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Arthroscopic knot tying occasionally requires a series of elemental instruments, both disposable and reusable, along with preferred suture material. It is imperative that the surgeon assures the said components are obtainable and at hand prior to conducting any appropriate procedure depending upon arthroscopic knot tying. There are important tools for arthroscopic knot tying such as sutures, cannulas, suture retrievers and knot pushers [1].

11.1 Sutures

The market offers a great variety of sutures for the arthroscopic surgeon, which presents different aspects of material quality such as strength, surface texture, resistance to fraying, and durability. An optimal suture is expected to ensure safe fixation with a least possible bulky knot, to have excellent resistance to mechanical abrasion, to demonstrate minimal resistance on the advancement of the knot and finally to yield excellent resistance to knot retreat or loosening. An effective

utilization of most knot pushers requires a suture of at least 27 in. (68.5 cm) in length. On the other hand a dual-lumen single-hole knot pusher requires a minimum suture length of 36 in. (91.4 cm) [2].

It is mainly the Arthroscopic surgeon's preference to decide upon the use of absorbable monofilament sutures such as polydioxanone (e.g., PDS and PDS II; Ethicon, Somerville, NJ) and polyglyconate (e.g., Maxon; Davis and Geck) or non-absorbable suture such as braided polyester (e.g., Ethibond Excel; Ethicon Somerville, NJ) and polyethylene terephthalate (e.g., Ticron; Tyco, Manfield, MA) and ultra-high molecular weight braided polyethylene sutures [1, 2].

However situation-specific factors such as the nature of reconstruction and the particular tissue being approximated will effect the surgeon's preference. Historical perspective refers to the use of monofilament suture providing a fairly easier pass with available arthroscopic suturing instruments. This has yet been found more difficult to tie securely, probably due to differences in surface characteristics of the two different suture types [1–5]. Nonabsorbable sutures give permanent fixation, however absorbable sutures gradually lose their mechanical strength as they are degraded by hydrolysis [6].

A brand new variety of high-strength braided sutures embodying ultra-high-molecular-weight polyethylene (UHMWPE) such as FiberWire (Arthrex, Naples, FL), Orthocord (DePuy-Mitek,

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Raynham, Mass), Hi-Fi (ConMed Linvatec, Largo, FL), Ultrabraid (Smith & Nephew, Andover, Mass), Force Fiber (Stryker Endoscopy, San Jose, Calif), MagnumWire (ArthroCare, Sunnyvale, Calif) and MaxBraid PE (Biomet, Warsaw, IN) have been introduced and have demonstrated advanced mechanical features when compared with traditional suture materials [2].

In addition, these new breed of sutures have also manifested different knot security qualities predominantly due to differences in surface features commanding the need for additional half hitches to lock these knots. One recent study suggests that a totality of four locking half-hitches supporting a sliding arthroscopic knot has not been found sufficient to securely rule out knot slippage with these high-strength sutures [2, 7–11]. As a matter of fact, no recommendation with regards to the adequate number locking half-hitches has been mentioned by the authors. Literature also points to some other researchers suggesting that the additional two locking half-hitches to the suggested number to be utilized in order to tie up more conventional suture materials may serve knot security effectively [2, 8].

A recent study reveals that some of the new high-strength sutures present greater bulk when compared with the same knots tied with more conventional sutures [2, 7]. When using more recent high-strength sutures, it is imperative that selecting a knot with a lower profile for use may be of extreme importance. In the process of knot tying, exertion of moderate force should be at stake particularly on tensioning the tissue loop to eliminate strangulation. Along with this issue, the surgeon should also take extra attention in that damage to gloves and even finger skin tears can be experienced when tying strenuously with these high-strength suture materials [2, 12].

11.2 Cannulas

Entanglement of soft tissue in the knot, one of the main complications in arthroscopic knot tying, can be substantially reduced through the utilization of

cannulas for arthroscopic knot tying [1, 2]. The entangled soft tissue within the knot can be effectually treated by means of passing the knot through the smooth lumen of a cannula rather than through muscle fibers and other soft tissue when penetrating the joint [2]. Disposable and plastic clear cannulas that are readily accessible on the market enable the surgeon to track the knot while it is led into the joint. This procedure provides the means for the surgeon to clearly recognize and get an immaculate view of the knot seat as well as spot any unintentional twisting or tangling.

A prominent feature that differs among various cannulas is the degree of flexibility of the cannula itself. Flexible cannulas can be distorted to some extent to make way for the passage of an instrument that would contrarily necessitate a larger diameter cannula. This flexibility brings about the use of smaller cannulas in several cases while at the same time enabling the transition of full-sized instruments (Fig. 11.1).



Fig. 11.1 Different types of cannulas. (DePuy-Mitek, Raynham, MA.Arthrex, Naples, FL)

Several manufacturers on the market produce and carry cannulas with threads or blunt spikes on their outer barrel, which help prevent the possibility of the cannula to snap out of the portal [2]. This format also effectively ties up the cannula to the joint wall through the passage of instruments in the course of prolonged or complicated procedures where swelling of the soft tissue can impinge upon portal placement. This fixation between the cannula and joint wall also brings up several other useful assets. For instance as the cannula is withdrawn from the operative field through an exertion of an outward pull, the joint wall is equally withdrawn from the operative field which opens up space for clear visual appearance on the part of the surgeon [2]. This can be considered as a huge gain when visualization is insignificant in any other way (Fig. 11.2).

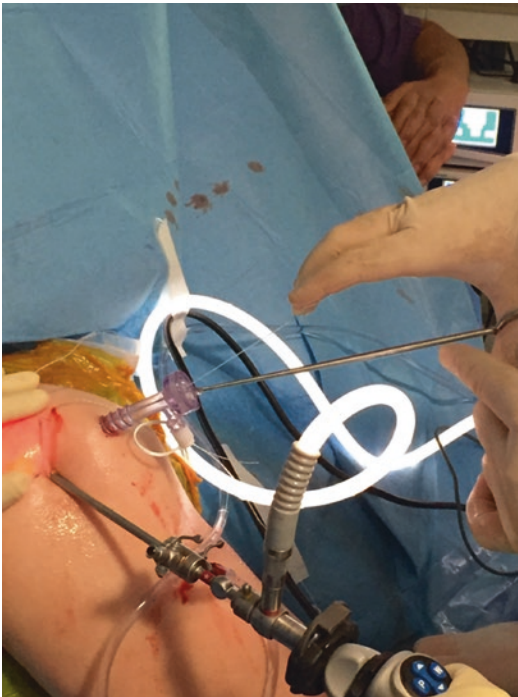


Fig. 11.2 Application and use of a plastic cannula during shoulder arthroscopy

11.3 Suture Retrievers

There are a number of instruments available for the surgeon to manipulate and retrieve the sutures arthroscopically (Fig. 11.3).

One of the common ways available is using a mere, nonspecific arthroscopic grasper with teeth. However this alternative may end up fraying and thus devitalizing the suture under question. A variety of graspers modelled particularly for suture or rotator cuff manipulation, which have seamless, atraumatic jaws allowing for damage and slide-free manipulation when the instrument is pulled out of the joint [1, 2]. Any possible trauma to the tissue that can be caused by the sawing effect of the suture sliding through the target tissue may thus be eliminated by this groundwork for suture movement within the jaws of the instrument.

11.4 Knot Pushers

The arthroscopic surgeon can make use of a number of different knot pusher alternatives available from Arthrex (Naples, FL), Linvatec (Largo, FL), Mitek (Westwood, MA), and Arthrotek (Warsaw, IN) such as single-hole, double-hole slotted, mechanical spreading, and dual-lumen single-hole [1, 2]. However, single-hole knot pushers can be considered as the most frequently preferred



Fig. 11.3 Suture retriever

type of all due to the fact that they can quite smoothly push a knot down with ease through employment on the post limb, or pull a loop down by employment on the wrapping limb (Fig. 11.4).

Right alongside, double-hole knot pushers can be utilized in the framework of these functions as well, however their added size and bulk render no convenience and therefore can complicate passage of individual knot loops. On the other hand, double-hole knot pushers excel in rectifying twists of the suture limbs right before knot tying. Both suture limbs are threaded through the knot pusher and the pusher is moved along to the target tissue intra-articularly (Fig. 11.5).

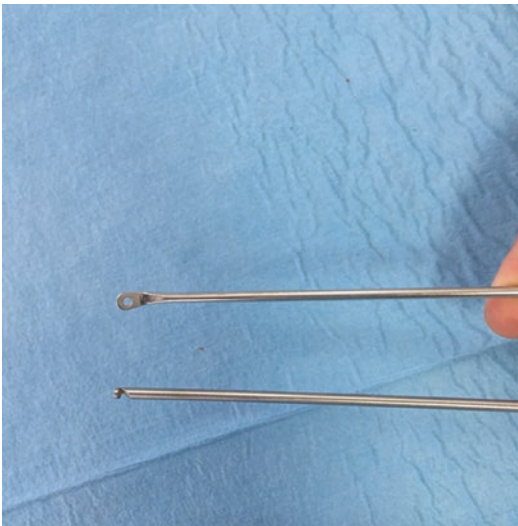


Fig. 11.4 Knot pusher



Fig. 11.5 Utilization of knot pusher

Slotted knot pushers act analogously to single-hole knot pushers, yet allow the knot pusher to be implemented and pulled out of the suture strand with no obligation to withdraw the knot pusher from the joint.

Provided the knot pusher is inadvertently separated from the intended suture limb at the time of the tying process, this function may arise like an obligation at that point. Aside from this, the half-done loop of the knot pusher tip may equally lead to soft tissue entanglement. The dual-lumen single-hole knot pusher such as sixth Finger device (Arthrex) has been patterned to absorb tension in that part of the knot already passed when additional throws have been tied and moved along (Fig. 11.6).

Studies conducted have pointed that this knot pusher type has been considerably effective in establishing loop security during arthroscopic knot tying procedure [2, 13]. Yet since it is disposable, this knot requires usage of longer sutures with the size of 36 compared to 27 in. [2]. At the same time it necessitates an advanced level of technical proficiency. In the case where the surgeon should conduct a non-sliding knot tie, the dual-lumen single-hole knot pusher may turn up as the most useful instrument. Since these non-sliding knots do not have a sliding element to hold temporary tension in the initial (tissue) loop on

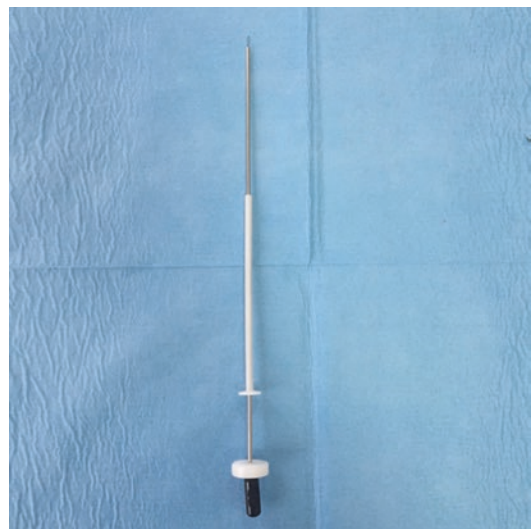


Fig. 11.6 Sixth Finger device (Arthrex, Naples, FL)

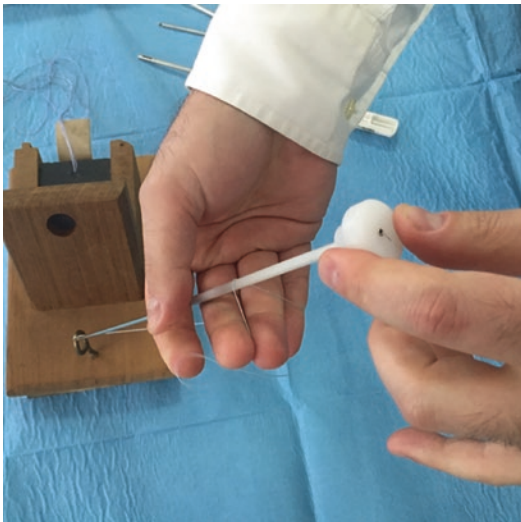


Fig. 11.7 Application for tying arthroscopic knot with sixth Finger device (Arthrex, Naples, FL)

the passage of additional securing throws, the dual-lumen single-hole knot pusher plays a prominent role in enabling this tension. It also eventually provides a solid loop security, even with mere half hitch–based non-sliding knots (Fig. 11.7).

In short, a single-hole knot pusher is a suitable alternative for a primary knot pusher due to its thorough overall utility in passaging and tensioning of knot loops. It can be concluded that a double-hole knot pusher can be considered as the most instantaneous instrument in the detection and correction of suture twisting preceding the tying process and also as an indispensable component complementing a single-hole knot pusher. Apart from this, a dual-lumen single-hole knot pusher is utilized essentially on tying non-sliding knots.

11.5 Suture Passage

Ideal suture passage allows for exact location of sutures to secure tissue fixation. Several techniques have been introduced to facilitate the passage of suture. Although many different suture-passing devices are available on the market, it is significant for the arthroscopic surgeon

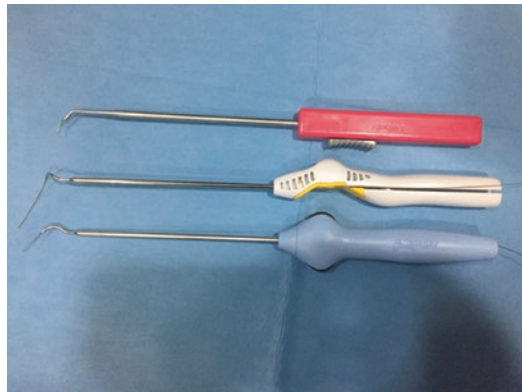


Fig. 11.8 Suture lassos are the basic instruments of arthroscopic shoulder surgery for suture passage from the soft tissue

to feel confident with different suture-passing techniques for a stable arthroscopic repair [14]. Convenience, cost-effectiveness, and tissue quality are main factors in use of any suture-passing device [15].

Suture relay has been the basic instrument for shoulder arthroscopy. Cannulated large-bore needle instruments, which have various twists and shapes, are passed through the soft tissue for a stable repair and fixation (Fig. 11.8). Before the arthroscopic operation, it is better to make some practice with several devices and use what works best in your hands on models and cadaveric specimen. Suture relay devices are particularly useful for difficult-to-reach or more delicate tissues such as the labrum, however it can be used also for the rotator cuff and biceps pathologies.

With these devices, the sharp cannulated needle is passed through the tissue; a suture lasso is deployed through the needle into the joint and retrieved with the desired suture to be passed through an accessory working portal. An easy technique to avoid this is to grasp the lasso and the suture in one pass, retrieving them through the same working portal (Fig. 11.9). The process is repeated as necessary until all sutures have been passed.

Tissue-penetrating instruments such as the Birdbeak (Arthrex, Naples, FL) are effective in

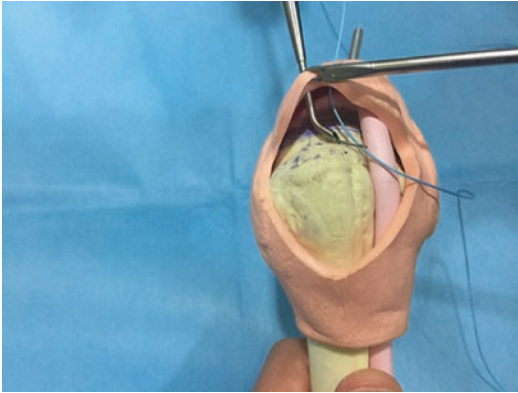


Fig. 11.9 Suture passage can be done in one pass with a special suture lasso

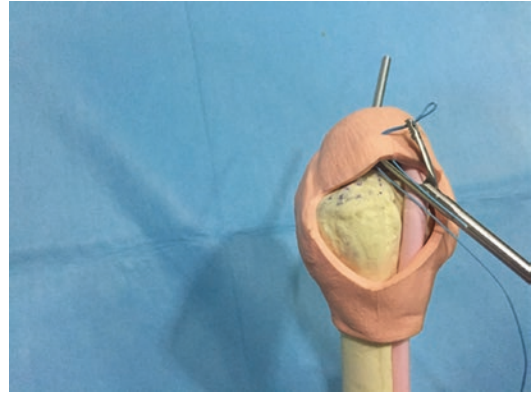


Fig. 11.11 Scorpion (Arthrex, Naples, FL) One-step suture passers were designed to minimize the number of steps involve

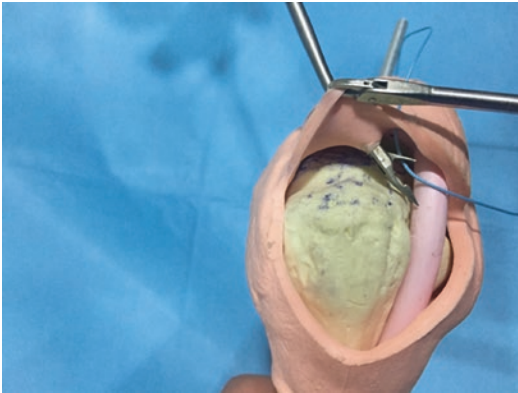


Fig. 11.10 Tissue-penetrating devices with various angles are extremely convenient and can be used in antegrade or retrograde fashion to pass suture

larger spaces with more thicker tissue (Fig. 11.10). These devices have sharp ends and are used to grasp suture in an antegrade or retrograde fashion directly through the soft tissue. Care must be taken with these instruments to avoid damage to the tissue through which the device is passing or the neighbouring cartilage and other important structures of the joint.

One-step suture punch devices use a needle to shuttle suture through tissue when the device is deployed (Fig. 11.11). Some of these devices allow for a one-step suture passage and retrieval on the opposite side of the tissue with the same instrument. Others require a suture grasper or

hook to retrieve the suture. Although several variations on this design are available, suture is passed directly through the tissue and retrieved through the same portal.

Conclusion

There are many instruments designed to be used in arthroscopic procedures, surgeons should choose among those according to their needs. It is very important to make some practice with several devices and use what works best in your hands on models prior to the real procedures.

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