FAST
FUNDAMENTALS OF ARTHROSCOPIC SURGERY TRAINING

Module 2: Basic Triangulation Skills

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Problem Identification and Needs Assessment

Identification of targeted learners

Orthopaedic surgery residents from PGY 1 through PGY 3 and practicing orthopaedic surgeons who have limited prior experience performing arthroscopic surgery (but wish to develop or improve their fundamental arthroscopic skills).

Identification of need or problem for targeted learners

Basic arthroscopy motor skills are difficult to acquire. These skills are dissimilar from the psychomotor tasks developed in early childhood for routine daily activities (for example, use of a knife and fork) and from other medical skills that involve direct visualization with associated hand-eye coordination (for example, use of tissue forceps and dissecting scissors).

Three-dimensional arthroscopic anatomy is projected via a two dimensional video display, whereby intricate hand motions are coordinated without direct visualization. Arthroscopic proficiency requires ambidextrous motor skills, as opposed to performance of most other surgical psychomotor tasks that allow for hand-dominant instrument use.

Arthroscopic proficiency requires cognitive management of multiple simultaneous psychomotor variables, which (without appropriate training and practice) can exceed the attention capacity of the operating surgeon. Arthroscopic surgery is particularly risky because iatrogenic articular cartilage damage cannot be accommodated by a compensatory healing response (as opposed to the relatively forgiving and predictable healing response observed in other musculoskeletal tissues).

Current educational approach to address need or problem

Most junior residents acquire arthroscopic skills by observation of faculty or senior residents in the operating room. In many cases, the learner's first performance experience on the learning curve involves the surgical care of humans, with the associated patient morbidity and inefficiency. Some training programs utilize motor skills labs, which are outfitted with arthroscopic instruments, models, and / or cadaveric material. Even when programs do possess arthroscopic instruments and laboratory space for motor skills training, it is rare (if ever) that objective demonstration of basic skills proficiency is required prior to surgical performance on live patients.

Ideal educational approach to address need or problem

Following demonstration of requisite cognitive knowledge, arthroscopic motor skills should be taught as individual elements, from basic toward advanced, outside of the operating room. Each skill should be mastered in a logical sequence to a pre-defined level of technical proficiency, prior to moving on to the next level of motor complexity.

Once individual basic skills are mastered, various elements should be combined and practiced simultaneously to acceptable proficiency, in order to improve the "automation" of relatively simple motor tasks. This strategy improves the learner's psychomotor attention reserve, which minimizes additional stress and iatrogenic risk associated with training in the patient care environment.

Learners must master all basic arthroscopy skills in an ambidextrous fashion, because effective use of the non-dominant hand is a particularly difficult and risky challenge for most inexperienced arthroscopists. Proficiency in all basic motor skill elements should be demonstrated prior to clinical performance on any living patients.

When residents return to the sub-specialty of arthroscopic surgery after being away for a while (for example with annual rotation schedules), proficiency in the basic skills should be re-demonstrated before technical application in the operating room. This educational approach requires substantial flexibility of time and resources. Residents must be allowed to progress along the learning curve at an individualized pace, with deliberate and appropriate faculty evaluation and (if needed) faculty remediation. At times, this paradigm may take learners out of the clinical care environment, thereby temporarily affecting the "system" of service delivery in the academic medical center.

Goals and Objectives

Specific educational goals

- The purpose of this training module is to develop the basic ambidextrous motor skills that are prerequisites for training and clinical performance of arthroscopic surgical procedures.

Specific cognitive, affective, psychomotor task objectives

The following motor skill elements were defined by task deconstruction. These basic elements include:

- Steadiness of the camera and arthroscope
- Image orientation (i.e., control of the horizon)
- Image centering
- Telescoping (i.e., pistoning)
- Periscoping (i.e., proper use of the 30 degree arthroscope)
- Deliberate linear scope motion
- Tracking a moving target with the scope
- Basic probe triangulation
- Touch and probe of a stationary target
- Simultaneous image tracking and probing of a moving target
- Measurement of articular dimensions with the tip of a probe
- Development of ambidextrous motor skills

Syllabus Development

Assumptions

Prior to initiation of this module, the learner must demonstrate proficiency in the "Basic Principles of Arthroscopy" (in other words, a passing score on Module 1 of the *FAST* Program). The objective of Module 2 is development of fundamental arthroscopic motor skills (as described above), with sequential demonstration of proficiency based upon clearly-defined performance benchmarks. Each arthroscopic skill will be trained via psychomotor exercises that will be demonstrated, practiced, and then tested using virtual reality simulation technology.

Each psychomotor element can be rehearsed using the *FAST* workstation (or with an alternative motor skills practice device), or they may be programmed for delivery on selected virtual reality training platform(s). For the computerized systems, each element should be associated with objective performance metrics (for example skill precision, path efficiency, time to completion, error rate). Other platforms simulating arthroscopic visualization systems and instruments may be utilized to complete this module as well.

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

- Primer of Arthroscopy: Text with DVD, 1e [Paperback] Mark D. Miller MD (Author), A. Bobby Chhabra MD (Author), Marc Safran MD (Author) 2010. Saunders
- AANA Advanced Arthroscopy: Expert Consult: Online, Print and DVD, edited by

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

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 set up of a basic skills workstation (i.e., the *FAST* workstation). Additional orientation information should be available from companies that provide virtual reality simulation platforms.

Description of techniques and procedures

The techniques and procedures will be dependent on the platform chosen for the module and the exercise – the basic skills of scope/camera handling with both hands and triangulation can be practiced utilizing whatever platform is available.

Common errors and prevention strategies

- At the beginning of each sub-module, the specific psychomotor task will be demonstrated with audio commentary, using relevant examples from arthroscopic surgery (acquired from patient care and /or cadavers).
- For each task and motor skill element, common errors will be demonstrated, with verbal explanation of associated risks during patient care.

Demonstrate expert performance

At the beginning of each sub-module, the learner will watch a video presentation of skill performance by an expert arthroscopist on the *FAST* workstation. Similar videos may also be available for the virtual reality platforms. These videos will describe the performance metrics that will be measured for each specific sub-module, and will demonstrate task proficiency that meets the pre-defined proficiency benchmarks.

Recommendations for motor skills practice

The motor skills practice will be dependent on the platform chosen by the program and program faculty, but should include camera handling/visualization/instrument handling/triangulation/utilization of both hands.

Supplies and station setup

The *FAST* workstation (or an appropriate alternative skills set up)

- For practice using a workstation, a suitable visualization alternative is required. This would either be a low cost USB camera-light source connected to a laptop or desktop computer, OR a mid-cost scope-USB camera-light source (also connected to a computer), OR a standard arthroscope-camera-light source connected to an arthroscopy monitor (i.e., an arthroscopy tower)
- Virtual reality platforms will be unique for each vendor.

Suggested duration for completion of module

Background reading and video review should be accomplished in 2 hours. The learner should be able to complete and demonstrate an acceptable level of ambidextrous psychomotor proficiency after one to three hours of training on each sub-module. It is anticipated that the entire module will require approximately twenty 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).
- The motor skills sub-modules may require replacement of disposable elements as they wear out.
- If programs utilize a virtual reality training system, there will be additional costs for lease or purchase of that equipment.
- Additional costs that should be considered include charges for simulation lab space, salaries for support personnel and dedicated faculty time, central data repository creation and maintenance, and indirect costs related to on-line content delivery.

Learner Evaluation and Feedback

Methods of performance assessment

For assessment of proficiency using the *FAST* workstation or other alternative platforms, metrics will be developed for each task being practiced.

For the virtual reality systems, computer-based performance metrics will be defined for each sub-module exercise. These metrics will probably be specific to each individual virtual reality training platform.

Suggested proficiency benchmarks

A passing score will fall within two standard deviations of performance for each metric based upon a cohort of expert level surgeons (assuming there is a normal distribution of performance on that metric for the experts). Passing scores will be defined for both the dominant and non-dominant hands.

Methods for learner debriefing and feedback

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

For computer-based metrics, the learner will be provided with a summary of his/her scores on each sub-module, which will include reference curves for performance of experts and (whenever possible) also reference curves for other residents at a similar level of training. If the learner is unable to achieve passing scores on all sub-modules for both the dominant and non-dominant hands, the department chair, program director or arthroscopy service chief will debrief the resident, with strategies developed for appropriate remediation.

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 *FAST* Program committee will review this data at a minimum of every other year, with program updates issued once every two years.]