Cost-Effective Training and Assessment Simulator for Orthopaedic Surgical Skills Via Fundamentals of Orthopaedic Surgery (FORS)

Gregory Lopez[1], MD; David Martin[2], MD; Rick Wright[3], MD; James Jung[1], BS; Dan Bracey[2], MD; Peter Hahn[1] and Ranjan Gupta[1], MD

[1]Department of Orthopaedic Surgery, University of California Irvine
[2]Department of Orthopaedic Surgery and Rehabilitation, Wake Forest School of Medicine
[3]Department of Orthopaedic Surgery, Washington University School of Medicine

All authors have no financial disclosures in relation to this study.

Old teaching paradigm

"See one, do one, teach one"

William Halsted

The Need for Change

- Financial concerns
- Restricted work hours
- Expanded skill requirements
- Increased public scrutiny

= Practice outside of the OR
Low risk/pressure setting
Increase efficiency
Basic skills learned

Simulation in Aviation

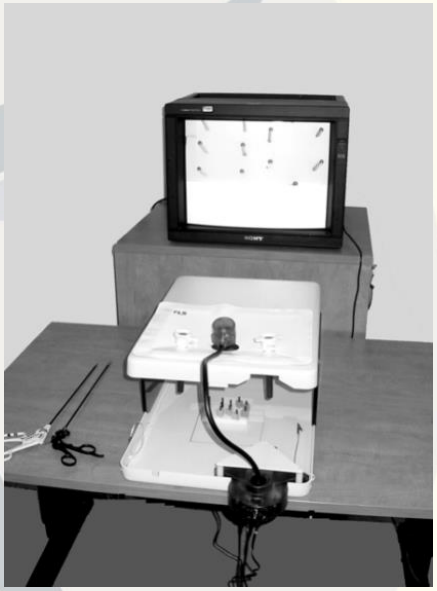
- Require > 200 hours of flight simulation before flying F18.
- Average 6 – 8 hours simulation before each flight.
- If away ≥ 15 days must complete full curriculum with simulated flying to proficiency requirements.

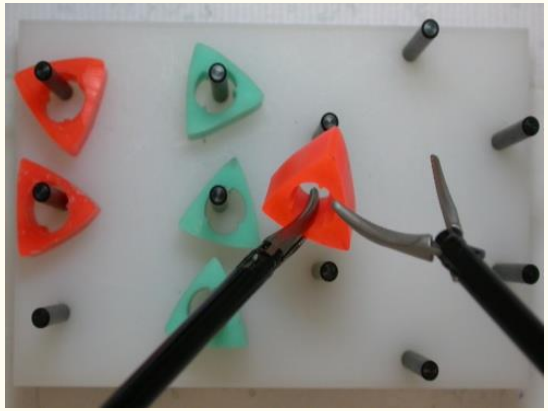
If it is required for pilots – why not surgeons??

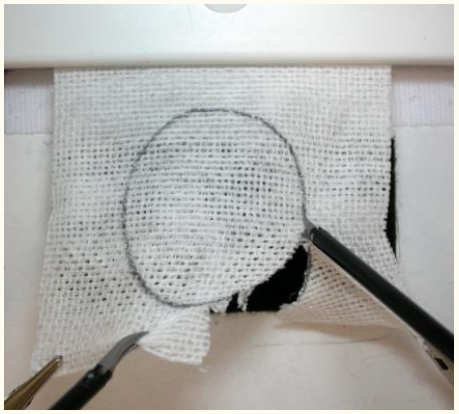
What is FLS?

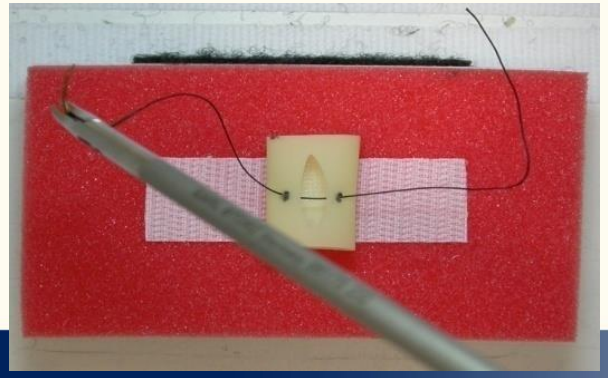
- Comprehensive Web-based modules
- **Hands-on skills training Component**
- Assessment Tool that teaches
  - Physiology
  - Fundamental knowledge
  - **Technical skills required for basic laparoscopic surgery**
- Designed to measure
  - cognitive knowledge
  - case/problem management skills
  - **manual dexterity**

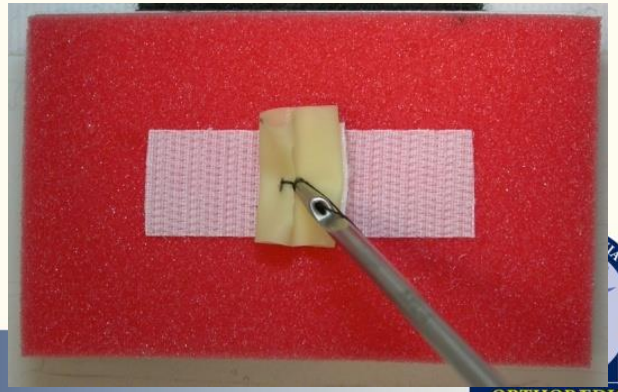
FLS Simulator Skills











Fundamentals of Laparoscopic Surgery

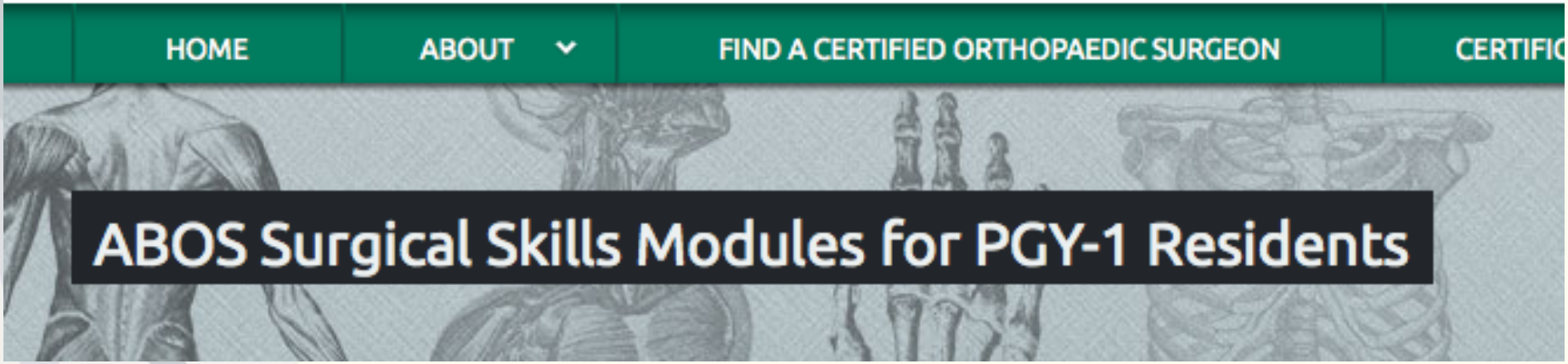
- Joint program of SAGES and American College of Surgeons
- Used for high-stakes examination
- Required by ABS to take qualifying exam

Peters et al.: Surgery 135: 21-27, 2004

What are we doing in Orthopaedic Surgery?

The American Board of Orthopaedic Surgery

Establishing Education & Performance Standards for Orthopaedic Surgeons



Traction Techniques

Joel T. Jeffries, MD
Shepard R. Hurwitz, MD

Problem Identification and Needs Assessment

Identification of targeted learners

Targeted learners will include PGY 1 Orthopaedic Surgery residents with potential inclusion of PGY 2 residents and ER/OR staff.

Identification of need or problem for targeted learners

Skeletal traction is a fundamental treatment modality for fractures involving the cervical spine and long bones, specifically the femur. The implementation of traction often occurs in

traction rope. For the application of Gardner Wells tongs, the learner would apply tongs to a portion of large diameter PVC pipe. In doing so, the learner will demonstrate appropriate technique and the ability to secure the device to traction rope.

Goals and Objectives

Specific educational goals

- The learner will understand the indications for skeletal traction and the relevant local anatomy.
- The learner will understand the pros and

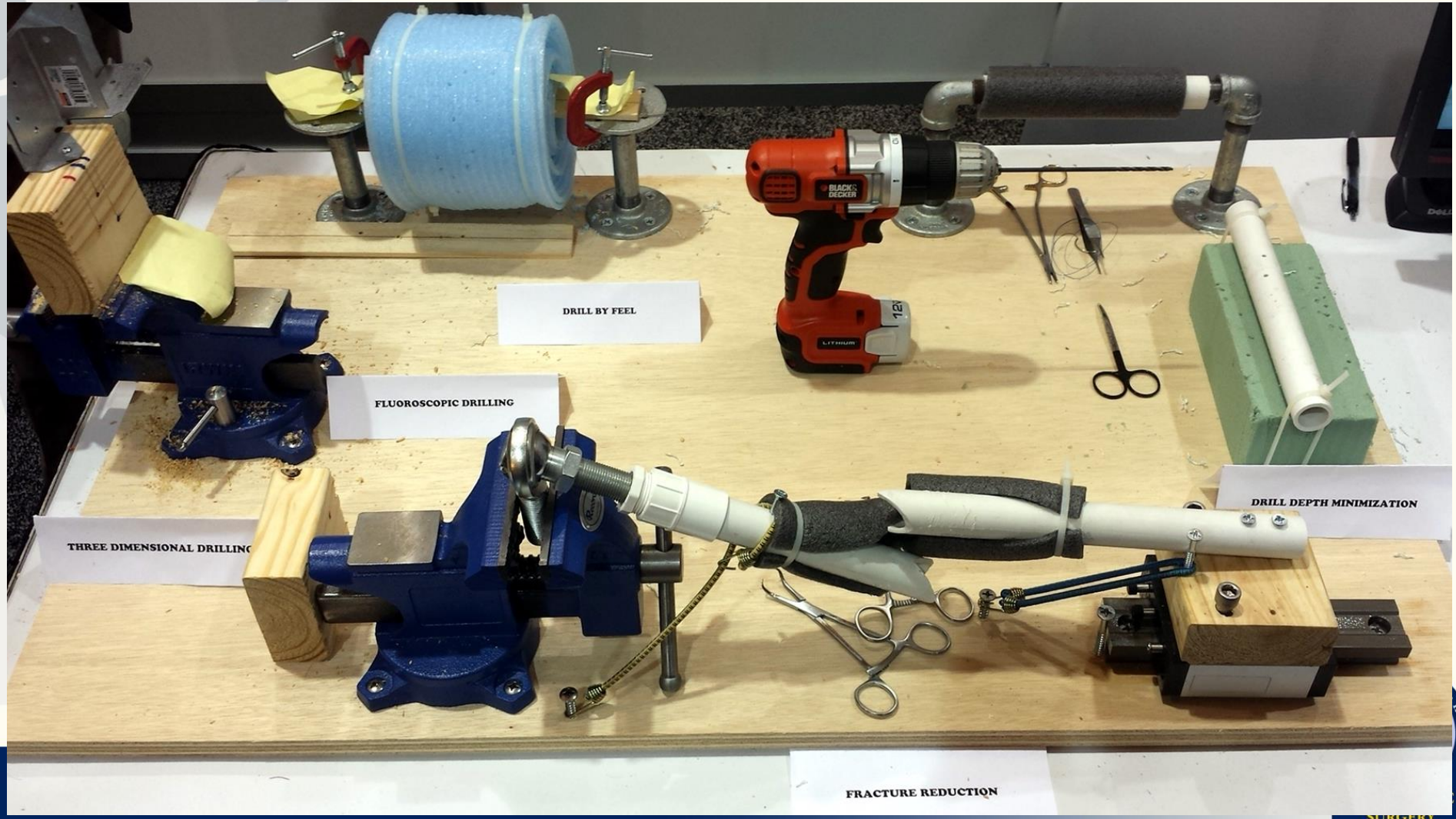
Where are we with Orthopaedic Surgery Simulation Training?

- Simulation is currently being used with:
  - cadaveric labs
  - synthetic bone exercises
  - high priced virtual reality simulators

- There is a need to supplement this training with cost effective simulation that teaches basic psychomotor skills that translate across a wide range of operations.

Educational Goals

- The purpose of this study was to develop and validate a cost-effective psychomotor training and assessment tool

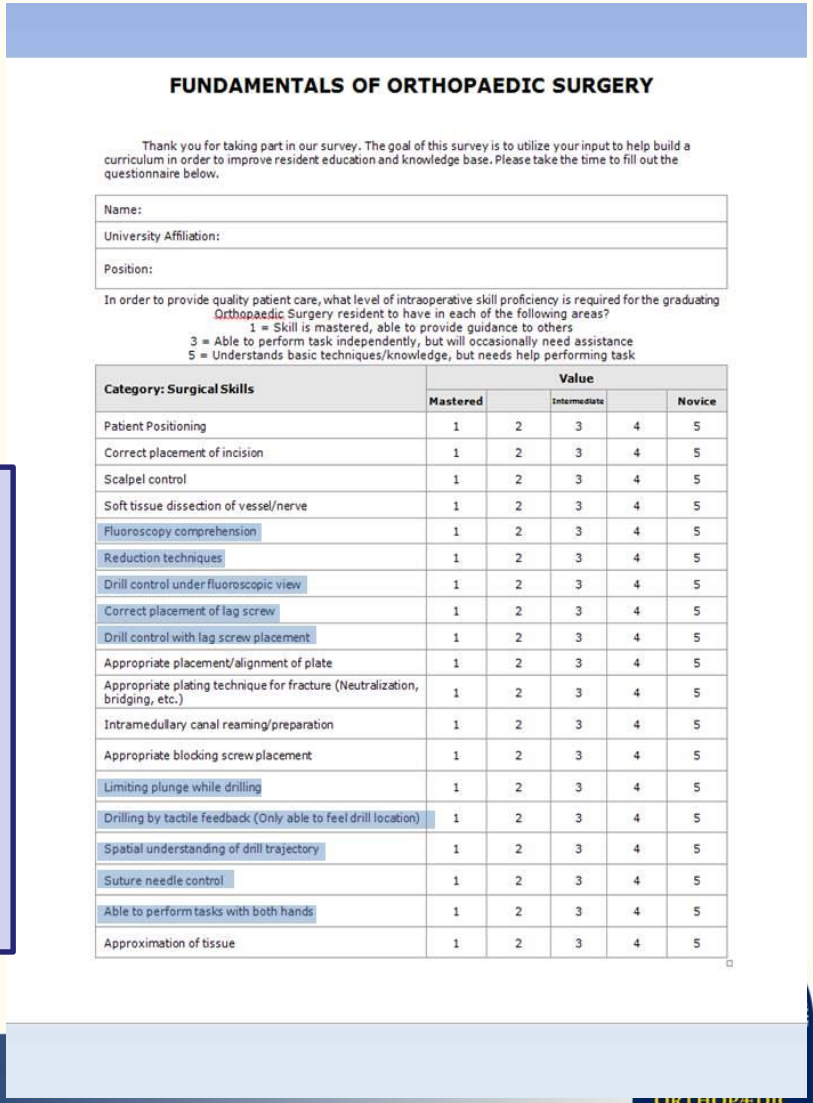


Methods

A questionnaire was distributed to twelve ABOS certified Orthopaedic surgery attending physicians asking them to rate basic skills necessary to become a competent Orthopaedic surgeon.

Highest Rated Skills

- Fracture reduction
- Correct lag screw placement/Directional control of the drill
- Fluoroscopic drilling
- Drilling with Tactile Feedback
- Drill plunge minimization
- Soft Tissue Closure



FUNDAMENTALS OF ORTHOPAEDIC SURGERY

Thank you for taking part in our survey. The goal of this survey is to utilize your input to help build a curriculum in order to improve resident education and knowledge base. Please take the time to fill out the questionnaire below.

Name:
University Affiliation:
Position:

In order to provide quality patient care, what level of intraoperative skill proficiency is required for the graduating Orthopaedic Surgery resident to have in each of the following areas?
1 = Skill is mastered, able to provide guidance to others
3 = Able to perform task independently, but will occasionally need assistance
5 = Understands basic techniques/knowledge, but needs help performing task

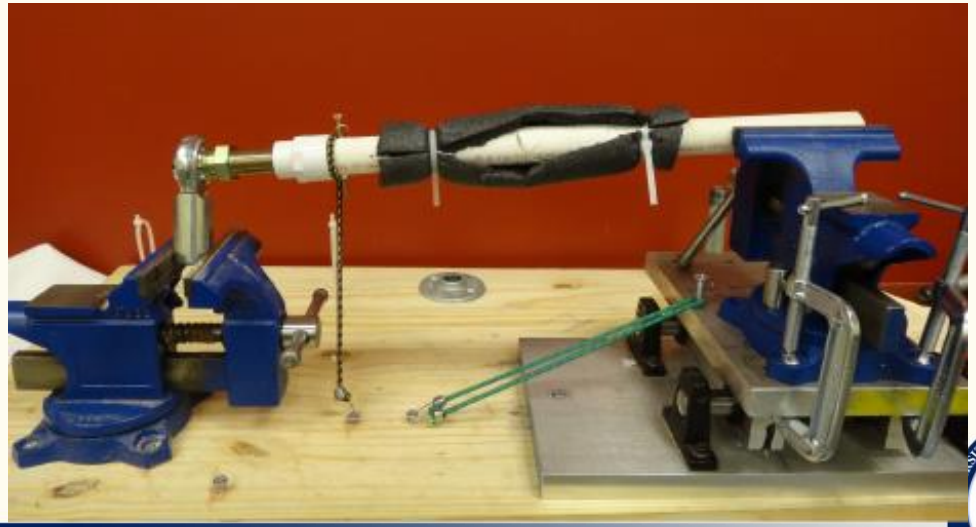
Category: Surgical Skills	Value				
	Mastered		Intermediate		Novice
Patient Positioning	1	2	3	4	5
Correct placement of incision	1	2	3	4	5
Scalpel control	1	2	3	4	5
Soft tissue dissection of vessel/nerve	1	2	3	4	5
Fluoroscopy comprehension	1	2	3	4	5
Reduction techniques	1	2	3	4	5
Drill control under fluoroscopic view	1	2	3	4	5
Correct placement of lag screw	1	2	3	4	5
Drill control with lag screw placement	1	2	3	4	5
Appropriate placement/alignment of plate	1	2	3	4	5
Appropriate plating technique for fracture (Neutralization, bridging, etc.)	1	2	3	4	5
Intramedullary canal reaming/preparation	1	2	3	4	5
Appropriate blocking screw placement	1	2	3	4	5
Limiting plunge while drilling	1	2	3	4	5
Drilling by tactile feedback (Only able to feel drill location)	1	2	3	4	5
Spatial understanding of drill trajectory	1	2	3	4	5
Suture needle control	1	2	3	4	5
Able to perform tasks with both hands	1	2	3	4	5
Approximation of tissue	1	2	3	4	5

Simulator Development

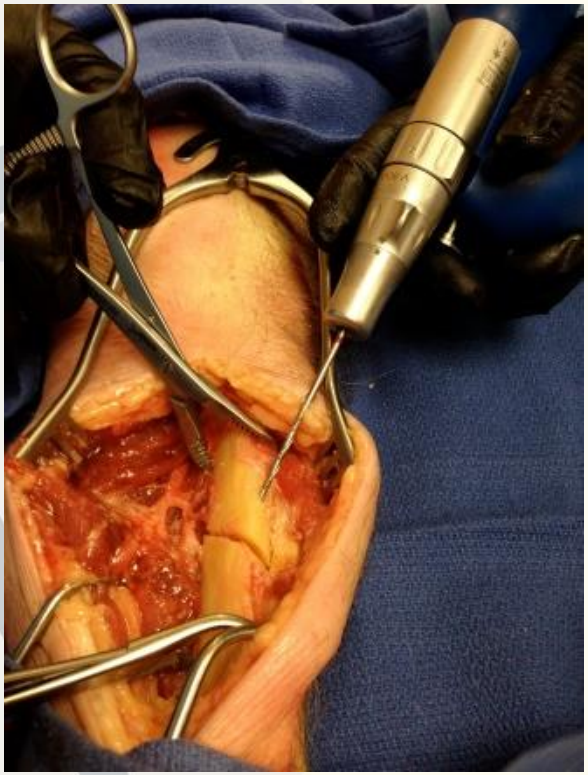
- Less than $400 total
- Materials are available at hardware stores
- No cadaver bone, synthetic bones, medical equipment
- Quick setup, reusable parts, easily assembled

Simulator Tasks

Fracture Reduction
The participant uses two crab claws and reduces a PVC pipe fracture without grabbing the surrounding soft tissue. Rotational and shortening forces are present.



Simulator Tasks



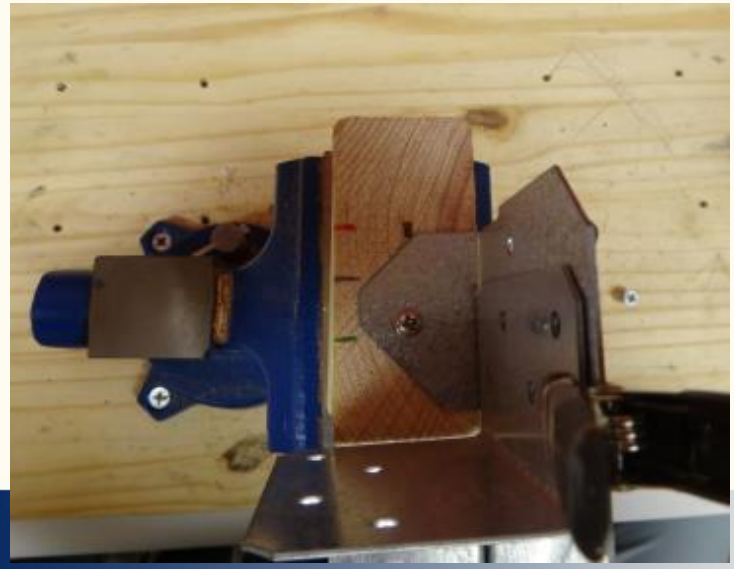
Three Dimensional Drilling

The participant aims a drill bit at different angles through a pre-marked block of wood with color-coordinated visible entry and exit points.

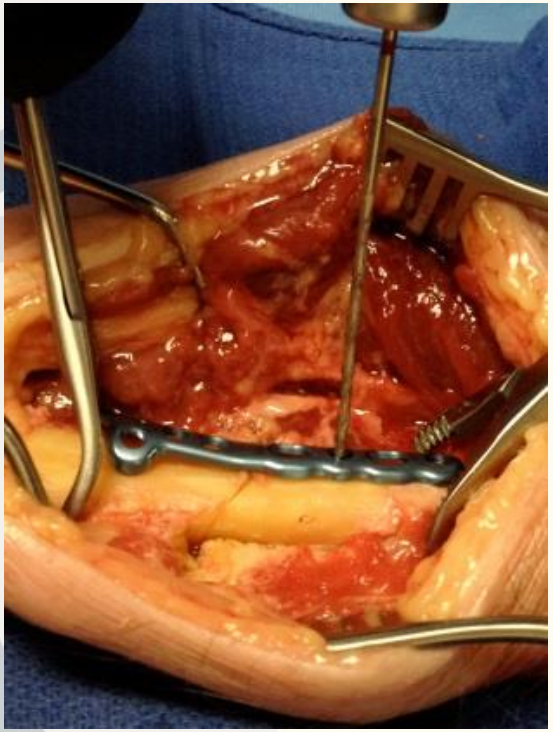
Simulator Tasks

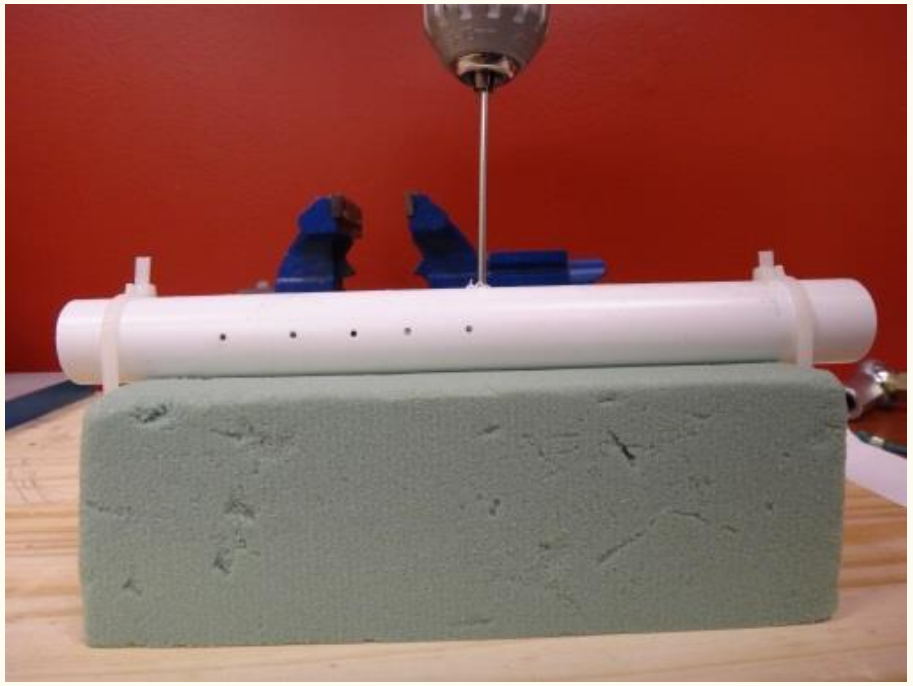
Fluoroscopic Drilling
The participant aims a drill bit through a pre-marked block of wood with color coordinated visible entry points.

The participant triangulates the covered exit point by using the color-coordinated guide marks on perpendicular planes of the block.



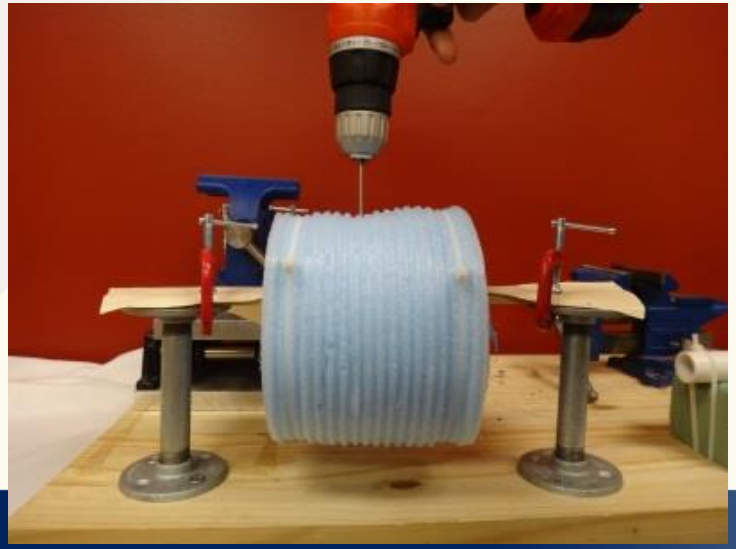
Simulator Tasks





Depth of Plunge Minimization
Participants drill multiple holes in in a PVC pipe while limiting the distance they plunge into the foam base on the other side.

Simulator Tasks



Drill by Feel
A flat wooden board is wrapped in a foam envelope. The participants use the tip of their drill to feel the board and attempt to drill through the midline.

Simulator Tasks

Suture Closure

Participants suture across a defect in the PVC pipe insulation. Participants place simple interrupted sutures across the defect.

Testing

- 3 ACGME accredited Orthopaedic Surgery Residency Programs
- An identical simulation board was created at each institution
- Different observers/score keepers were used at each site
- 26 medical students were retained for longitudinal tracking. Biweekly training labs were held with initial testing then 15 minutes of training. This occurred over a 4 week period.

Washington University in St. Louis

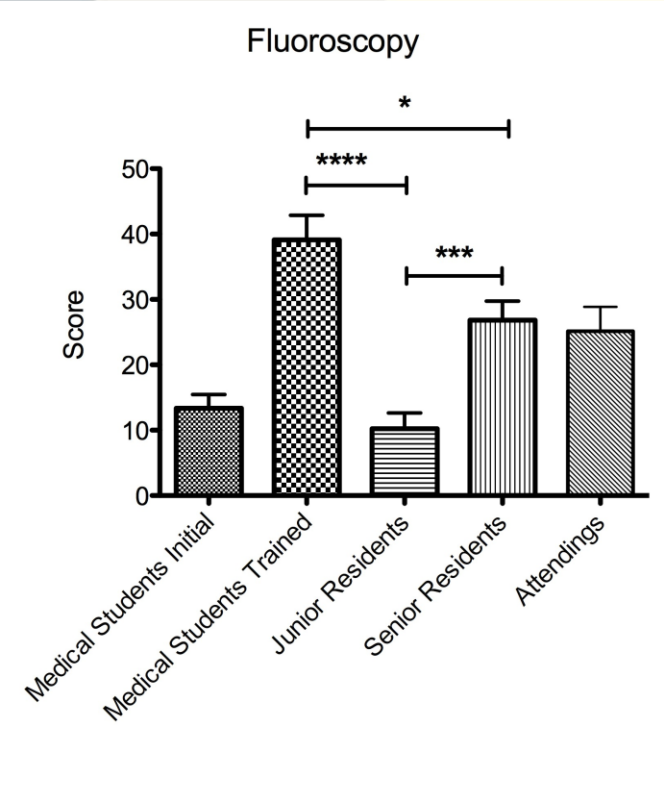
Wake Forest® School of Medicine

Results

- 46 Medical students, 25 Attending physicians, and 58 Orthopaedic surgery residents participated in the study.
- Comparisons between medical students initial vs. trained scores, junior vs. senior level resident scores, and students trained vs. junior level resident scores were evaluated.
- A one- way Anova test was performed to determine statistical significance (p value < 0.05).
- Statistical significance was found in the majority of the exercises between groups.
- The twenty six medical students who were retained for longitudinal training and teaching improved above junior resident level in four of the six tasks.

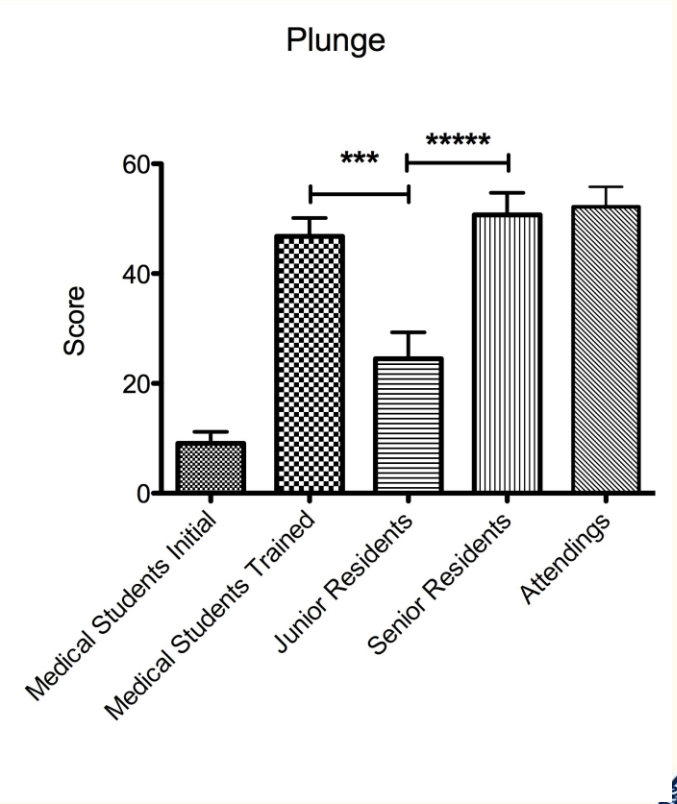
Demographics				
Medical Students Initial	**Medical Students Trained**	**Junior Residents**	**Senior Residents**	**Attendings**
33	26	29	29	25

Fluoroscopic Drilling



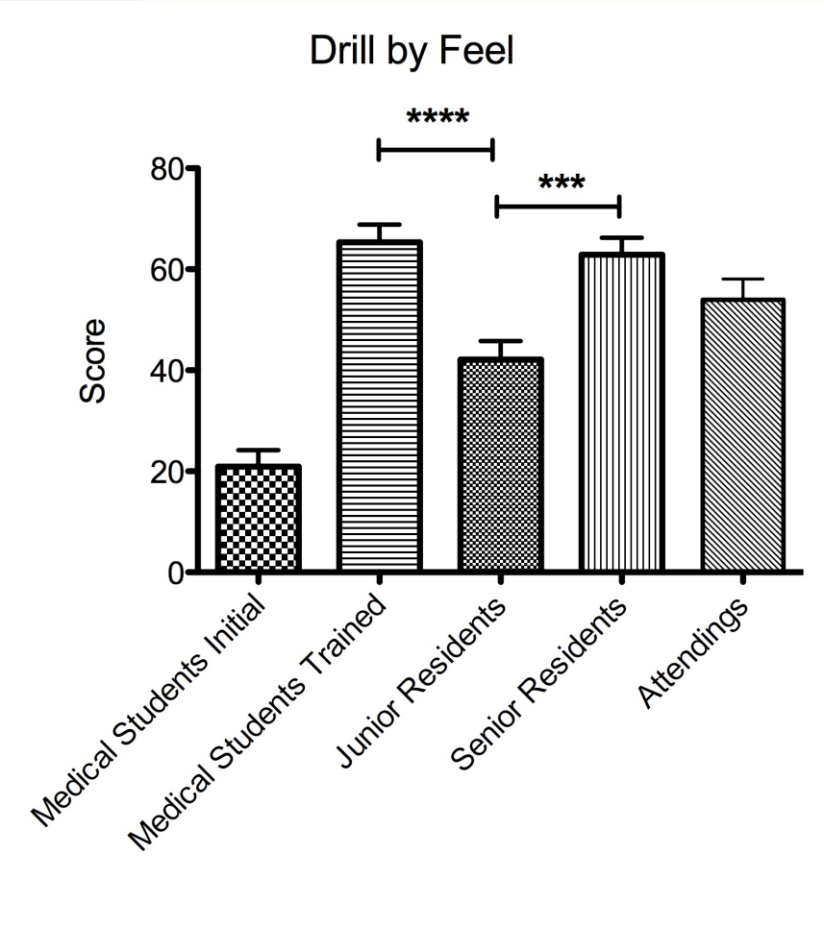
Fluoroscopy: Scores were calculated for fracture reduction for each group and compared. *p<0.05, **p<0.01, ***p<0.001, ****p<0.0001

Depth of Plunge Minimization



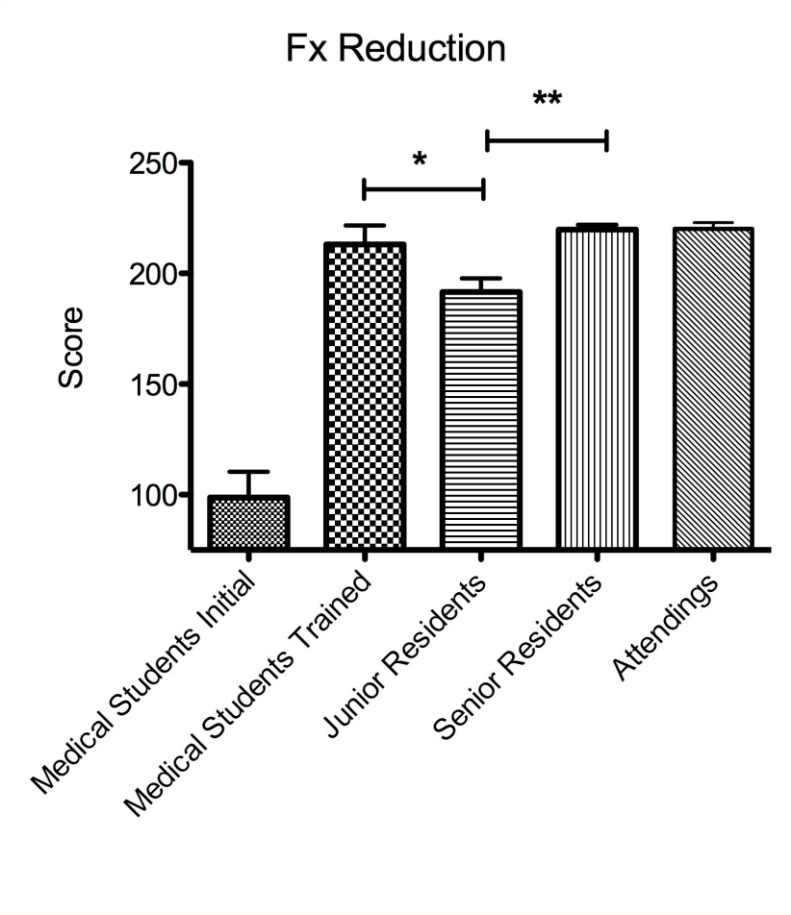
Plunge: Scores were calculated for each group and compared. A significant difference was shown between medical student groups and the resident groups. *p<0.05, ***p<0.001

Drill by Feel



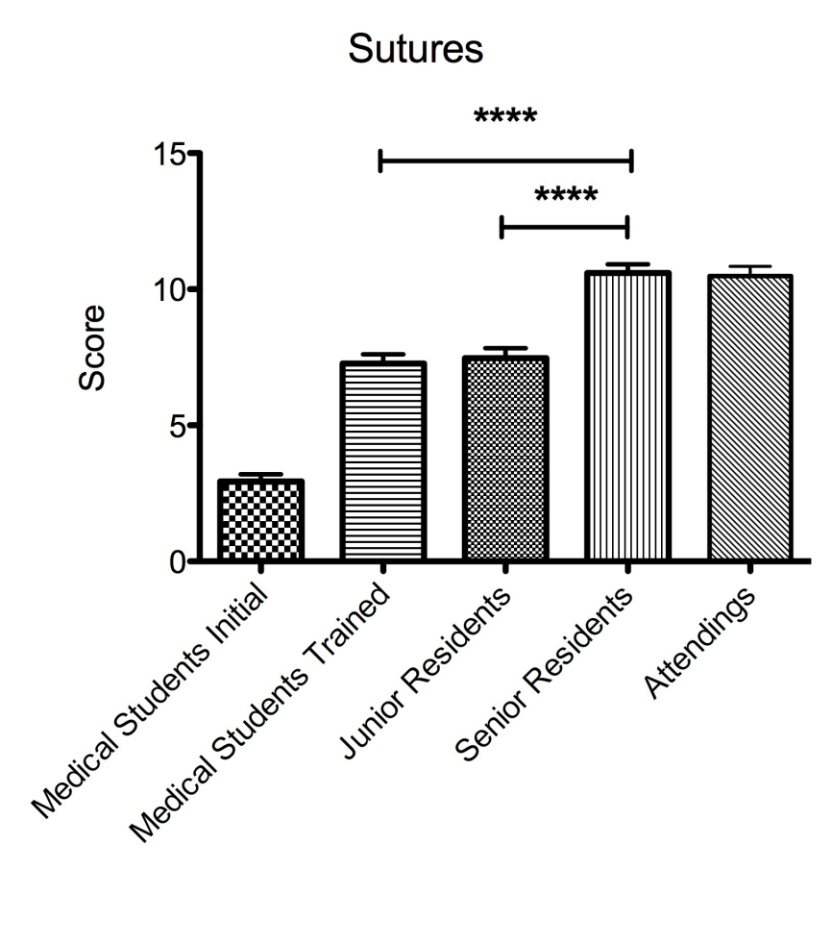
Drill by Feel: Scores were calculated for each group and compared. Significance was shown between the medical student groups, the trained medical students and junior residents, and the resident groups. ***p<0.001

Fracture Reduction



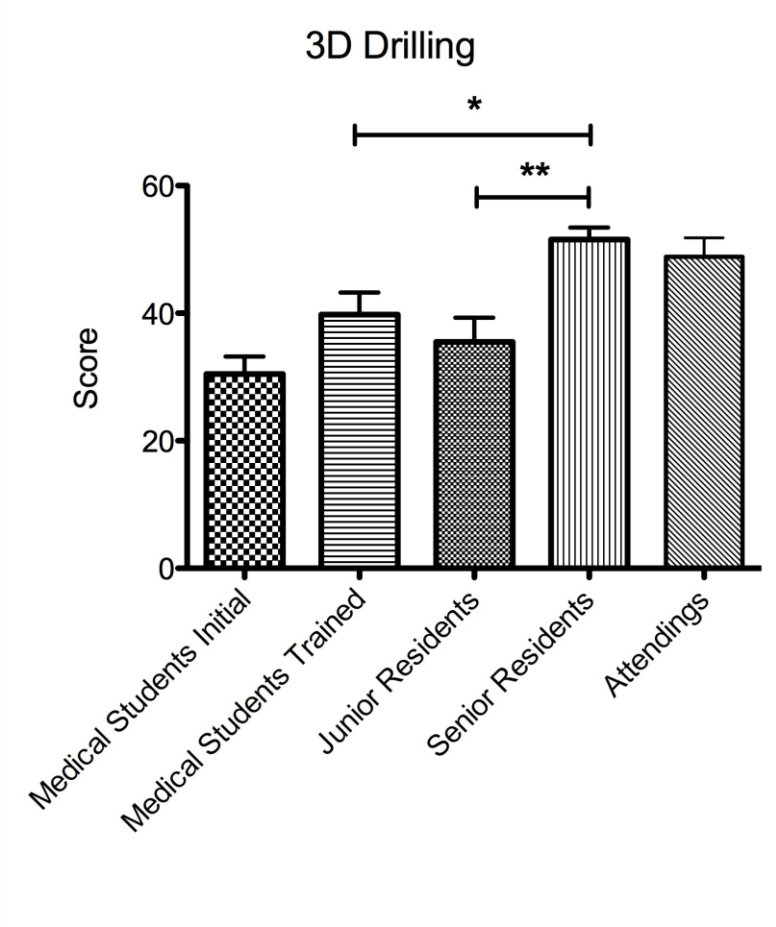
Fracture Reduction Group: Scores were calculated for each group and compared. A significant was shown between medical student groups. ***p<0.001

Suturing



Sutures: Scores were calculated and compared for each group. Significance was shown between the medical student groups and the resident groups. ****p<0.0001

3D Drilling



3D Drilling: Scores were calculated for each group and compared. No scores were significant.

Discussion

Neurophysiology of Motor Skill Learning

Simulation is advantageous as it allows for repetitive practice of a particular skill with immediate feedback, that if repeated over an extended period of time, long-term structural modifications occur in the brain

Phase I "Fast Learning" GABA-related neural processes that select optimal routine for the performance of the task.

Phase II "Slow Learning" Long-term structural modification of basic motor modules. Time dependent strengthening of links between motor neurons in different areas of the brain.

Acquisition of Skilled Motor Performance A Karni et al: Proc Natl Acad Sci 1998; 95: 861 – 868

U Ziemann et al: Brain 2001; 124: 1171 - 1181

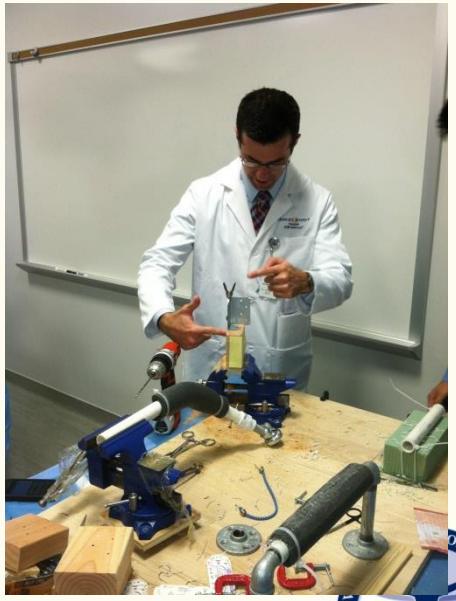
Discussion

Fundamentals of Orthopaedic Surgery Simulator

Discussion

Fundamentals of Orthopaedic Surgery Simulator

- Tasks that clearly are trainable with this Simulator
  - Fracture reduction
  - Fluoroscopic Drilling
  - Depth of plunge minimization
  - Drill by Feel
- Greater numbers being collected for Significance
  - Suturing
  - 3 D drilling
- The Fundamentals of Orthopaedic Surgery Simulator
  - Cost effective
  - Able to differentiate between training levels
  - Has demonstrated the ability to improve the performance of novice trainees with training.



Thank you for your attention….