



Module 5:

Passing Suture through Tissue

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Problem Identification and Needs Assessment

Identification of targeted learners

Targeted learners for this template include junior residents, residents with minimal or no arthroscopic shoulder experience, and arthroscopists who are at the learning level of shoulder arthroscopy.

Identification of need or problem for targeted learners

The problem that exists now is that there are inadequate cases and patients to provide for adequate repetitions for a learning surgeon to develop skills that transform them from a beginner to a more experienced or polished surgeon. Surgical time is increased during the learning phase (because of the slow speed that a learner must employ in order to minimize iatrogenic tissue damage), with associated increased cost to the system. Compounding the problem is the fact that there are inadequate models to gain significant arthroscopic skills and cadaveric specimens are both expensive and cumbersome to use.

Current educational approach to address need or problem

The current approach to training beginning surgeons arthroscopic surgical skills is by allowing them progressively more exposure and opportunity to operate on living patients in a true operating room theater. In some educational centers, there are laboratory models available but there is neither an established curriculum nor programmed approach to progressive learning on these models.

Ideal educational approach to address need or problem

The ideal solution to teaching the passage of suture through tissue is for the learning surgeon to first have access to very basic models that allow the learning of fundamental motor skills. This should be followed by more anatomically correct models that allow learners to fine tune motor skills in a more appropriate and exacting environment that reflects a more realistic surgical experience. Further, the ideal educational opportunity would allow for a learning surgeon to have multiple repetitions at each level of skill development, so they can become facile with the motion and skill. It is critically important to develop sufficient ambidextrous skills, because these surgical techniques require symmetrical use of both hands in the clinical situation.

A requirement for such an experience would be access to both hand-held and powered equipment as well as the necessary suture material and anchors to simulate the surgical experience.

When residents (and practicing surgeons) return to the sub-specialty of arthroscopic surgery after being away for a while (for example with annual rotation schedules), proficiency in these basic skills should be re-demonstrated before technical application in the operating room. This educational approach requires substantial flexibility of time and resources. Residents should be allowed to progress along the learning curve at an individualized pace, with deliberate and appropriate faculty evaluation and (if needed) faculty remediation.

Goals and Objectives

Specific educational goals

The broad purpose of this training module is to develop the basic motor skills that are required to pass suture through tissue arthroscopically. Specific goals include:

- Familiarization of the learning surgeon with tools useful and used in the passage of suture through tissue.
- Understanding of the various techniques and options available for the passage of suture through tissue.
- The development of psychomotor skills necessary to perform these tasks both left and right-handed.
- Understanding of the sequence of steps necessary to progress from a starting position to the final completion of the suture-passing process.

Specific cognitive, affective, psychomotor task objectives

The following suture-passing objectives were defined by task deconstruction:

- Ability to perform basic motor functions for the passage of suture through tissue using both left and right hands.
- Ability to coordinate motor activities between an operating surgeon and a surgical assistant such that maneuvers and procedures requiring more than two hands can be done in a smooth and skillful way.
- Ability to effectively position an arthroscope and position equipment in space to facilitate adequate visualization, with enough distance to gain a broad view.
- The cognitive ability to choose between various methods of suture passage in order to select a method that is appropriate for a given clinical setting.
- The ability to perform skills and tasks in a 3-dimensional world using a 2-dimensional video arthroscopy display.

Syllabus Development

Assumptions

To engage in this module, the beginning surgeon must have acquired the basic skills of diagnostic arthroscopy, must be able to effectively triangulate and position equipment in space in a coordinated and delicate way, and should have mastered the knowledge and skills needed to create working portals in the glenohumeral joint and subacromial space (*FAST Program Modules 1-3*).

Suture passage skills can be learned initially on a flat surface that allows for a suture to be passed through a flat piece of material using the various methods available to perform these skills with either hand. Once basic steps are learned and the basic handling of instrumentation is learned, these skills can then be practiced using arthroscopic visualization.

The second phase involves suture passage using a more anatomically correct model. Initially, these exercises can be performed with direct visualization of instruments using a transparent model cover.

In the third phase, the learner should advance to ambidextrous motor skills rehearsal using arthroscopic visualization with an opaque model cover. Inherent in the progression from the second step to this final third step is the introduction of a “skilled assistant”. The “assistant” provides adequate hands to allow for orientation and position of the arthroscope as well as retrieval of sutures that are delivered by the learner.

Proficiency benchmarks (defined for dominant and non-dominant hand performance) should be created using appropriate cohorts of experienced arthroscopic surgeons. Learners should progress sequentially to the next exercise only after demonstration of sufficient proficiency for each sub-module. Learners will be allowed, and encouraged, to go back and practice the skills elements in order to enhance their integrated psychomotor performance.

Suggested readings

- AANA Advanced Arthroscopy: The Shoulder: Expert Consult: Online, Print and DVD, 1e Richard L Angelo, James Esch,

Richard K. N. Ryu 2010. Saunders, Philadelphia, PA

- Shoulder arthroscopy: principles and practice. Rao AG, Yokota A, McFarland EG. Phys Med Rehabil Clin N Am. 2004 Aug;15(3):vi, 627-42.
- Arthroscopic Techniques of the Shoulder: A Visual Guide (Visual Arthroscopy) Tal David MD (Author), James Andrews MD (Author). 2009 Slack Incorporated. Thorofare, NJ
- Powerpoint presentations from AANA and AAOS course and instructional lectures
- Videos of specific motor skills performed in the motor skills laboratory and during surgical cases

Description of laboratory module

A brief video presentation will be available on-line that describes the overall rationale for each individual training exercise. Introductory videos will also present important information about how to set up the skills sessions (i.e., the *FAST* workstation or an equivalent platform). For these modules, the laboratory setting would include:

- A “flat board” with the appropriate equipment and instrumentation to practice basic skills of arthroscopic suture passage through tissue.
- An ergonomically correct box model and/or an anatomically sufficient shoulder model. These models should have lucent and opaque covers.
- An arthroscope and camera for visualization as part of the last phase of the learning exercise.

Description of techniques and procedures

There are many challenges in shoulder arthroscopy but one of the most daunting is the actual passage of suture material through tissue in preparation for fixing the tissue back to a bony bed or to soft tissue. Although there are many instruments on the market to accomplish arthroscopic suture passage, the skills can be divided into three general approaches: (1) Pierce and grab, (2) Pierce and carry, (3) Pierce and shuttle. By understanding the difference in these techniques and by becoming skilled with each method, the learner will be more likely to accomplish successful arthroscopic repair of soft tissues with minimal iatrogenic tissue injury.

Pierce and Grab: For this exercise, an instrument is passed through the soft tissue from the side where the knot will be tied and towards the side where the sutures are present (either from a suture anchor or as they rest having been passed through another piece of soft tissue). The instrument is passed through soft tissue, and by opening the jaw of the instrument or by extending a grasping metal loop from the instrument, the target suture desired is captured and pulled back through the soft tissue.

- Technical tip: The potential trap in this technique is the possibility that the suture becomes entrapped in the instrument as it is being grabbed rather than captured in such a way that the suture will continue to slide through the instrument. If the suture is pinched or trapped, then as one retrieves the suture back out through the soft tissue, the suture is being pulled through the anchor which can, if not controlled, offload the suture from the anchor by the time the suture is successfully pulled through supporting cannula. This pitfall must be recognized, so that the trailing end of the suture is controlled with a hemostat or by an assistant surgeon (see video example and figures).

Pierce and Carry: In this technique, a suture is preloaded onto an instrument, and then passed through the soft tissue from the side of the anchor (or from the side where the suture rests) to the opposite side, exiting at the point where a knot will be tied. After penetration of the instrument through the tissue, the suture is grasped and then brought out through a cannula.

- Technical tip: Using this technique, the mistake that can be made is entrapment of the suture in the passing instrument. When this occurs, as the instrument is pulled back out of the joint or space, the instrument pulls the suture back through the tissue, which requires that the step be repeated. In an effort to avoid this technical trap, it is best to do this technique with two instruments. Instrument #1 passes the suture from the anchor side to the opposite side. Instrument #2 grasps the suture that has just been passed and holds it there while instrument #1 is removed. This reduces the likelihood of inadvertent removal of the suture while Instrument #1 is removed from joint (see video example and figures).

Some passing instruments allow for the capture of the suture as it is passed through tissue. In this case, extracting the passing instrument

simultaneously pulls the passed suture from the joint/space.

Pierce and shuttle: The third technique for passing suture through soft tissue is called pierce and shuttle. This is a very versatile technique and is applicable both in the glenohumeral joint and the subacromial space. The technique gives the surgeon a great deal of flexibility from the standpoint of the direction from which the soft tissue is approached and the distance between the soft tissue penetration and the anchor.

In this technique, a passing monofilament suture or suture shuttle device is passed through the soft tissue, and then a permanent suture is attached to the passing filament or shuttle and pulled back through the soft tissue. The technique involves placement of a monofilament suture or a dedicated suture shuttle device through any instrument that can effectively and easily penetrate soft tissue. This can be a grasping instrument, a simple passing instrument with an eyelet, or a cannulated suture passing instrument.

The instrument is used to penetrate the tissue, so that the exit point of the suture will be positioned where the permanent suture knot is ultimately desired. A grasper is used to capture the monofilament (or suture shuttle device), which is then pulled out through the working cannula. The desired permanent suture from a suture anchor is then retrieved through this same portal, or a separate permanent suture is brought to the surgical field. The permanent suture is then connected to the monofilament with a simple knot created in the monofilament suture (or placed in the loop of the suture shuttle suture device). The monofilament or suture shuttle device is then pulled back through the tissue, which delivers the permanent suture out through the original working cannula (see video example and Figures).

Common errors and prevention strategies

The following errors are common:

- Improper direction of instrument / suture passage resulting in a suture placed on the wrong side of the tissue for knot tying.
- Improper use of portals.
- Imprecise passage of sutures making retrieval difficult or impossible.
- Imprecise delivery of suture to a grasping instrument.

- Pull back of suture through tissue once it has been passed.
- Off-loading of a suture anchor as the suture is pulled through tissue and out the cannula.
- Improper sequence of suture passage and tangling of sutures during a procedure that involves multiple suture applications.

There are specific strategies for prevention of all of these common errors. Understanding of the basic techniques, which can be learned on a flat board in an anatomically relevant manner, is the best way to ultimately avoid these technical errors. It is very important to practice these techniques on the flat model before progressing to the anatomic joint model, in order to master the required cognitive elements and motor skills.

Demonstrate expert performance

At the beginning of this module, the learner will watch a video presentation of motor skill performance by an expert arthroscopist using the flat board elements of the *FAST* workstation. The skills will also be demonstrated using the anatomic joint model. Finally, the expert will show narrated examples of these suture passing techniques using real surgical cases in patients.

Recommendations for motor skills practice

The learning of skills necessary to pass sutures through tissue breaks occurs in three stages:

Stage 1: Flat Board: The learning of basic skills on a flat board in a simple but relevant environment. This is the setting to develop left and right hand expertise and coordinated ambidextrous right / left hand interaction.

Stage 2: Anatomic Model (Lucent Cover): The application of these learned skills in a more anatomically-correct joint model using direct visualization with the naked eye. The surgical “assistant” can be added later in this phase.

Stage 3: Anatomic Model (Opaque Cover): The advancement of these learned skills in an anatomically-correct joint model using the arthroscope for visualization and employing the surgical “assistant”, for tasks that require more than two hands for completion of the task. During this phase, the assistant either holds the scope or helps with retrieval of sutures within the working space.

Supplies and station setup

- The *FAST* workstation (or an appropriate alternative) on a flat working surface
- Simulated tissue that is stabilized on a flat surface for the preliminary exercises
- An anatomically correct shoulder model with lucent and opaque covers
- Hand instruments to implement the three suture passing methods
- Working cannulas and suture anchors with accompanying sutures
- Braided permanent sutures, monofilament shuttle sutures, and suture shuttle devices
- An arthroscope / light source
- An arthroscopic probe, a tissue grasper, a suture grasper, and hemostats

Suggested duration for completion of module

Background reading and video review should be accomplished in one hour.

- Phase 1: The completion of skills development on a flat surface: One hour.
- Phase 2: The completion of skills in the anatomically correct model using direct visualization: One hour.
- Phase 3: The application of an arthroscope and “an assistant” to perfect skills developed in Phases 1 and 2: Three to four hours.

It is anticipated that this entire module will require approximately six to seven hours for completion and demonstration of proficiency.

Estimated budget

- The budget should include expenses associated with the *FAST* workstation (or another suitable alternative that meets the educational requirements).
- Costs associated with the anatomic joint models and surgical instruments
- These motor skills modules will require replacement of disposable elements as they are consumed.

Learner Evaluation and Feedback

Methods of performance assessment

Assessment could be either by direct visualization by the mentor (with completion of a task oriented check list) or by submission of unedited video data for secondary grading. Given that there are three levels in this module, each phase would have to be adequately passed before moving to the next phase in the learning process.

Suggested proficiency benchmarks

Proficiency could be measured with both a time requirement and a measure of manual dexterity, with a passing grade demanding that work be done in a set time period and that it be done with the left hand and the right hand without undue mistakes in steps and without any damage to either the shoulder model or to the surgical instruments themselves.

Measurement of technical “proficiency” is very difficult and largely subjective. On the other hand, technical failures may be easier to define, recognize and record using a checklist. In these motor skills exercises, failure could be defined as:

- Excessive time to set up and complete the exercise
- Breakage of any piece of equipment
- Off-loading of a suture from a suture anchor
- Pulling a suture out after it has been passed through the tissue
- Improper direction of suture passage
- Loss of control of the suture during passage or shuttling
- Improper sequence of instrument passage and removal
- Improper sequence of suture passage in a multiple suture passage exercise.

Successful completion of the module would then be defined as the absence of any failures.

Methods for learner debriefing and feedback

Immediate viewing of one’s own work is a very powerful teaching vehicle. Video recording and intermediate viewing by the learner should be an integral part of this exercise. The learner can then apply the same grading paradigm to his/her own work. Once the learner feels that they have

achieved a “passing grade” by self-evaluation they would be allowed to perform the exercise for grading by the instructor / advisor (either by direct observation or by submission of a video recording by the learner).

Learners will provide curriculum feedback using a web-based, anonymous tool assessing module didactic content, expert video quality and usefulness of skills training.

Periodic Curriculum Review, Evaluation, Validation, and Refinement

Curriculum faculty will annually review learner comments and assess potential improvements in the didactic and manual skills portion of the module. Educational validation will occur when the learner is observed and graded in the clinical setting, noting the specific steps of arthroscopic equipment set up and portal placement.

The clinical process of passing suture through tissue is very dependent on equipment available for this purpose. As arthroscopy evolves and as new instrumentation is developed, clinicians are provided with new tools that facilitate more effective and consistent ways to pass suture through tissue arthroscopically. These new technologies and techniques should be incorporated into this module, in order to keep the module consistent with current clinical technologies. Therefore, this module should be evaluated annually, and updated as these technologies change over time.