good holding strength.[3]

Sliding/locking

The tautline (or Midshipman's) hitch (Figures 7.30–7.37) is one of the more forgiving of the locking sliding knots.

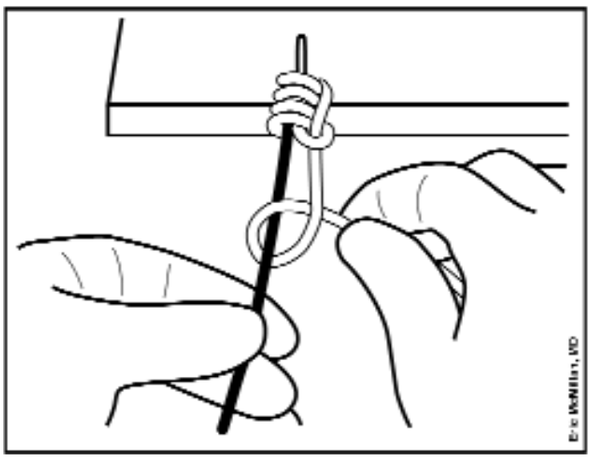

Figure 7.19

Throw an underhand loop on the post limb.

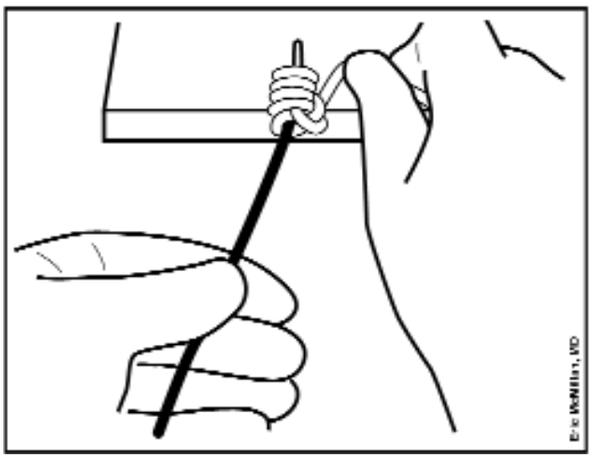

Figure 7.20

Pull the underhand loop down onto the knot and past-point to tighten. When using suture, the knot pusher should be on the non-post limb.

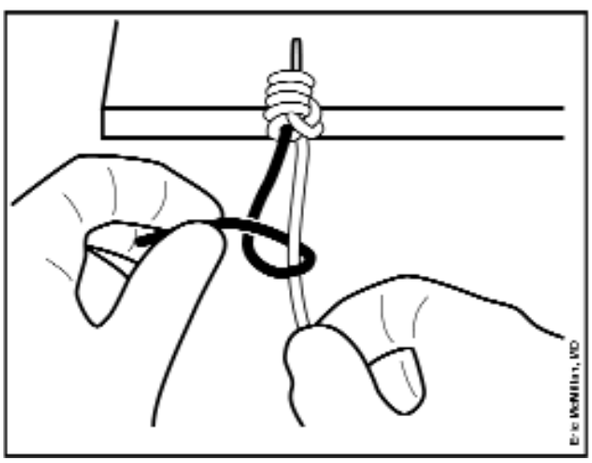

Figure 7.21

Switch posts and throw an overhand loop on the new post.

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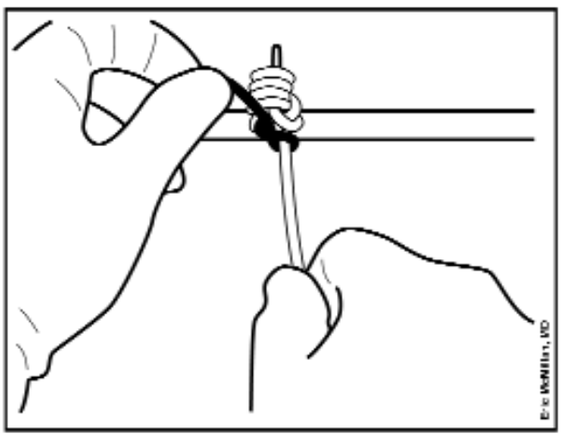

Figure 7.22
Pull the overhand loop down onto the knot and past-point to tighten.

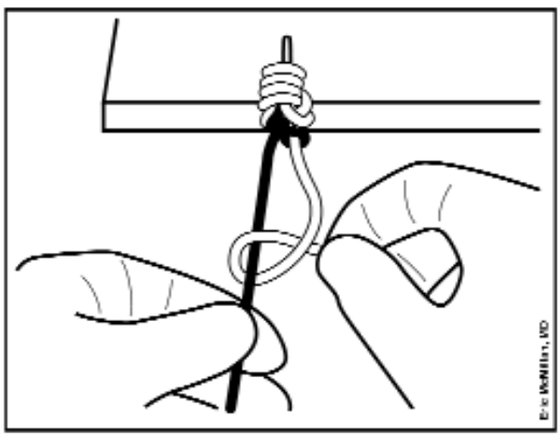

Figure 7.23
Switch posts again and throw an underhand loop on the new post.

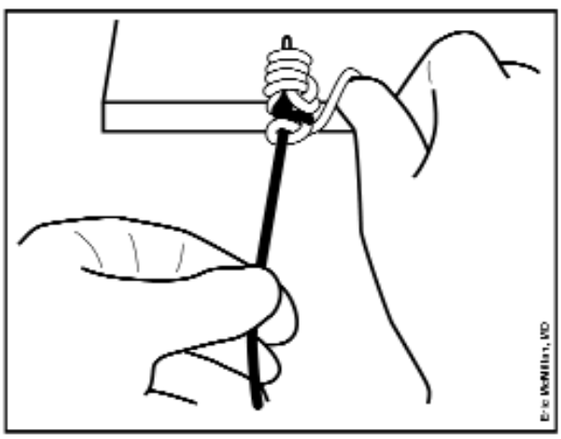

Figure 7.24
Pull the underhand loop down onto the knot and past-point to finish the knot.

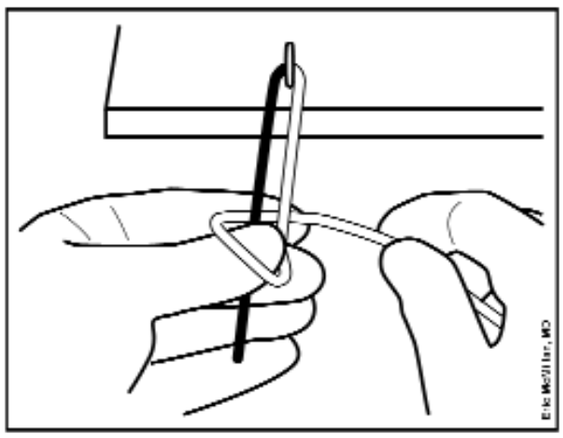

Figure 7.25
Adjust the suture limbs for a sliding knot and hold both limbs between the left thumb and middle finger. Throw an overhand loop over both limbs.

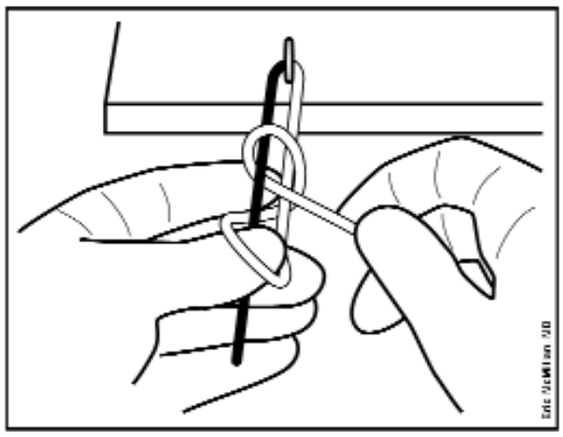

Figure 7.26
Throw an overhand loop on the post and pass the non-post suture back through the knot, as shown.

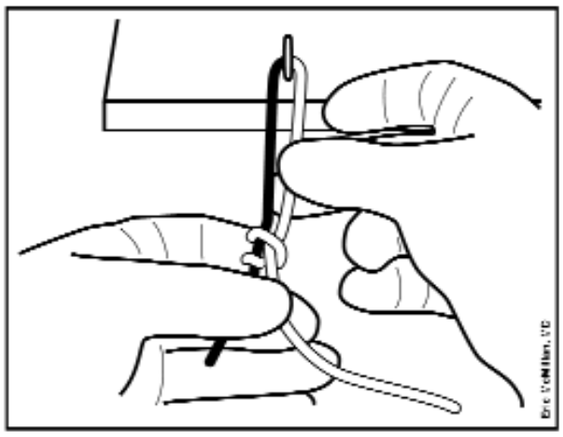

Figure 7.27
Apply tension to both ends of the non-post limb to snug the knot. Seat the knot by applying tension to the post and/or pushing the knot into the joint with a knot pusher on the post limb.

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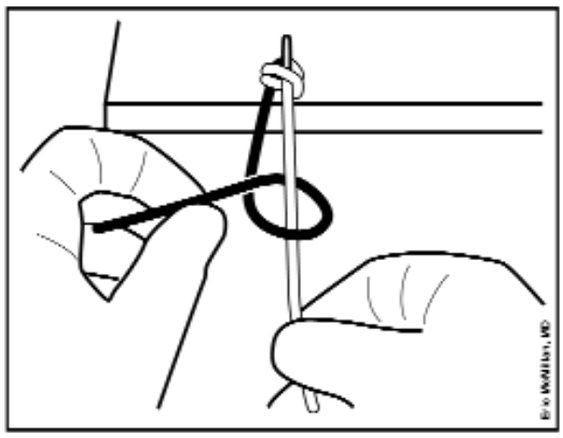

Figure 7.28
Switch posts and throw an overhand loop on the new post. Pull the loop down and past-point to tighten.

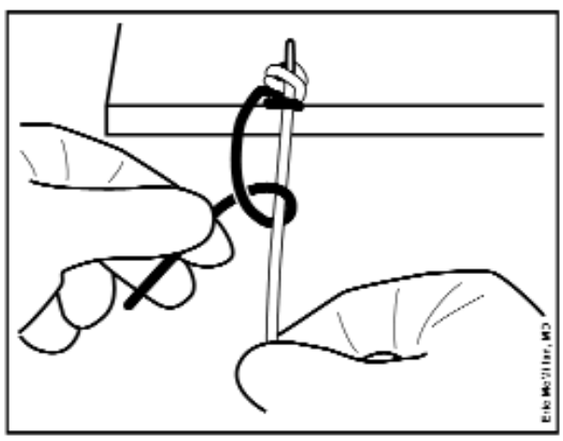

Figure 7.29
Switch posts and throw an underhand loop on the new post. Pull the loop down and past-point to tighten.

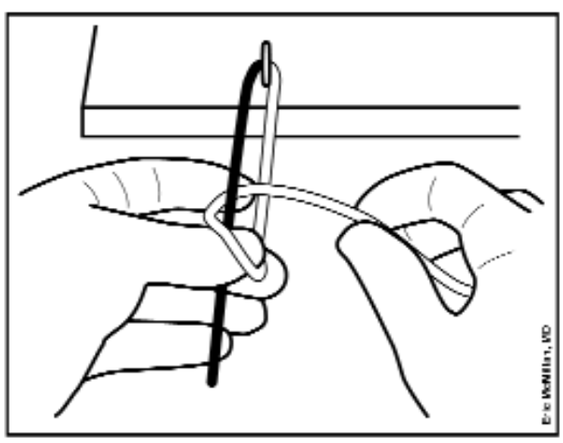

Figure 7.30
Adjust the suture limbs for a sliding knot and hold both limbs between the left thumb and middle finger. Throw an overhand loop on the post.

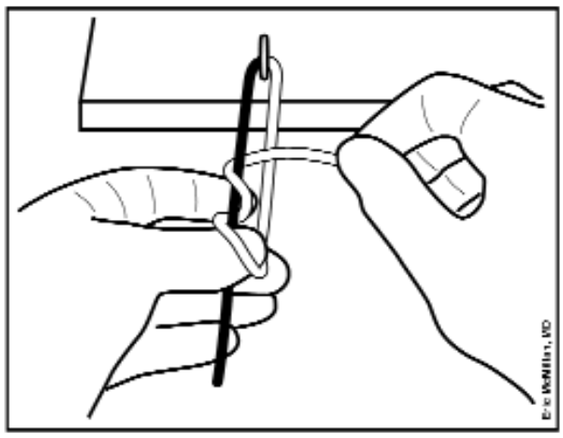

Figure 7.31
Throw another overhand loop on the post.

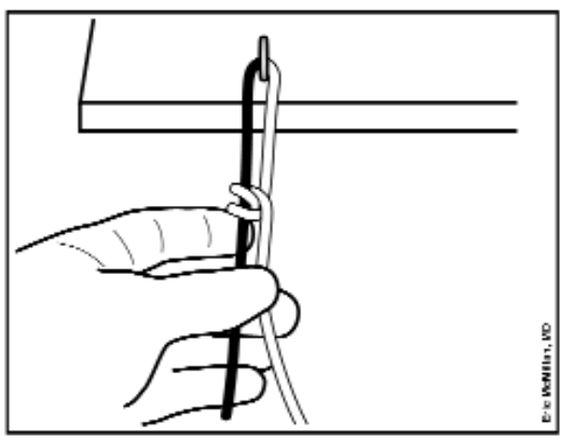

Figure 7.32
Slide your left thumb and middle finger down so that the original loops are held under slight tension.

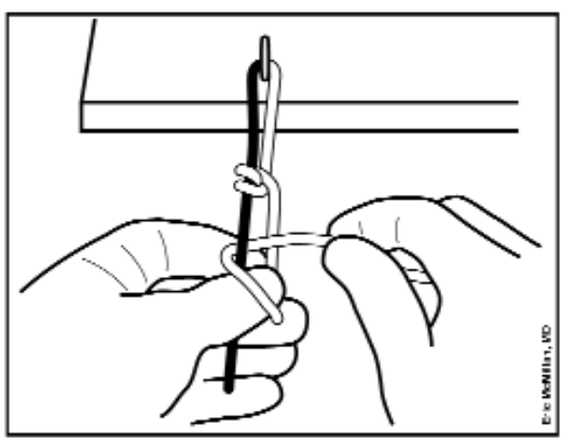

Figure 7.33
Throw an overhand loop on the post in this new position.

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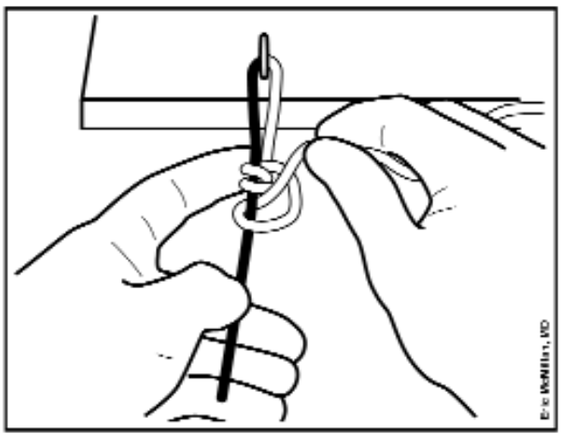

Figure 7.34
Pull the loop down to snug the knot.

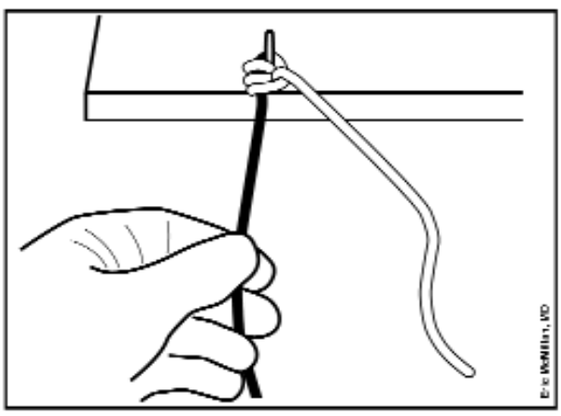

Figure 7.35
Seat the knot by applying tension to the post and/or pushing the knot into the joint with a knot pusher on the post limb.

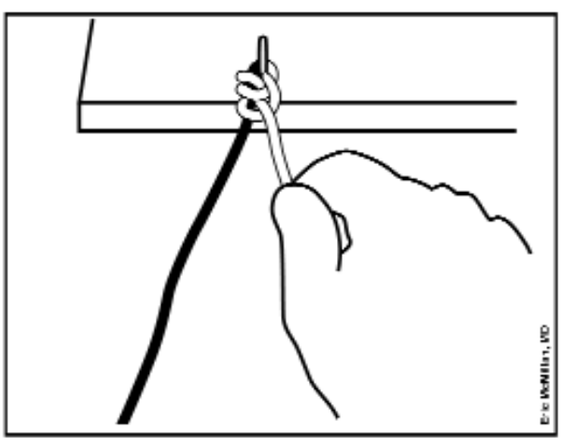

Figure 7.36
Release the post limb and grasp the non-post limb with your right thumb and index finger.

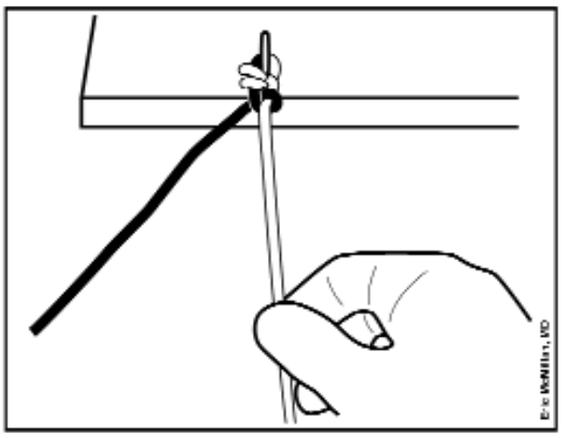

Figure 7.37
Change the knot to a non-sliding configuration by pulling on the non-post limb to finish the knot.

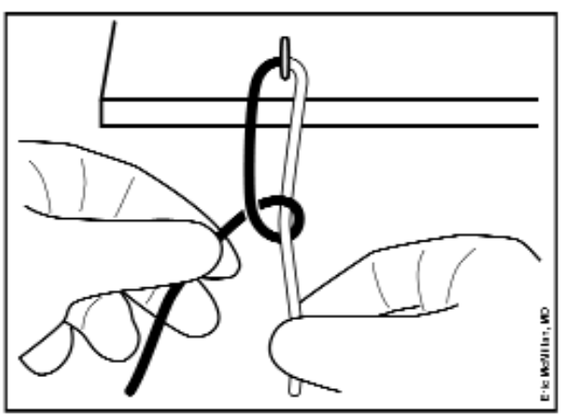

Figure 7.38
Adjust the limbs for a non-sliding knot and throw an underhand loop on the post. Pull the loop down to form the beginning of the knot and past-point to tighten.

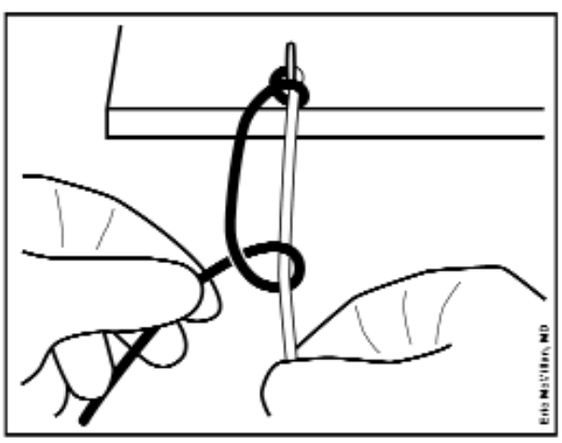

Figure 7.39
Throw another underhand loop on the post. Pull the loop down and past-point to tighten.

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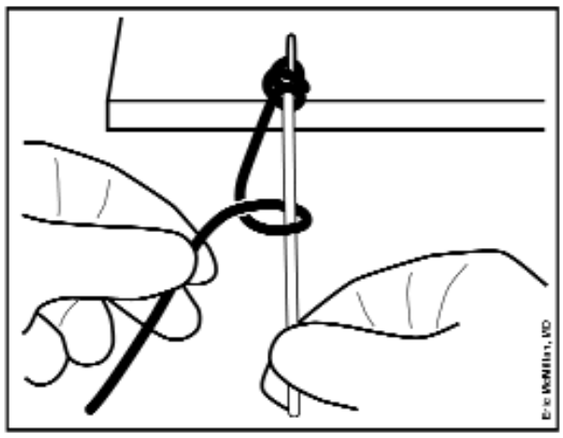

Figure 7.40

Throw an overhand loop on the post. Pull the loop down and past-point to tighten.

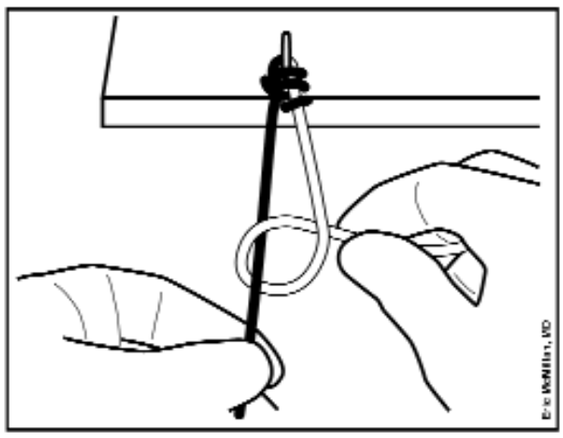

Figure 7.41

Switch posts and throw an underhand loop on the new post. Pull the loop down and past-point to tighten.

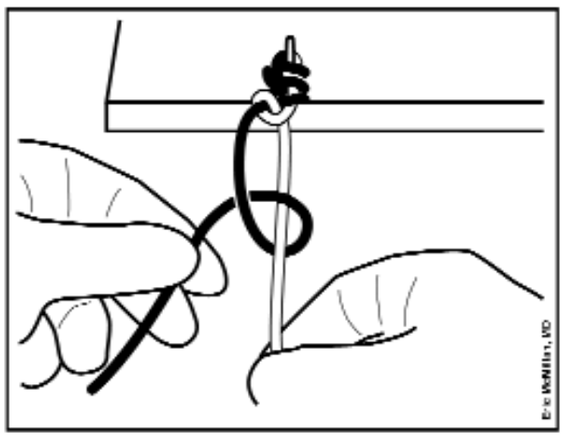

Figure 7.42

Switch posts again and throw an underhand loop on the new post. Pull the loop down and past-point to finish the knot.

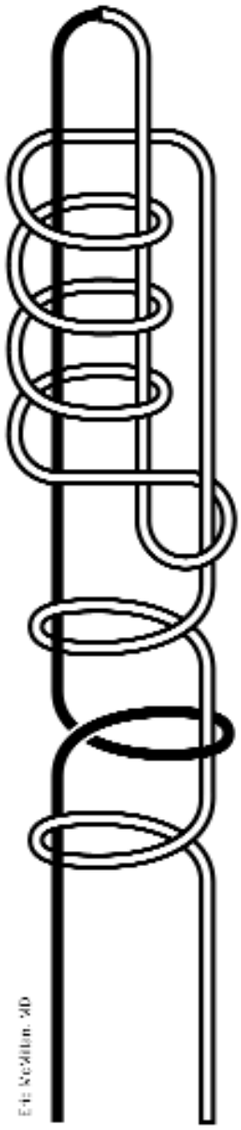

Figure 7.43

The Duncan loop knot backed with alternating post half-hitches—a non-locking sliding knot.

Figure 7.44

The Tennessee slider knot[7]—a non-locking sliding knot.

It has a small bulk and good holding strength empirically.

Non-sliding

The Revo knot (Figures 7.38–7.42) is a good choice when the need to tie a non-sliding knot arises. It is relatively easy to tie and has been shown to be very secure.[3]

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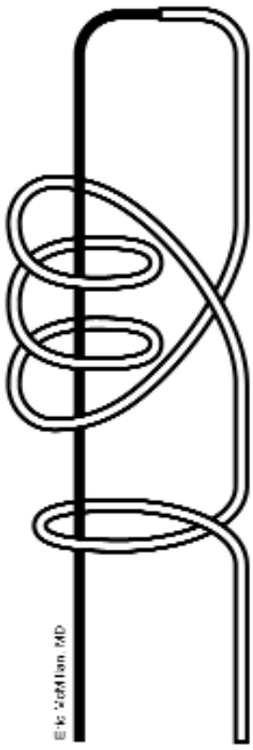

Figure 7.45
The Tautline (or Midshipman's[14]) Hitch knot—a locking sliding knot.

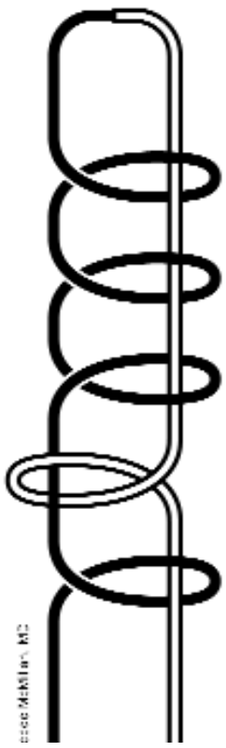

Figure 7.46
The Revo knot[7]—a non-sliding knot.

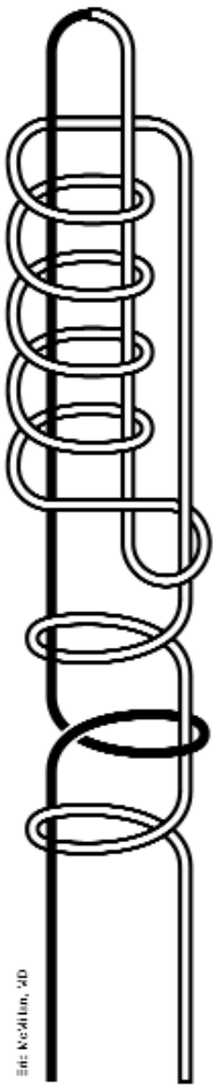

Figure 7.47
The Hangman's loop knot backed with alternating post half-hitches—a non-locking sliding knot.

Figure 7.48
The Roeder knot[11]—a non-locking sliding knot.

Figure 7.49
The Weston knot[15]—a locking sliding knot.

Knot diagrams (Figures 7.43–7.49)

Diagrammatic representations of all of the knots shown above as well as a few other common knots are included.

Conclusion

Arthroscopic knot tying is an exciting aspect of arthroscopy that significantly expands the arthroscopist's capabilities. Although technically demanding, observation of a few precautions and use of a few simple techniques can bring arthroscopic knot tying within the grasp of the interested arthroscopist.

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