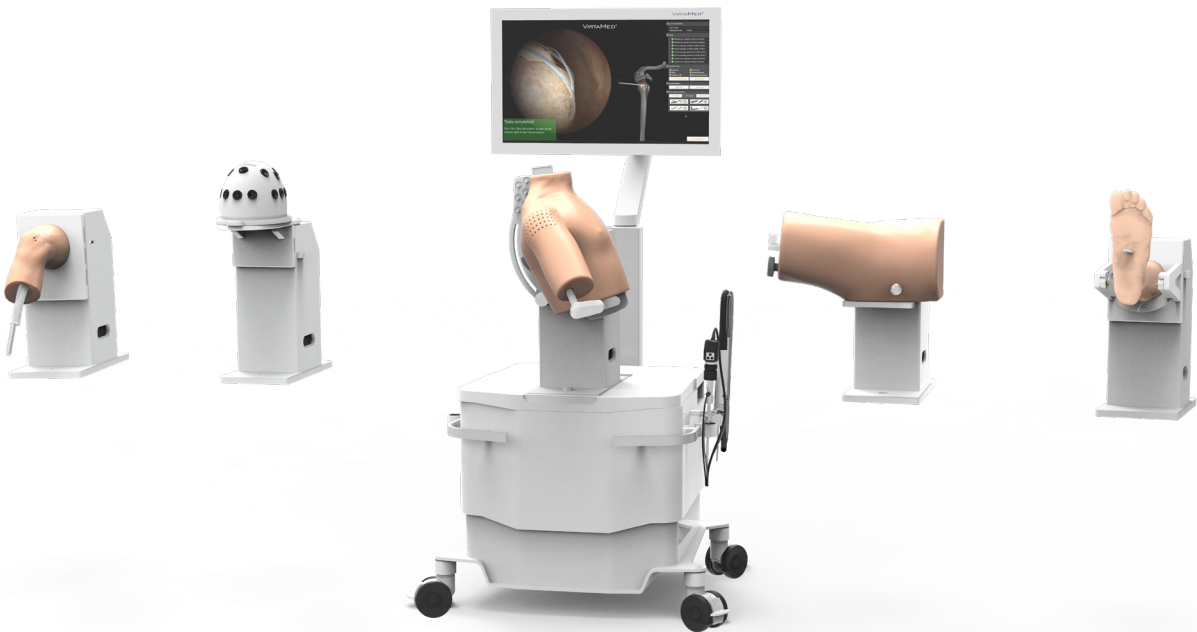




VirtaMed ArthroS™

The most advanced and comprehensive arthroscopy simulator available



Exclusive and preferred training partner of



Why is medical training better with simulation?



Prepare Trainees for Success

- Original instruments and highly-realistic graphics mean that skills transfer seamlessly from the simulator to the OR.
- Anatomically correct models support life-like joint movement and realistic haptic feedback.
- Simulators offer risk-free and hands-on experience for trainees to make mistakes and test boundaries.
- Society-endorsed and proficiency-based courses motivate students to reach benchmarks.



Save Money

- Simulation reduces long-term costs for personnel, materials, equipment, and operating-room time.
- Trainees enter the OR having already mastered the basics and can focus on learning more complex skills.
- Simulator-trained surgeons take less time to complete procedures in the OR and make fewer mistakes.
- All-in-one platform is compatible with other VirtaMed specialties such as gynecology, urology, and laparoscopy.



Accelerate Training

- Quickly meet the ABOS-mandated requirement for skills training with our structured curriculum and FAST module.
- Trainees with regular access to a simulator progress faster, meaning they get into the OR sooner.
- Simulators can be used 24/7 so trainees can practice when and as often as they want.
- Objectively assess trainees' skills with impartial feedback reports; quickly identify areas for improvement.



Support Better Patient Care

- Trainees will have mastered the basics prior to working with patients.
- Instructors can ensure trainees reach pre-defined standards before treating patients.
- Improve the overall patient experience with surgeons who are confident and comfortable with the procedure.

” Simulation shortened the learning curve because they could learn all the basic skills here in the lab. I didn't have to teach them in the theater, and it's also safer for patients [if surgeons are] able to come and practice on the simulator before trying a new technique.

— Professor Rob Middleton, Head of the Orthopaedic Research Institute, Bournemouth University.



VirtaMed ArthroS™ FAST

In 2013 the Fundamentals of Arthroscopic Surgery Training (FAST) program was developed with the goal of improving and standardizing surgical education in the field of arthroscopy. VirtaMed has an exclusive partnership with Sawbones, and their FAST dome has been adapted for virtual reality simulation offering exciting new training opportunities.



Learning objectives

- Control camera movements and center an image
- Control image orientation (i.e. camera horizon)
- Perform basic triangulation
- Minimize unnecessary movement of the scope
- Practice deliberate linear scope movements
- Track a moving target with the scope
- Correctly use the angled optics (i.e. periscoping)
- Find, grasp and manipulate objects

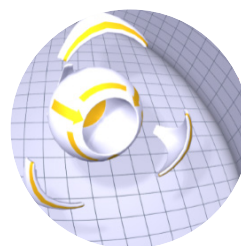
Cases

- 8 cases with 136 exercises for camera navigation: image centering, horizon control and periscoping
- 8 cases with 164 exercises for basic bi-manual skills: triangulation, probing, and grasping



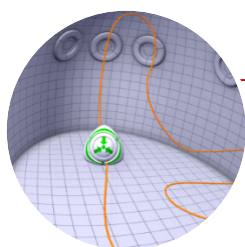
Image Centering

Get familiar with horizon alignment and image steadiness



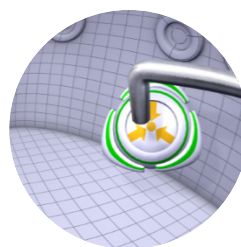
Camera Alignment

Correctly perform camera alignment using both portals



Object Tracking

Visualize, track and center a moving object

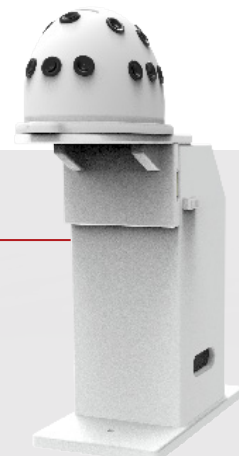


Triangulation

Practice triangulation skills by combining the camera and a probe. Probing tasks.

Hardware

- FAST workstation gives your trainees diverse training scenarios
- Instruments adapted for virtual reality provide metrics to measure performance
- Supports ambidextrous training



VirtaMed ArthroS™ Knee

Trainees have the chance to perform complete diagnostic arthroscopic interventions on numerous and diverse patient cases. Mastering these basic tasks enables trainees to perform a complete knee arthroscopy more easily, efficiently and safely.

Courses

- Knee Basic Skills Course
- Knee Course in Diagnostics
- Knee Advanced Course in Diagnostics
- Knee Advanced Course
- AANA Knee Course
- Balgrist Knee Arthroscopy Course

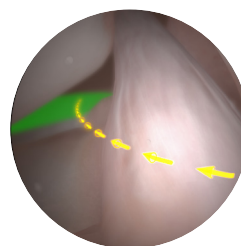
Cases

- 12 cases for basic skills training: guided diagnostics, triangulation, and therapeutic arthroscopies
- 19 cases for diagnostic arthroscopy: different meniscus lesions, unhappy triad, arthrosis grade I-IV, synovitis
- 11 cases for therapeutic arthroscopy: different meniscus lesions, combined arthrosis and tears, synovitis, and loose body removals



Arthroscopy Basic Skills

Learn instrument handling and triangulation skills while avoiding cartilage damage



Guided Diagnostic Tours

Get familiar with the arthroscopic anatomy and learn to visualize relevant structures



Diagnostic Cases

Visualize and palpate various pathologies in the knee joint including arthrosis, meniscus lesions, etc.

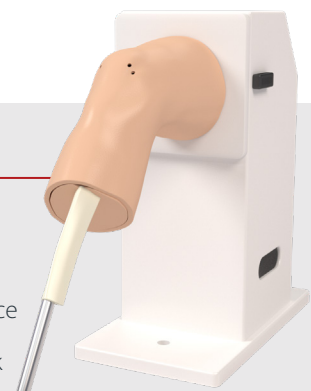


Therapeutic Cases

Master different complete therapeutic procedures such as meniscectomy or loose body removal

Hardware

- Anatomic right knee model allows for physical manipulation of the knee joint, including varus and valgus, flexion, and extension
- Original instruments adapted for virtual reality provide metrics to measure performance
- Internal structures such as bones and tendons offer learning-essential haptic feedback



VirtaMed ArthroS™ Knee ACL Reconstruction

The Concepts of ACL Reconstruction module is an advanced add-on to the ArthroS™ Knee module and contains all the necessary software to perform an anatomical ACL reconstruction.

Trainees will learn:

- Navigate the 3D anatomy of the knee joint in relation to the relevant landmarks for ACL reconstruction
- Consequences and effects of tunnel placement and graft positioning
- Mastery of correct graft positioning, a skill paramount to safe and effective ACL reconstruction
- Correctly use the following instruments: grasper, probe, punch, tibia targeting tool, and shaver

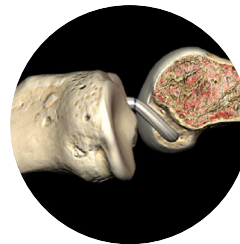
Cases

- 2 cases for concept training: main principles of ACL reconstruction and anatomical concepts
- 4 cases for therapeutic arthroscopy: complete ACL tear (guided and unguided), complete ACL rupture, and partial ACL rupture with knee instability



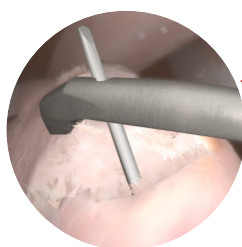
ACL Basic Skills

Learn basic ACL biomechanics, principles of ACL reconstruction, and mechanisms of injury



Anatomical Concepts

Identify the anatomical landmarks, concepts, and kinematics of the ACL. Understand consequences of graft malpositioning



Guided Therapeutic Case

Step-by-step guided ACL reconstruction, patient in a chronic state with a complete ACL tear



Unguided Therapeutic Cases

Perform ACL reconstructions for complete and partial ACL ruptures, with chronic and subacute patients

Hardware

- The Concepts of ACL Reconstruction module is supplemental to the ArthroS™ Knee Module
- Guidewire adapted for simulation



VirtaMed ArthroS™ Shoulder

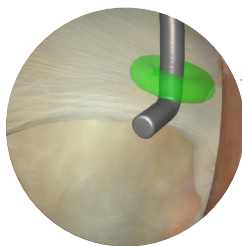
Includes guided basic skill training cases integrated into a realistic simulation. Mastering these basic tasks enables trainees to perform a complete shoulder arthroscopy.

Courses

- Shoulder Basic Skills Course
- Shoulder Course in Diagnostics
- Shoulder Advanced Course in Diagnostics
- Shoulder Advanced Course
- AANA Shoulder Diagnostic Training Course
- Balgrist Shoulder Arthroscopy Course

Cases

- 12 cases for basic skills training: guided diagnostic tour of the glenohumeral and subacromial spaces, instrument triangulation, and joint palpation
- 14 cases for diagnostic arthroscopy: healthy 15-point anatomy exam, lesions of the rotator cuff (L-shaped and crescent-shaped supraspinatus tears, subscapularis tear, PASTA tear), SLAP lesions, Bankart lesions (anterior and posterior), and subacromial impingement syndrome
- 3 cases for therapeutic arthroscopy: subacromial decompression, subacromial debridement, and loose body removal



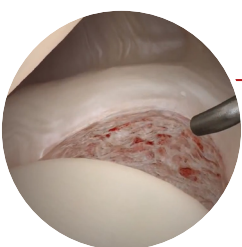
Arthroscopy Basic Skills

Learn instrument handling and triangulation skills while avoiding cartilage damage



Guided Diagnostic Tours

Get familiar with the arthroscopic anatomy and learn to visualize the relevant structures



Diagnostic Cases

Visualize various pathologies in the shoulder joint including impingements and calcification.

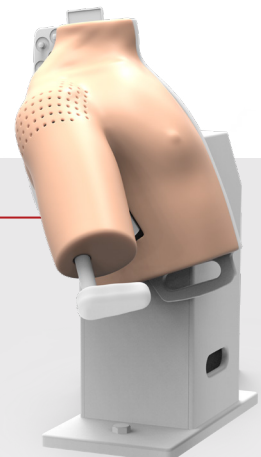


Therapeutic Cases

Master complete procedures such as loose body removals or subacromial decompressions

Hardware

- Anatomic right shoulder model provides learning-essential haptic feedback, including a realistic palpation of landmarks, and movements such as abduction, adduction, flexion, traction and rotation
- Free choice of portals for portal placement training
- Rapid switch between lateral decubitus and beach chair position



VirtaMed ArthroS™ Shoulder Rotator Cuff Repair

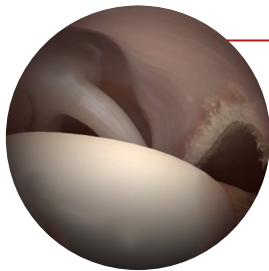
The Rotator Cuff Repair module is an-add on to the ArthroS™ Shoulder module and contains the necessary software and additional instruments necessary to perform a double-row rotator cuff repair.

Trainees will learn:

- Procedure steps to perform a double-row rotator cuff repair
- Manipulation of the shoulder joint and to select appropriate portals to gain access to the subacromial space
- Evaluate a supraspinatus tendon tear
- Become versed in the the double-row repair construct

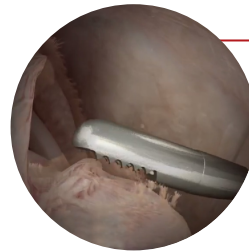
Cases

- 3 simulated diagnostic and preparatory patient cases with different rotator cuff tears (Crescent and L-Shaped)
- 2 therapeutic cases for training double row rotator cuff repair, including correct anchor locations, placement, knotless suture management, tendon piercing, and fixation procedure steps



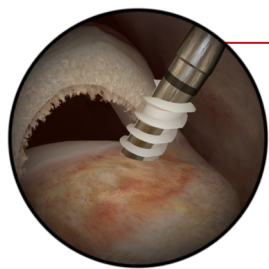
Diagnostics

Diagnostic tours in glenohumeral and subacromial spaces to assess tear pattern and location of crescent and L-shaped tears



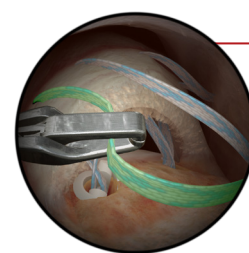
Preparation

Use an arthroscopic shaver to debride the damaged tissue



Anchor Placement

Training of correct anchor location, trajectory and placement

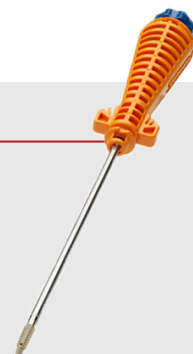


Suture Management

Manage multiple sutures, pierce the tendon and complete double-row fixation

Hardware

- Arthroscopic awl adapted for simulation

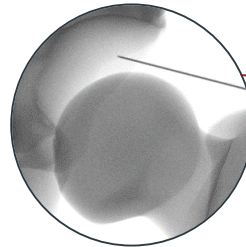


VirtaMed ArthroS™ Hip

To prepare surgeons for a successful hip arthroscopy, the ArthroS™ Hip offers realistic soft tissue layers that allow trainees to palpate bony landmarks to find the correct portals.

Trainees will learn:

- Efficiently use 70 degree angled optics
- Triangulate in either supine or lateral decubitus position
- Navigate the camera and instruments in the central and peripheral aspects of the hip

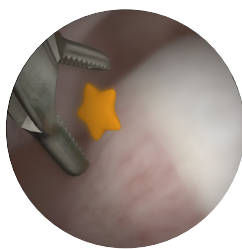


Zero Radiation Fluoroscopy

Real-time simulated fluoroscopic imaging lets trainees adjust instruments during the procedure without the need for a C-arm

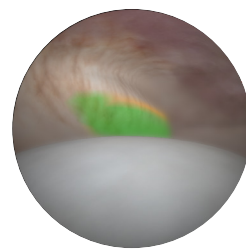
Cases

- 16 cases for basic skills training: guided diagnostic cases and triangulation cases in peripheral and central compartments
- 4 cases for diagnostic arthroscopy: healthy anatomy, labral tear, wave sign cartilage, cartilage flaps
- 2 cases for therapeutic arthroscopy: loose body removal, cam decompression



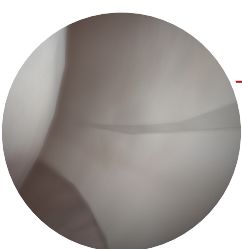
Arthroscopy Basic Skills

Learn instrument handling and triangulation skills while avoiding cartilage damage



Guided Diagnostic Tours

Get familiar with the arthroscopic anatomy and learn to visualize the relevant structures



Diagnostic Cases

Visualize various pathologies in the hip joint including labral tear, and cartilage flaps

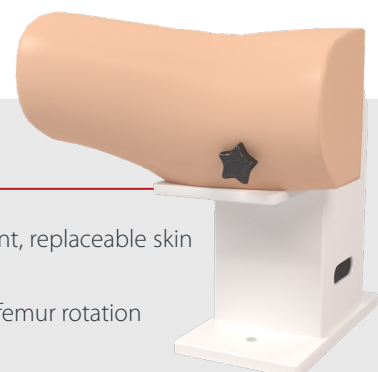


Therapeutic Cases

Master complete procedures such as loose body removals and cam decompressions

Hardware

- Anatomic left hip model with adapted guidewire, halfpipe for portal placement, replaceable skin insert with portals, and two replaceable skin inserts without portals
- Allows for realistic palpation of bony landmarks, joint traction, hip flexion, and femur rotation
- Switch quickly between lateral decubitus and supine positions



VirtaMed ArthroS™ Ankle

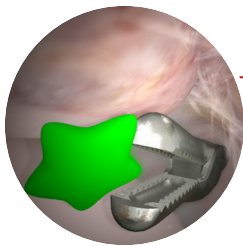
Navigating the ankle joint is difficult; the joint is narrow and the risk of damaging cartilage or nerves is higher than most other arthroscopic surgeries, the curved bone horizon is disorienting, and surgeons often lose track of the exact location of the arthroscopic camera in the absence of visual landmarks. The ArthroS™ Ankle allows trainees to tackle and overcome these challenges prior to their first live patient case.

Trainees will learn:

- Navigate the camera and instruments in the anterior and posterior aspects of the ankle joint
- Visualize the most important anatomical structures and identify pathological conditions
- Triangulate in either prone or supine position
- Control two instruments at the same time and triangulate while avoiding unnecessary tool movement and unintended contact with the cartilage surfaces in the ankle joint.

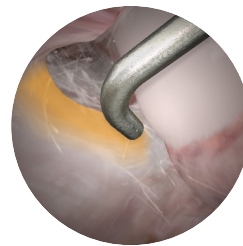
Cases

- 6 cases for basic skills training: guided diagnostic cases, triangulation cases
- 5 cases for diagnostic arthroscopy: healthy anatomy, cartilage defects, loose bodies and impingement conditions
- 2 cases for therapeutic arthroscopy: loose body removal, impingement decompression



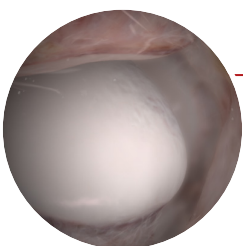
Arthroscopy Basic Skills

Learn instrument handling and triangulation skills while avoiding cartilage damage



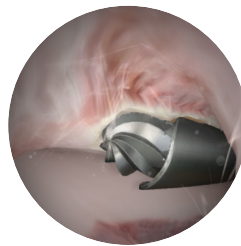
Guided Diagnostic Tours

Get familiar with the arthroscopic anatomy and learn to visualize the relevant structures



Diagnostic Cases

Visualize various pathologies in the ankle joint including impingements and osteochondritis.

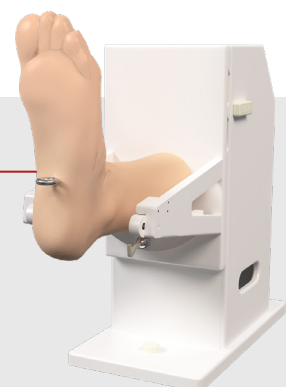


Therapeutic Cases

Master complete procedures such as loose body removals or impingement decompressions

Hardware

- Anatomic left ankle model with bones and tendons provides learning-essential haptic feedback
- Allows for realistic physical manipulation of the joint such as traction and flexion
- Switch quickly between supine and prone positions



Real surgical instruments for OR-ready training

Trainees learn using original instruments specially adapted for simulation. This means that what they practice with is what they use in the operating room.



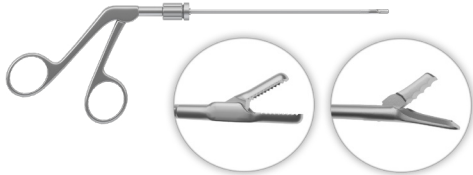
Arthroscope

- Simulated fluid handling
- Focus wheel and functional buttons allow trainees to take images of the procedure which can be reviewed and used for debriefing
- Camera management, with 0, 30 and 70-degree optics available



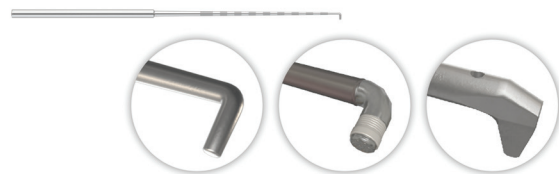
Shaver / Hooded Burr

- Operated with a foot pedal or buttons on the instrument
- Simulated suction
- Switches virtually between a shaver and hooded burr, giving trainees access to more instruments



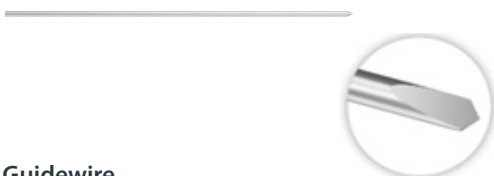
Grasper / Punch

- Instrument can switch virtually between a grasper and a punch
- Ambidextrous; accommodates both dominant and non-dominant hands



Probe / Electrocautery Device

- Multi-use device switches between a probe and electrocautery device
- Electrocautery device is pedal-operated and provides auditory feedback



Guidewire

- Adapted for use with the Concepts of ACL Reconstruction and hip module
- Used with our zero-radiation fluoroscopy to train correct portal placement



Awl

- Adapted for use with the Rotator Cuff Repair module

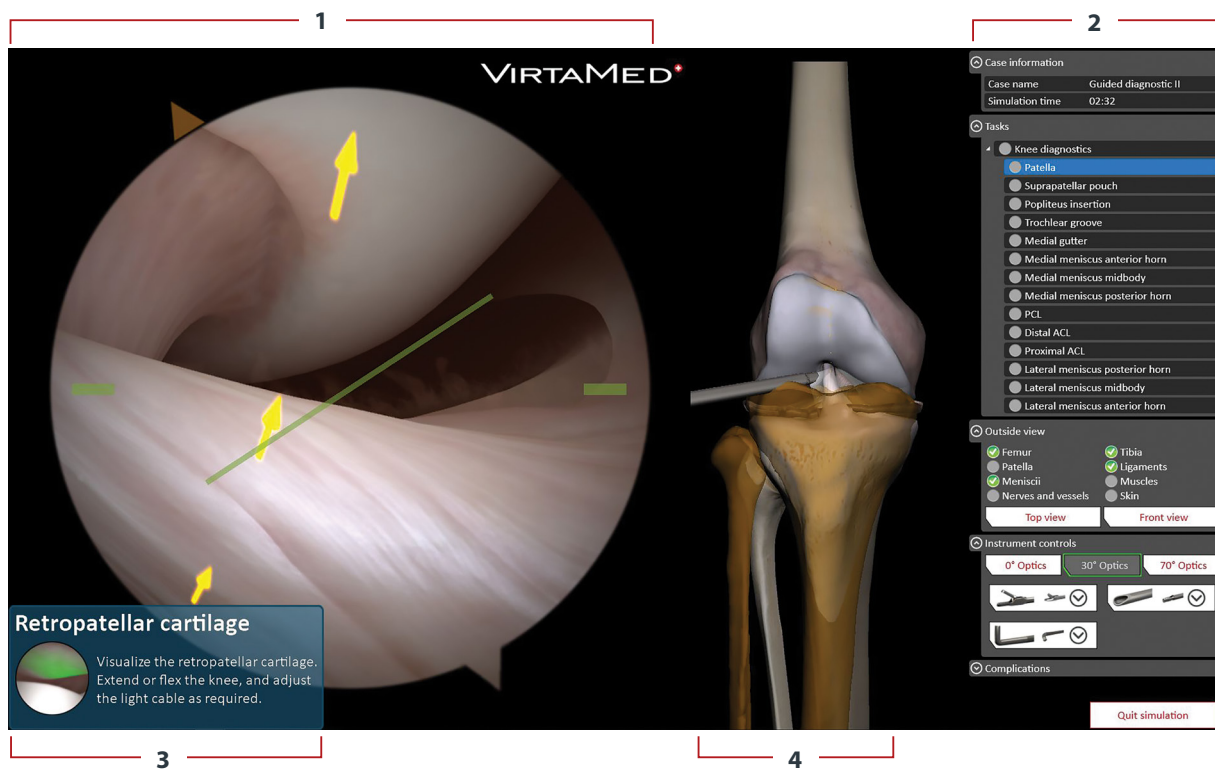
Software designed to make training faster and more effective

1. Arthroscopic view and learning guidance

- Photo-realistic camera view is identical to what trainees would see in the operating room
- Virtual structures can be palpated, shaved, and cut. Joints are movable and external movement is reflected in the arthroscopic view
- Guide arrows and horizon control to help trainees learn diagnostic tours and camera usage

2. Task list, instrument access, and complications

- Tasks automatically check off, letting trainees know what is still left to complete
- Tasks can be selected for additional hints
- Switch between instruments with touch-screen controls
- Complications can be added when trainees are ready



3. Guidance and Severe Error Messages

- Step-by-step messages lead trainees through initial cases and provide basic instruction
- Severe error messages emphasize: potential patient safety issues and costly damage to instruments

4. Inside and outside views

- Trainees can orient themselves and their instruments to quickly learn triangulation and joint navigation
- Can be used to illustrate portal placement, and demonstrate the muscle and nerve structures of the joint
- Suggests external joint movements for best access

Students progress faster with impartial feedback reports

Objective and detailed feedback reports provide information on all aspects of the completed case. Pre-defined benchmarks help students self-assess their progress and empower them to take control of their learning. Data is then stored on the simulator or in the cloud with VirtaMed Connect and can be reviewed at any time.

1. Individualized metrics

- Easily identify areas for improvement
- Ensure trainees are up-to-standard with pre-defined proficiency scores

2. Progress tracking

- Feedback reports are saved and can be reviewed by case and time
- Trainers can easily access reports and view progress over time

3. Videos and images

- The procedure is recorded and can be used along with photos for case review
- Joint overviews highlights iatrogenic damage

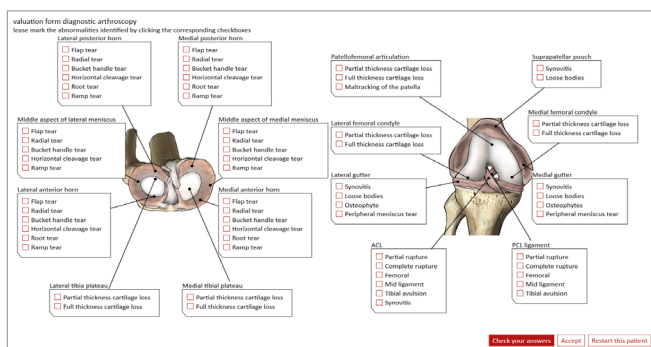


4. Procedure task breakdown

- Easily identify areas for improvement
- Ensure trainees are up-to-standard with pre-defined proficiency scores

5. Interactive graphs

- Identify trends over time and track trainee progress at a glance with interactive graphs

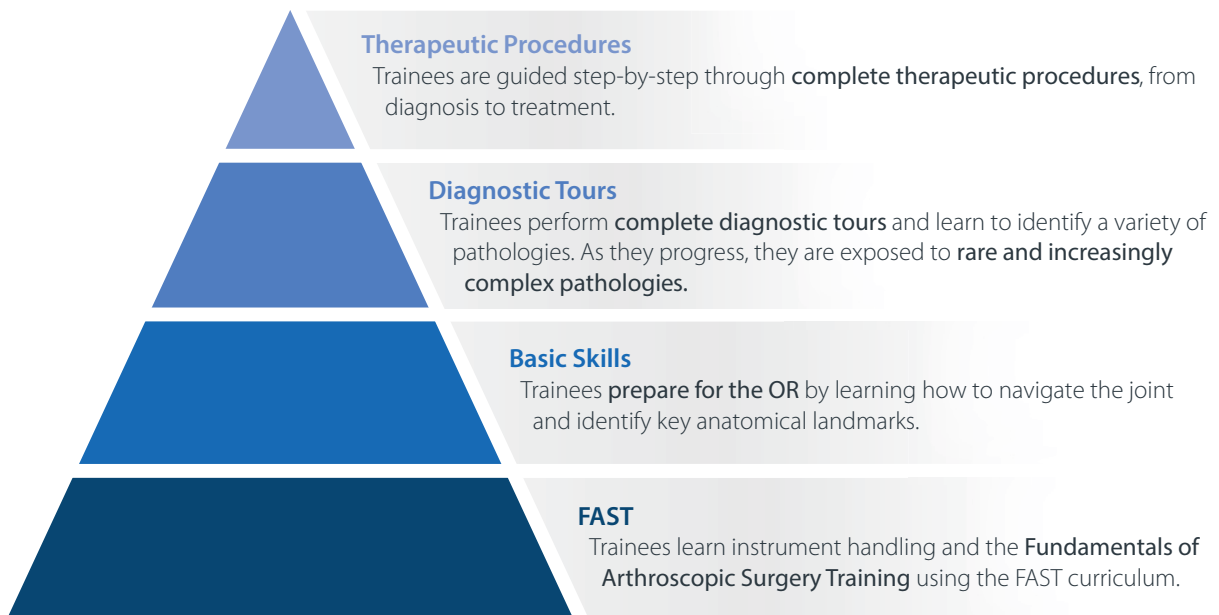


Demonstrable knowledge

Diagnostic cases contain an anatomical diagram and questionnaire which tests trainee knowledge of joint anatomy, pathology identification, and terminology.

Training & Education

We support the entire learning journey. VirtaMed's Training & Education team are experts in the pedagogy of using simulation for medical education. They have in-depth simulator knowledge, medical expertise, years of collaboration experience with world-class physicians. Anything but ordinary, no one is more qualified to help you integrate simulation into your existing training curriculum.



Curriculum Integration Process

Test

- Use simulation to establish a baseline and benchmarks for trainees
- Keep trainees on track and motivated with formative and impartial assessments



Train

- Competency-based courses let trainees progress at the right pace
- Multiple modules/cases offer training for all disciplines and skill levels



Transfer

- Trainees learn on the same types of instruments they will use
- Trainees enter to OR having already mastered the basics

”

VR is more likely to be successful if it is systematically integrated into a well-thought-out education and training program which objectively assesses technical skills and improvement proximate to the learning experience.¹

¹ Gallagher, A. G., et al. "Virtual Reality Simulation for the Operating Room: Proficiency-based Training as a Paradigm Shift in Surgical Skills Training." *Annals of Surgery*. 241, no. 2 (2005): 364.

Curriculum Integration

VirtaMed's high-fidelity virtual-reality simulators support all styles of learning and all levels of curriculum integration. For a one-off course, a week-long seminar, or for the entire residency, the ArthroS offers you and your trainees unparalleled realism, convenience, and risk-free learning opportunities. The platform is compatible with VirtaMed modules for gynecology, urology, and laparoscopy, making it ideal an all-in-one training tool.

One-day courses

- Simulator is ideal for single-day introductory or refresher courses, or skills assessments
- Simulator is portable and can conveniently be used for off-site trainings

Multi-day seminars

- Hold multi-day seminars and utilize competency-based courses to motivate and guide trainees
- Use specific modules for in-depth training on certain joints

Longer courses

- Diverse course offerings support training across the entire learning journey
- Simulator is ready for use 24/7. Supports independent and convenient learning.

6:30 - 7:00 AM	Meet & greet with coffee	
7:00 - 7:45 AM	Introduction to the Simulation Lab <ul style="list-style-type: none"> Introduction to the simulator, how it works, and how to independently operate it Introduce concepts of performance-based proficiency and how to interpret feedback metrics 	
	Group 1	Group 2
8:00 - 9:30 AM	Simulation exercises I (FAST Module) Basic Skills Warm-up with VirtaMed FAST Module <ul style="list-style-type: none"> 6x Image centering (3x camera in dominant hand and 3x camera in non-dominant hand) 6x Telescoping (3x camera in dominant hand and 3x camera in non-dominant hand) 6x Periscoping (3x camera in dominant hand and 3x camera in non-dominant hand) 	Round tables/didactic challenges I <ul style="list-style-type: none"> Overview of relevant joint anatomy Portal placement and function Video demonstration of an arthroscopic tour
3x is the minimum number of repetitions suggested. However, trainees should practice until they reach the predefined proficiency benchmarks provided by AANA before progressing to the next section.		
9:30 - 11:00 AM	Round tables/didactic challenges I	Simulation exercises I (FAST Module)
11:00 - 12:30 PM	Simulation exercises II (FAST and anatomic model) <ul style="list-style-type: none"> Skills evaluation: Diagnostic tour with photos 1x instructor-led demonstration 6x Probe triangulation 3x camera in dominant hand 3x camera in non-dominant hand Practice: 1x Catch the Stars, 1x Triangulation, 1x Diagnostic Tour 	Round tables/didactic challenges II <ul style="list-style-type: none"> Determined by course organizer
12:30 - 1:30 PM	Lunch	
1:30 - 3:00 PM	Round tables/didactic challenges II	Simulation exercises II (FAST and anatomic model)
3:00 - 4:30 PM	Simulation exercises III (anatomic model) <ul style="list-style-type: none"> 3x Diagnostic Tour 3x Unknown pathology with palpation hook 3x Catch the Stars Skills evaluation: Diagnostic tour with photos 	Round tables/didactic challenges III <ul style="list-style-type: none"> Practical exercises Question and answer session
4:30 - 6:00 PM	Round tables/didactic challenges III	Simulation exercises III (anatomic model)
6:00 - 6:30 PM	Final debrief and closing comments. Presentation of Certificates of Achievement	



” Our goal is to improve patient care by advancing education in arthroscopy. We want to ensure all arthroscopic surgeons have access to high-quality skills training and continuous education. Working with VirtaMed's first-rate simulators, experienced developers and dedicated education specialists helps AANA reach that goal.

— Joseph C. Tauro, MD AANA Learning Center Committee Chair

¹ Course outline is based upon a several courses that were conducted by or for AANA members at the OLC Education & Conference Center in Rosemont, IL as well as input from VirtaMed's Training & Education team. Specific courses and their agendas can be found at www.aana.org.



VirtaMed Connect

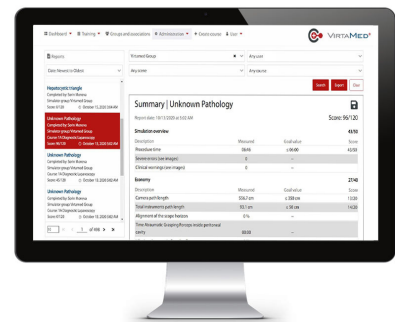
Connect is VirtaMed's cloud-based solution that lets you access your simulator data any time from anywhere. Use Connect to remotely create courses, track student progress, and manage your simulator usage, all from the convenience of your desk or tablet.



Keep your focus on education

Simulator management that lets you focus on what is important

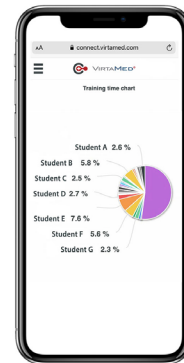
- Access simulators remotely; no need to leave your office
- Conveniently create courses and manage curricula
- Motivate your students with online leader boards



Proficiency-based progression

Use objective performance measurements to guide learning

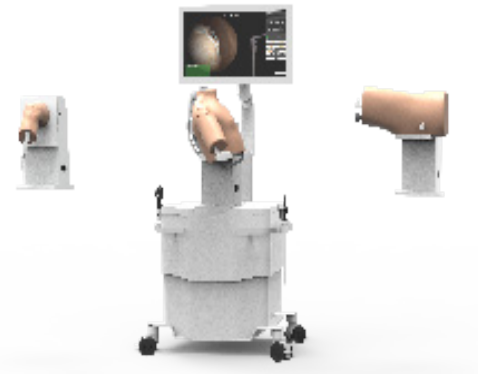
- Coach students on key areas for improvement
- Monitor cohort progress; know who is training and when
- Capture and compare student results over time



Scale to your needs

Log in anywhere: across your simulators and devices

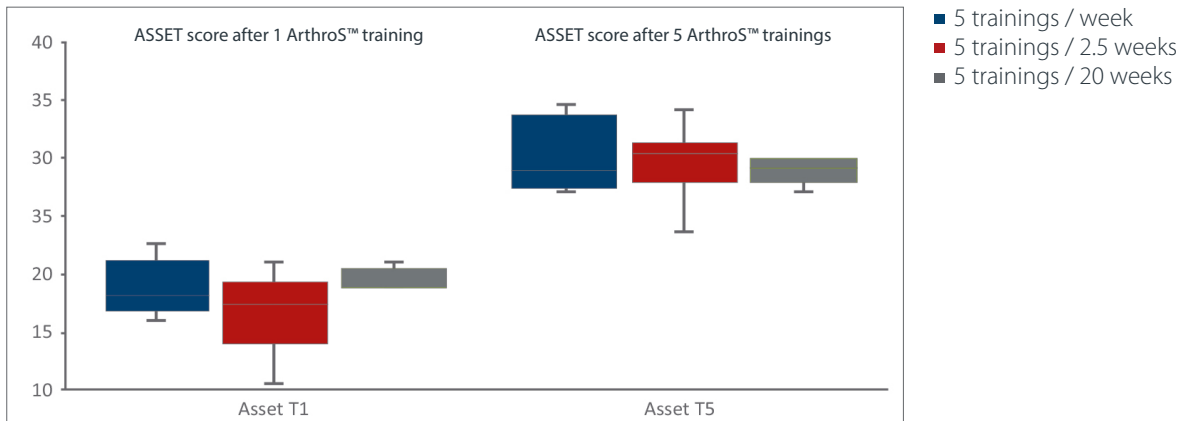
- Facilitate research collaboration with cloud-based data
- Manage multi-simulator and multi-site training programs
- Know your simulator status and location with fleet management
- Requires a stable Internet connection and access to certain services



Validation

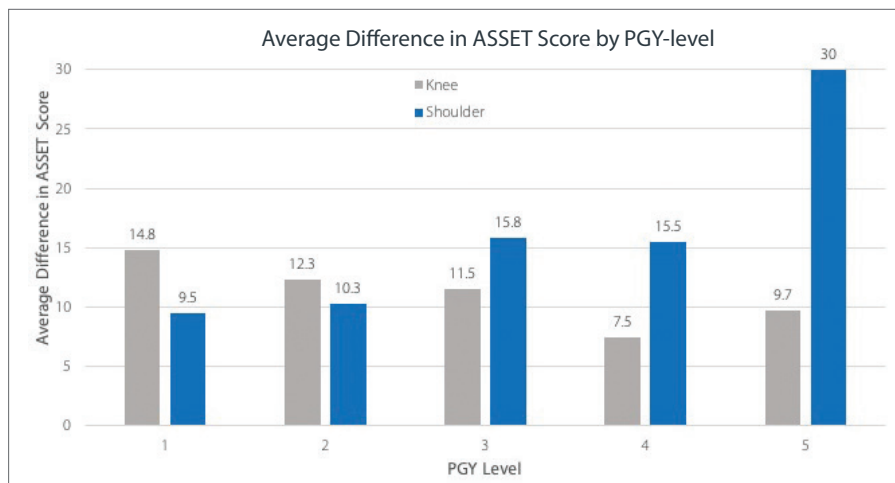
VirtaMed ArthroS™ is the most realistic, accurate, and helpful tool on the market for arthroscopy training.¹

Effectivity of Arthroscopic Skill Acquisition in Virtual Reality Knee Arthroscopy Training²



Simulator training makes a difference, as shown by the ASSET scores of different groups after one training session and again after five training sessions on the VirtaMed ArthroS™ Knee. Any level of training was deemed beneficial, with training twice a week yielding the highest improvement.²

Efficacy of an Arthroscopic Virtual Based Simulator for Orthopaedic Surgery Residents by Year in Training³



Residents training on the VirtaMed ArthroS™ made significant improvements in both their knee and shoulder arthroscopic skills.³

All residents improved with simulation training, with junior residents improving more on the ArthroS™ Knee, and senior residents improving more on the ArthroS™ Shoulder.

” We have assessed all virtual reality arthroscopy simulators on the market, and VirtaMed was clearly the best fit to partner with AANA. The combination of lifelike anatomic models, high-fidelity graphics and original tools adapted for simulation make the VirtaMed ArthroS™ the closest thing to real surgery.

— Laura Downes, CEO of the Arthroscopy Association of North America (AANA)



¹ Pedowitz, R., et al. "Asymmetry in Dominant/Non-Dominant Hand Performance Differentiates Novices from Experts on an Arthroscopy Virtual Reality Serious Game." *Studies in Health Technology and Informatics*. (2016) 220: 289–294.

² Reppenhausen, S., et al. "Effectivity of Arthroscopic Skill Acquisition in Virtual Reality Knee Arthroscopy Training." Poster presented at: ESSKA (May 2016) Barcelona.

³ Yari, S., et al. "Efficacy of an Arthroscopic Virtual Based Simulator for Orthopaedic Surgery Residents by Year in Training." *Orthopaedic Journal of Sports Medicine* (2018).