VirtaMed ArthroS™
The most advanced and comprehensive arthroscopy simulator available
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: surgeons can now learn the basic skills needed before applying them in a joint.

**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 and almost 100 exercises for camera navigation: image centering, horizon control and periscoping, following an object
- 8 cases and almost 100 exercises for basic bi-manual skills: triangulation, probing, and grasping

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**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.

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**Hardware**

- FAST workstation giving your trainees diverse training scenarios
- Instruments adapted for virtual reality provide metrics to measure performance
- Supports ambidextrous training with 90 degree adapter plate
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**
- 14 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

**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 addition to the ArthroS™ Knee. All relevant procedure steps of an anatomical ACL reconstruction can be performed.

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
- 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 provide learning-essential haptic feedback
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 with palpation, more accurate internal pivot points, and improved positioning and feel of biceps tendon.
- Realistic manipulation of the joint, including traction, internal and external rotation, flexion extension, and abduction and adduction.
- Free portal placement lets trainees with additional trocars, provided guidance sheet.
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

Cases

- 8 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, femoroacetabular impingement, 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 impingement, 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

Zero Radiation Fluoroscopy

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

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

**Grasper / Punch**
- Instrument can switch virtually between a grasper and a punch
- Ambidextrous; accommodates both dominant and non-dominant hands.

**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

**Probe / Electrocautery Device**
- Multi-use device switches between a probe and electrocautery device
- Electrocautery device is pedal-operated and provides auditory feedback.

**Guidewire**
- Specially adapted for use in our hip module
- Used with our zero-radiation fluoroscopy to train correct portal placement
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. Progress tracking
   - Feedback reports are saved and can be reviewed by case and time
   - Trainers can easily access reports and view progress over time

2. Procedure task breakdown
   - Debrief trainees on complete and incomplete tasks within the case
   - Trainees learn from mistakes with our severe error warnings

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

4. Individualized metrics
   - 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.
FAST
Trainees learn instrument handling and the Fundamentals of Arthroscopic Surgery Training using the FAST curriculum.

Therapeutic Procedures
Trainees are guided step-by-step through complete therapeutic procedures, from diagnosis to treatment.

Diagnostic Tours
Trainees perform complete diagnostic tours and learn to identify a variety of pathologies. As they progress, they are exposed to rare and increasingly complex pathologies.

Basic Skills
Trainees prepare for the OR by learning how to navigate the joint and identify key anatomical landmarks.

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.

Training & Education Team

Martina Vitz, PhD
Head of Training & Education

Candice Cuvelier
Training & Education Manager

Jimmy Wu
Training & Education Manager

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

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.

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**Course outline is based upon 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.**

“...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
VirtaMed Connect

Connect is VirtaMed’s cloud-based solution that lets you access your simulator data any time from anywhere. Use Connect to remotely assign and update 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 assign 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
- Keep your simulators up-to-date; always know their status
- Requires a stable Internet connection
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

![ASSET score chart](chart.png)

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

![Average Difference in ASSET Score by PGY-level chart](chart2.png)

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)

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Validation Studies

Below is a sample list of validation studies performed on VirtaMed's ArthroS™ simulator. For a full list, please visit our website or contact one of our sales representatives.

I: Studies analyzing face validity of ArthroS™

Validation of the Updated ArthroS Simulator: Face and Construct Validity of A Passive Haptic Virtual Reality Simulator With Novel Performance Metrics
DOI:10.1007/s00167-016-4114-1

Comparison of Three Virtual Reality Arthroscopic Simulators As Part of An Orthopedic Residency Educational Curriculum
Martin K. D, Akoh C. C, Amendola A, Phisitkul P

II: Studies analyzing construct validity

Lessons Taught by a Knee Arthroscopy Simulator About Participants in a European Arthroscopy Training Programme
Baumann Q, Hardy A, Courage O, Lacombes P, Accadbled F
DOI:10.1016/j.otsr.2019.09.008

Validation of the Hip Arthroscopy Module of the VirtaMed Virtual Reality Arthroscopy Trainer
Gallagher K, Bahadori S, Antonis J, Immins T, Wainwright T, Middleton R
Surgical Technology International. 2019 (34).
URL: http://eprints.bournemouth.ac.uk/31821/3/Manuscript.pdf

Knee, Shoulder, and Fundamentals of Arthroscopic Surgery Training: Validation of a Virtual Arthroscopy Simulator
DOI: 10.1016/j.arthro.2016.09.014

III. Studies analyzing training effects and simulator-based learning

Fundamentals of Arthroscopic Surgery Training Program Improves Knee Arthroscopy Simulator Performance in Arthroscopic Trainees
Cychosz C, Tofte J, Johnson A, Gao Y, Phisitkul P
DOI: 10.1016/j.arthro.2017.11.028

Efficacy of Standardized Training on a Virtual Reality Simulator to Advance Knee and Shoulder Arthroscopic Motor Skills
DOI: 10.1186/s12891-018-2072-0

Simulation-Based Training Platforms for Arthroscopy: A Randomized Comparison of Virtual Reality Learning to Benchtop Learning
DOI:10.1016/j.arthro.2016.10.021

Performance of Medical Students on a Virtual Reality Simulator for Knee Arthroscopy: An Analysis of Learning Curves and Predictors of Performance.
Rahm S, Wieser K, Wicki I, Holenstein L, Fucentses S, Gerber C