http://dx.doi.org/10.2106/JBJS.19.00982

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Supplementary Appendix

Table of Contents:

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Performance of Orthopedic Surgical Steps Pre-Activity Questionnaire

Q1 What is your current level of orthopaedic education?

- O Resident
- O Fellow
- O Staff appointed surgeon

Q2 If you are a resident, what post-graduate year of training (PGY) are you currently enrolled?

- O 1
- O 2
- O 3
- O 4
- O 5
- O 6

Q3 If you are a fellow, what fellowship number are you currently enrolled?

- O 1st
- O 2nd
- O 3rd

Q4 How would you subjectively quantify your experience with shoulder surgical approaches?

- O Not very familiar
- O Somewhat familiar
- O Very familiar

Q5 How would you subjectively quantify your experience with shoulder arthroplasty (total shoulder arthroplasty or reverse total shoulder arthroplasty requiring glenoid exposure and preparation)?

- O Not very familiar
- O Somewhat familiar
- O Very familiar

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Q6 How many shoulder surgery specific courses or lectures have you attended outside of your surgical training curriculum for which you are currently, or were previously enrolled?

- O 0-1
- O 1-3
- O >3

Q7 How many shoulder arthroplasty cases (total shoulder arthroplasty or reverse total shoulder arthroplasty) have you been primary surgeon?

- O 0
- O 1-20
- O 20-40
- O >40

Q8 If you are a staff appointed shoulder surgeon, how many estimated total shoulder arthroplasty, or reverse total shoulder arthroplasty cases do you perform yearly?

- O 0
- O 1-20
- O 20-40
- O >40

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Q9 Have you utilized simulators in your surgical education, residency, fellowship, or otherwise?

O Yes

O No

Q10 If you have utilized simulators in your surgical education, did you feel these improved your technical skill or knowledge?

O Not at all improved

O Somewhat improved

O Much improvement

Q11 Have you ever used any virtual reality products?

O Yes

O No

Q12 Have you ever used any virtual reality products in your surgical education, residency, fellowship or otherwise?

O Yes

O No

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Q13 If you have utilized virtual reality products in your surgical education, do you feel that these improved your technical skill or knowledge?

- O Not at all improved
- O Somewhat improved
- O Much improvement

Performance of Orthopedic Surgical Steps Post-Activity Questionnaire

Q1 Please enter your candidate code in the space provided

_____

Q2 Did you enjoy your pre-cadaveric activity?

- O Definitely yes
- O Mostly yes
- O Somewhat
- O Mostly not
- O Definitely not

Q3 Did you learn anything from your pre-cadaveric activity?

- O Definitely yes
- O Mostly yes
- O Somewhat
- O Mostly not
- O Definitely not

Q4 Did you feel that your pre-cadaveric/mock operating room learning tool was easy to understand and to use?

- O Definitely yes
- O Probably yes
- O Somewhat
- O Mostly not
- O Definitely not

Q5 Did you feel that your pre-cadaveric/mock operating room activity adequately prepared you for your cadaveric operating room experience?

- O Definitely yes
- O Probably yes
- O Somewhat
- O Mostly not
- O Definitely not

Q6 How would you rate the appearance of the anatomic structures in your pre-cadaveric activity in regard to realism?

- O Very real
- O Somewhat real
- O Unsure
- O Somewhat not real
- O Very unrealistic

Q7 How would you rate the appearance of the surgical equipment used in the pre-cadaveric activity in regard to realism?

- O Very real
- O Somewhat real
- O Unsure
- O Somewhat not real
- O Very unrealistic

Q8 How would you rate the interactive ability of the anatomic structures in regards to realism?

- O Very real
- O Somewhat real
- O Unsure
- O Somewhat not real
- O Very unrealistic

Q9 How would you rate the interactive ability of the surgical instrumentation with the anatomic structures in regard to realism?

- O Very real
- O Somewhat real
- O Unsure
- O Somewhat not real
- O Very unrealistic

Q10 How would you rate the user control scheme in regard to surgical operating room realism?

- O Very real
- O Somewhat real
- O Unsure
- O Somewhat not real
- O Very unrealistic

Q11 How would you rate the realism of the haptic feedback provided by the controllers when interacting with the anatomic structures?

- O Very real
- O Somewhat real
- O Unsure
- O Somewhat not real
- O Very unrealistic

Q12 How ergonomic was the control system used in the pre-cadaveric activity?

- O Very ergonomic
- O Somewhat ergonomic
- O Unsure
- O Somewhat not ergonomic
- O Very not ergonomic

Q13 How would you rate the realism of the movement of the instruments?

- O Very real
- O Somewhat real
- O Unsure
- O Somewhat not real
- O Very unrealistic

Q14 What is your OVERALL impression of realism of the pre-cadaveric activity?

- O Very real
- O Somewhat real
- O Unsure
- O Somewhat not real
- O Very unrealistic

Q15 How proficient was the pre-cadaveric activity in teaching anatomy?

- O Very good
- O Somewhat good
- O Neither good nor bad
- O Somewhat not good
- O Very poor

Q16 How good was the pre-cadaveric activity in teaching retractor placement around the glenoid?

- O Extremely good
- O Somewhat good
- O Neither good nor bad
- O Somewhat bad
- O Extremely bad

Q17 How proficient was the pre-cadaveric activity in teaching glenoid preparation in shoulder arthroplasty?

- O Very good
- O Somewhat good
- O Neither good nor bad
- O Somewhat not good
- O Very poor

Q18 How proficient was the pre-cadaveric activity in teaching key surgical steps in shoulder arthroplasty?

- O Very good
- O Somewhat good
- O Neither good nor bad
- O Somewhat not good
- O Very poor

Q19 How proficient was the pre-cadaveric activity in teaching problem-solving of poor glenoid exposure in shoulder arthroplasty?

- O Very good
- O Somewhat good
- O Neither good nor bad
- O Somewhat not good
- O Very poor

Q20 How similar was the pre-cadaveric activity to the OR scenario in regards to teaching points and teaching surgical steps?

- O Very similar
- O Somewhat similar
- O Unsure
- O Somewhat not similar
- O Very dissimilar

Q21 How well did the pre-cadaveric activity prepare you for the OR scenario?

- O Extremely well
- O Very well
- O Moderately well
- O Slightly well
- O Not well at all

Q22 What is your OVERALL impression of the pre-cadaveric activity in teaching key steps to glenoid preparation in total shoulder arthroplasty compared to the OR activity?

- O Very good
- O Somewhat good
- O Neither good nor bad
- O Somewhat not good
- O Very poor

Q23 Would you use the pre-cadaveric activity again to learn steps in shoulder arthroplasty?

- O Yes
- O Maybe
- O No

Q24 Do you feel that repeated use of the pre-cadaveric/mock operating room preparation learning tool would provide additional benefit, or continued learning?

- O Definitely yes
- O Probably yes
- O Might or might not
- O Probably not
- O Definitely not

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Q25 Do you feel that the pre-cadaveric/mock operating room preparation learning tool has a role in surgical education?

- O Yes
- O Maybe
- O No

Q26 Do you feel that the pre-cadaveric/mock operating room preparation learning tool would benefit surgical education for novice surgeons, such as residents or fellows?

- O Yes
- O Maybe
- O No

Q27 Do you feel that the pre-cadaveric/mock operating room preparation learning tool would provide benefit to expert surgeons performing shoulder arthroplasty?

- O Yes
- O Maybe
- O No

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Q28 Do you feel that Immersive Virtual Reality simulators have a role in surgical education?

O Yes

O Maybe

O No

Performance of Orthopedic Surgical Steps Post Activity Questionnaire - Paper

Q1 Please enter your candidate code in the space provided

_____

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Q2 Did you enjoy your pre-cadaveric activity?

- O Definitely yes
- O Mostly yes
- O Somewhat
- O Mostly not
- O Definitely not

Q3 Did you learn anything from your pre-cadaveric activity?

- O Definitely yes
- O Mostly yes
- O Somewhat
- O Mostly not
- O Definitely not

Q4 Did you feel that your pre-cadaveric/mock operating room learning tool was easy to understand and to use?

- O Definitely yes
- O Probably yes
- O Somewhat
- O Mostly not
- O Definitely not

Q5 Did you feel that your pre-cadaveric/mock operating room activity adequately prepared you for your cadaveric operating room experience?

- O Definitely yes
- O Probably yes
- O Somewhat
- O Mostly not
- O Definitely not

Q6 What is your OVERALL impression of realism of the pre-cadaveric activity?

- O Very real
- O Somewhat real
- O Unsure
- O Somewhat not real
- O Very unrealistic

Q7 How proficient was the pre-cadaveric activity in teaching anatomy?

- O Very good
- O Somewhat good
- O Neither good nor bad
- O Somewhat not good
- O Very poor

Q8 How good was the pre-cadaveric activity in teaching retractor placement around the glenoid?

- O Extremely good
- O Somewhat good
- O Neither good nor bad
- O Somewhat bad
- O Extremely bad

Q9 How proficient was the pre-cadaveric activity in teaching glenoid preparation in shoulder arthroplasty?

- O Very good
- O Somewhat good
- O Neither good nor bad
- O Somewhat not good
- O Very poor

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Q10 How proficient was the pre-cadaveric activity in teaching key surgical steps in shoulder arthroplasty?

- O Very good
- O Somewhat good
- O Neither good nor bad
- O Somewhat not good
- O Very poor

Q11 How proficient was the pre-cadaveric activity in teaching problem-solving of poor glenoid exposure in shoulder arthroplasty?

- O Very good
- O Somewhat good
- O Neither good nor bad
- O Somewhat not good
- O Very poor

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Q12 How similar was the pre-cadaveric activity to the OR scenario in regards to teaching points and teaching surgical steps?

- O Very similar
- O Somewhat similar
- O Unsure
- O Somewhat not similar
- O Very dissimilar

Q13 How well did the pre-cadaveric activity prepare you for the OR scenario?

- O Extremely well
- O Very well
- O Moderately well
- O Slightly well
- O Not well at all

Q14 What is your OVERALL impression of the pre-cadaveric activity in teaching key steps to glenoid preparation in total shoulder arthroplasty compared to the OR activity?

- O Very good
- O Somewhat good
- O Neither good nor bad
- O Somewhat not good
- O Very poor

Q15 Would you use the pre-cadaveric activity again to learn steps in shoulder arthroplasty?

- O Yes
- O Maybe
- O No

Q16 Do you feel that repeated use of the pre-cadaveric/mock operating room preparation learning tool would provide additional benefit, or continued learning?

- O Definitely yes
- O Probably yes
- O Might or might not
- O Probably not
- O Definitely not

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Q17 Do you feel that the pre-cadaveric/mock operating room preparation learning tool has a role in surgical education?

- O Yes
- O Maybe
- O No

Q18 Do you feel that the pre-cadaveric/mock operating room preparation learning tool would benefit surgical education for novice surgeons, such as residents or fellows?

- O Yes
- O Maybe
- O No

Q19 Do you feel that the pre-cadaveric/mock operating room preparation learning tool would provide benefit to expert surgeons performing shoulder arthroplasty?

- O Yes
- O Maybe
- O No

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Q20 Do you feel that Immersive Virtual Reality simulators have a role in surgical education?

- O Yes
- O Maybe
- O No

Performance of Orthopedic Surgical Steps Item Specific Rater Document

Q1 Please enter candidate start time

_____

Q2 Was the subject able to adequately perform capsulotomy?

- O Definitely yes
- O Mostly yes
- O Somewhat
- O Mostly not
- O Definitely not

Q3 Was the subject able to safely place a postero-inferior retractor?

- O Definitely yes
- O Mostly yes
- O Somewhat
- O Mostly not
- O Definitely not

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Q4 Was the subject able to safely place a posterosuperior retractor?

- O Definitely yes
- O Mostly yes
- O Somewhat
- O Mostly not
- O Definitely not

Q5 Was the subject able to safely place an anterior retractor?

- O Definitely yes
- O Mostly yes
- O Somewhat
- O Mostly not
- O Definitely not

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Q6 Was the subject able to correctly name retractors used in exposure of the glenoid?

- O Definitely yes
- O Mostly yes
- O Somewhat
- O Mostly not
- O Definitely not

Q7 If glenoid exposure using initial retractors was poor, was the subject able to identify this and utilize other retractor types?

- O Definitely yes
- O Mostly yes
- O Somewhat
- O Mostly not
- O Definitely not

Q8 Was the subject able to problem solve glenoid exposure and identify aids in improvement including: paralysis via anesthesia, triceps release, separation of capsule and subscapularis, humeral head cut revision?

- O Definitely yes
- O Mostly yes
- O Somewhat
- O Mostly not
- O Definitely not

Q9 Do you feel that the subject was adequately prepared for the cadaveric task?

- O Definitely yes
- O Mostly yes
- O Somewhat
- O Mostly not
- O Definitely not

Q10 Did you feel that the subject completed the tasks in a reasonable time?

- O Definitely yes
- O Mostly yes
- O Somewhat
- O Mostly not
- O Definitely not

Q11 Do you feel that the subject requires further training in relation to shoulder arthroplasty?

- O Definitely yes
- O Mostly yes
- O Somewhat
- O Mostly not
- O Definitely not

Q12 Please enter candidates end-time

_____

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Performance in Orthopedic Surgical Skills Post-Activity Test

Q1 The following questions will act as an assessment of learning key steps to glenoid preparation for shoulder arthroplasty derived from your activity.

Q2 What anatomic structure must be incised to gain access to the glenohumeral joint and labrum?

_____

Q3 What structure is at risk during surgical exploration INFERIOR to the glenoid?

_____

Q4 Please list as many options for retractors to aid in glenoid visualization as possible

_____

_____

_____

_____

_____

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Q5 Please list as many options for aids in improving glenoid visualization if poor visualization is encountered

_____

_____

_____

_____

_____

Q6 What is the ideal position of the arm to aid in glenoid visualization?

_____

Q7 Partial resection of this ligamentous structure allows greater posterior retraction of the humerus and improved visualization of the superior glenoid

_____

Q8 Release of the glenoid capsule during capsulectomy beyond the 6 o'clock position may contribute to this phenomenon

_____

_____

_____

_____

_____

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Q9 Two key parameters of humeral preparation aid in glenoid visualization. Name them.

_____

_____

_____

_____

Objective Structured Assessment of Technical Skills (OSATS)(1)

Q1 RESPECT FOR TISSUE

O Frequently used unnecessary force on tissue or caused damage by inappropriate use of instruments

O Careful handling of tissue but occasionally caused inadvertent damage

O Consistently handled tissue appropriately with minimal damage

---

Q2 TIME AND MOTION

O Many unnecessary moves

O Efficient time/motion but some unnecessary moves

O Economy of movement and maximum efficiency

Q3 INSTRUMENT HANDLING

- O Repeatedly makes tentative or awkward moves with instruments
- O Competent use of instruments although occasionally appeared stiff or awkward
- O Fluid moves with instruments and no awkwardness

Q4 FLOW OF OPERATION AND FORWARD PLANNING

- O Frequently stopped operating or needed to discuss next move
- O Demonstrated ability for forward planning with steady progression of operative procedure
- O Obviously planned course of operation with effortless flow from one move to the next

Reference:

1. Martin JA, Regehr G, Reznick R, MacRae H, Murnaghan J, Hutchison C, et al. Objective structured assessment of technical skill (OSATS) for surgical residents. Br J Surg. 1997 Feb;84(2):273–8.

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CONSORT 2010 checklist of information to include when reporting a randomised trial*

Section/Topic	Item No	Checklist item	Reported on page No
Title and abstract			
	1a	Identification as a randomised trial in the title	1
	1b	Structured summary of trial design, methods, results, and conclusions (for specific guidance see CONSORT for abstracts)	4
Introduction			
Background and objectives	2a	Scientific background and explanation of rationale	3,4
	2b	Specific objectives or hypotheses	4
Methods			
Trial design	3a	Description of trial design (such as parallel, factorial) including allocation ratio	5
	3b	Important changes to methods after trial commencement (such as eligibility criteria), with reasons	n/a
Participants	4a	Eligibility criteria for participants	5
	4b	Settings and locations where the data were collected	5
Interventions	5	The interventions for each group with sufficient details to allow replication, including how and when they were actually administered	5,6,7
Outcomes	6a	Completely defined pre-specified primary and secondary outcome measures, including how and when they were assessed	6,7
	6b	Any changes to trial outcomes after the trial commenced, with reasons	n/a
Sample size	7a	How sample size was determined	7
	7b	When applicable, explanation of any interim analyses and stopping guidelines	n/a
Randomisation:			
Sequence generation	8a	Method used to generate the random allocation sequence	5
	8b	Type of randomisation; details of any restriction (such as blocking and block size)	5

Allocation concealment mechanism	9	Mechanism used to implement the random allocation sequence (such as sequentially numbered containers), describing any steps taken to conceal the sequence until interventions were assigned	5
Implementation	10	Who generated the random allocation sequence, who enrolled participants, and who assigned participants to interventions	5
Blinding	11a	If done, who was blinded after assignment to interventions (for example, participants, care providers, those assessing outcomes) and how	6
	11b	If relevant, description of the similarity of interventions	5
Statistical methods	12a	Statistical methods used to compare groups for primary and secondary outcomes	7
	12b	Methods for additional analyses, such as subgroup analyses and adjusted analyses	7
Results			
Participant flow (a diagram is strongly recommended)	13a	For each group, the numbers of participants who were randomly assigned, received intended treatment, and were analysed for the primary outcome	8
	13b	For each group, losses and exclusions after randomisation, together with reasons	8
Recruitment	14a	Dates defining the periods of recruitment and follow-up	n/a – single session
	14b	Why the trial ended or was stopped	n/a
Baseline data	15	A table showing baseline demographic and clinical characteristics for each group	9
Numbers analysed	16	For each group, number of participants (denominator) included in each analysis and whether the analysis was by original assigned groups	8
Outcomes and estimation	17a	For each primary and secondary outcome, results for each group, and the estimated effect size and its precision (such as 95% confidence interval)	9,10,11
	17b	For binary outcomes, presentation of both absolute and relative effect sizes is recommended	n/a
Ancillary analyses	18	Results of any other analyses performed, including subgroup analyses and adjusted analyses, distinguishing pre-specified from exploratory	n/a
Harms	19	All important harms or unintended effects in each group (for specific guidance see CONSORT for harms)	n/a
Discussion			
Limitations	20	Trial limitations, addressing sources of potential bias, imprecision, and, if relevant, multiplicity of analyses	15
Generalisability	21	Generalisability (external validity, applicability) of the trial findings	14
Interpretation	22	Interpretation consistent with results, balancing benefits and harms, and considering other relevant evidence	12,13,14,15
Other information			
Registration	23	Registration number and name of trial registry	n/a

Protocol	24	Where the full trial protocol can be accessed, if available	n/a – provided as supplemental information
Funding	25	Sources of funding and other support (such as supply of drugs), role of funders	5

*We strongly recommend reading this statement in conjunction with the CONSORT 2010 Explanation and Elaboration for important clarifications on all the items. If relevant, we also recommend reading CONSORT extensions for cluster randomised trials, non-inferiority and equivalence trials, non-pharmacological treatments, herbal interventions, and pragmatic trials. Additional extensions are forthcoming: for those and for up to date references relevant to this checklist, see www.consort-statement.org.