Validation of Assessing Arthroscopic Skill using the ASSET Evaluation

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BACKGROUND: The Accreditation Council for Graduate Medical Education and the American Board of Orthopaedic Surgery have implemented "milestones" to evaluate residents during their progression in medical education. The purpose of this study was to determine whether a validated evaluation tool correlates with surgical experience, year in training, and progression over time.

DESIGN: This was a retrospective study of already collected curriculum assessment data where 2 unbiased, blinded orthopedic surgeons evaluated resident performance on basic diagnostic knee arthroscopy using the Arthroscopic Surgical Skills Evaluation Tool (ASSET) over 3 years. Residents also gained arthroscopy experience through a structured arthroscopy curriculum and clinical experience.

SETTING: The study was conducted at the TRIA Orthopaedic Center (Bloomington, Minnesota, USA), an institutional site for The University of Minnesota orthopedic surgery residency program.

PARTICIPANTS: Eleven orthopedic surgery residents at postgraduate years 2 to 5 were evaluated using the ASSET.

RESULTS: The Pearson's Correlation Coefficient was used to validate both the number of arthroscopic procedures performed by residents ($r = 0.946$) and their level in training ($r = 0.89$). Residents who were re-evaluated after undergoing the arthroscopy curriculum throughout the year displayed significant increases in total ASSET scores ($p < 0.01$).

CONCLUSION: Resident performance on the ASSET correlated with arthroscopic experience based on year-in training. More importantly, performance improved with additional years of training, demonstrating validity over time. The data also demonstrates interobserver reliability. Due to these correlations between exposure to surgery and score on the ASSET, we believe the tool could serve as a suitable means for assessing residents' technical proficiency as required by The Accreditation Council for Graduate Medical Education program guidelines. (J Surg Ed 76:1640–1644. © 2019 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

ABBREVIATIONS: ACGME, Accreditation Council for Graduate Medical Education ABOS, American Board of Orthopaedic Surgery ASSET, Arthroscopic Surgical Skills Evaluation Tool ICC intraclass correlation coefficient

KEY WORDS: Lower limb orthopaedics, Education, ASSET, arthroscopy, residents

COMPETENCIES: Medical Knowledge, Practice-Based Learning and Improvement, Professionalism

INTRODUCTION

Orthopedic education is rapidly evolving. The Accreditation Council for Graduate Medical Education (ACGME), as of July 1st, 2013, is now requiring medical residency programs to show that they are helping their residents achieve proficiency in many clinical areas known as "milestones".[1] These milestones cover the medical knowledge and patient care areas of clinical work. Inside the area of clinical work is included surgical skill. This is a transformative difference. Rather than the traditional time-based and experience-based determination of competency, there is increasing interest in more structured assessment of graduating residents. In the past, surrogates such as time on rotation and case experience (e.g. case logs), as well as rotation evaluations by faculty, have been used to show that residents should be allowed to graduate and therefore sit for their certifying examinations. Now that there are more stringent requirements of programs to demonstrate improvement of their learners over time, new tools are required to demonstrate

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this progression. These different areas of knowledge require different testing methods in order to be effectively assessed. For instance, in terms of medical knowledge, it is possible to use written tests to assess this. For clear reasons, technical skills, such as knee arthroscopy, are not adequately evaluated using written tests alone.

Several tools have been developed to assess surgical skills. The Objective Structured Assessment of Technical Skill global rating skills have been used for evaluation in open general surgery procedure skills.[7] Similar scales have been created for minimally invasive procedures such as laparoscopic and endoscopic procedures.[2,3,9] The Arthroscopic Surgery Skill Evaluation Tool (ASSET) was created for assessing global arthroscopic technical skill. It was designed to be applicable in multiple arthroscopic procedures in both the live operating room as well as the simulation center.[5] Its fundamental design is to be generalizable while maintaining validity and reliability. Furthermore, it can be used (as it was in this paper) in an anonymous fashion allowing blinding of those doing the assessment. Previously, the tool has been shown to differentiate residents based on the level of training,[5] thereby indicating that there is correlation between scores on the ASSET and traditional methods of determining surgeon competence.

The goal of this paper was not only to verify that the ASSET correlates with traditional educational benchmarks, but also to see if the ASSET improves as a resident progresses through residency. This second level of validation is important to determine if there are additional confounding factors in the assessment of resident learning and technical improvement. Based on existing work, it was the goal of this study to determine if the ASSET was reliable and valid at evaluating surgical skill in orthopedic surgery residents as they progress in surgical experience and year in training.

METHODS

The original ASSET was designed and tested at the University of Rochester.[5] This observational descriptive study was performed on retrospective data that exist as a part of the standard educational curriculum and, as it represented minimal risk to the participants, was determined to be exempt from further review by our Institutional Review Board. In this paper, as a part of our existing arthroscopic simulation curriculum, a cadaveric arthroscopy was performed using standard operating room equipment. Participants performed one arthroscopy on a fresh cadaver that had been prepared prior to their arrival. The residents performed a diagnostic arthroscopy with access to the content-specific checklist posted at the arthroscopy station. The residents received assistance from an assistant for leg position during their assessment. No communication from the assistant was allowed. Eleven residents participated in the study. The residents had not participated in the curriculum previously.

The Arthroscopic Surgery Skill Evaluation Tool (ASSET)

The ASSET is an assessment of arthroscopic technical skill. It assesses 8 domains: Safety, Field of View, Camera Dexterity, Instrument Dexterity, Bi-manual Dexterity, Flow of Procedure, Quality of Procedure, and Autonomy. The evaluator rates the resident in a rating scale ranging from 1 (Novice in the skill) to 5 (Expert in the skill) (Fig. 1).

Establishing the Validity and Reliability of Asset

To determine the number of arthroscopic surgeries done, and specifically knee arthroscopic surgeries, we used the residents' ACGME case logs through the year of 2013 to determine the number of arthroscopic surgeries performed and specifically the number of knee arthroscopies performed. This was compared to postgraduate year in training of each resident. Eleven residents participated in the study initially. Seven of these residents performed a second phase of the study exactly a year later. Two board-certified orthopedic faculties served as blinded raters, who were trained on how to evaluate arthroscopy using the ASSET. Each participant was asked to complete a preset checklist of tasks which was posted in front of them at their surgery station. Raters watched a screen of the arthroscopy in a location that did not allow them to see who did the arthroscopy. Participants were allowed to perform the diagnostic knee arthroscopy or until their time limit had been reached (10 minutes). All score sheets were correlated with a randomly generated number, linked to their identity, to protect resident identity, and eliminate possibility of rater bias.

Statistical Analysis

The reliability of the ASSET was estimated using the intraclass correlation coefficient (ICC), for absolute agreement between a fixed, nonrandom set of raters.

The ICC was used to estimate the reliability of the total scores of each participant between the raters.

The validity of the ASSET was evaluated using the Pearson correlation coefficient (r) to determine the

Safety	**1 – Novice**	**2**	**3 - Competent**	**4**	**5- Expert**
	Significant damage to articular cartilage or soft tissue		Insignificant damage to articular cartilage or soft tissue		No damage to articular cartilage or soft tissue
Field of View	**1 – Novice**	**2**	**3 - Competent**	**4**	**5- Expert**
	Narrow field of view, inadequate arthroscope or light source positioning		Moderate field of view, adequate arthroscope and light source positioning		Expansive field of view, optimal arthroscope and light source positioning
Camera Dexterity	**1 – Novice**	**2**	**3 - Competent**	**4**	**5- Expert**
	Awkward or graceless movements, fails to keep camera centered and correctly oriented		Appropriate use of camera, occasionally needs to reposition		Graceful and dexterous throughout procedure with camera always centered and correctly oriented
Instrument Dexterity	**1 – Novice**	**2**	**3 - Competent**	**4**	**5- Expert**
	Overly tentative or awkward with instruments, unable to consistently direct instruments to targets		Careful, controlled use of instruments, occasionally misses targets		Confident and accurate use of all instruments
Bi-Manual Dexterity	**1 – Novice**	**2**	**3 - Competent**	**4**	**5- Expert**
	Unable to use both hands or no coordination between hands		Uses both hands but occasionally fails to coordinate movement of camera and instruments		Uses both hands to coordinate camera and instrument positioning for optimal performance
Flow of Procedure	**1 – Novice**	**2**	**3 - Competent**	**4**	**5- Expert**
	Frequently stops operating or persists without progress, multiple unsuccessful attempts prior to completing tasks		Steady progression of operative procedure with few unsuccessful attempts prior to completing tasks		Obviously planned course of procedure, fluid transition from one task to the next with no unsuccessful attempts
Quality of Procedure	**1 – Novice**	**2**	**3 - Competent**	**4**	**5- Expert**
	Inadequate or incomplete final product		Adequate final product with only minor flaws that do not require correction		Optimal final product with no flaws
Autonomy	**1**		**2**		**3**
	Unable to complete procedure even with intervention(s)		Able to complete procedure but required intervention(s)		Able to complete procedure without intervention

Added Complexity of Procedure

1	2	3
No difficulty	Moderate difficulty (mild inflammation or scarring)	Extreme difficulty (severe inflammation or scarring, abnormal anatomy)

FIGURE 1. Arthroscopic Surgery Skill Evaluation Tool (ASSET) score sheet.

relationship between arthroscopic experience (post-graduate year and ACGME case log reports) and total ASSET scores.

A Student's *t* test was also performed to assess the significance of residents' ASSET scores from an additional year of study and skills training.

RESULTS

Reliability of the ASSET

The intrarater reliability of the ASSET was obtained for the total scores of all videos (n = 11) using the ICC and was found to be .89. There was no significant difference in the mean total ASSET scores assigned by each rater ($p < 0.01$). The previous validity of the ASSET showed there was no significant difference between raters when participants used the left or right knee, so that statistical analysis was not repeated in this study.[6]

Validity of the ASSET

Pearson's Correlation Coefficient showed the ASSET scores increased with level of training. There were strong correlations with the participants level of training ($r = 0.89$, $p < 0.01$, Fig. 2) and the number of knee arthroscopies performed as reported in the ACGME case logs ($r = 0.856$, $p < 0.01$). The Student *t* test that was performed showed significant differences from concurrent years of residents' training (minus graduated year-5 residents), demonstrating concurrent criterion-oriented validity ($p < 0.01$).

The progression of ASSET scores were assessed in 7 residents. There was a mean increase of 11.9 ± 1.6 points from the initial testing, $p < 0.01$ (Fig. 3).

DISCUSSION

The transition from time-based and exposure-based graduation requirements to a competency-based set of requirements has begun. In order to accomplish this, there is a need for feasible, reliable and valid assessment tools to aid in measuring desired competencies. In our study, the ASSET has proven to correlate with more traditional benchmarks of competency while filling this void. In addition, it has proven validity across multi-year learning to assess improvement of residents' technical abilities. Technical skill is something that has been difficult to quantify. Our study further reduces the bias that can occur from nonblinded rating.[5,6]

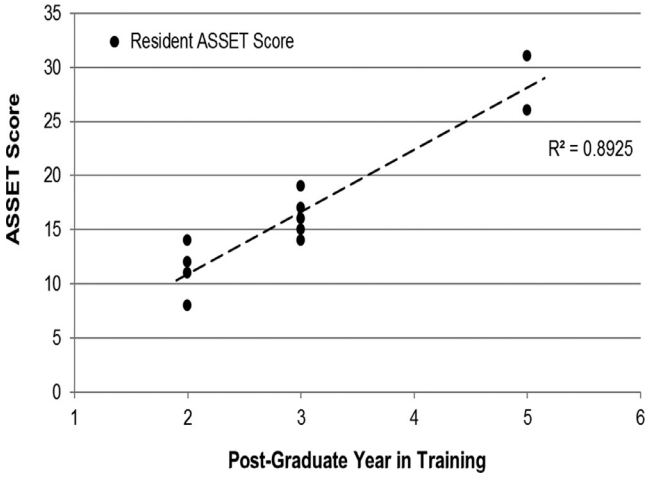

FIGURE 2. Arthroscopic Surgery Skills Evaluation Tool (ASSET) scores increase with level of training.

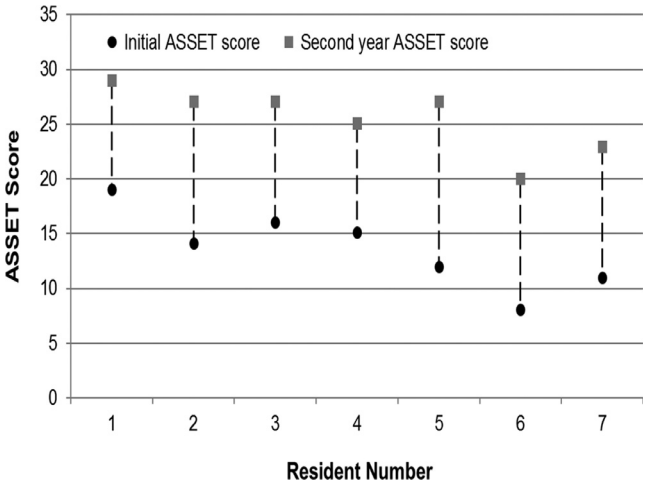

FIGURE 3. Comparison of the Arthroscopic Surgery Skill Evaluation Tool (ASSET) score for the first and second trial (second trial with additional year of training).

The ASSET does have some limitations; however, the assessment is based on raters grading video feed instead of being present in the operating room. Some authors have commented on the importance of the external anatomical knowledge as well as the role of room behavior and communication in a full assessment of competency.[2,8] While there is certainly merit to this concept, using a video feed allows the rater to view the participants blindly, eliminating potential bias.[3,4,7] Furthermore, the ASSET can be used with video recordings, allowing the raters to view them when it is more convenient. Regardless of the measures taken to create an objective assessment, ultimately the ASSET is still a subjective measure of technical performance.

During this time of transition from traditional metrics of competency such as time spent on rotation to those requiring meaningful assessment, orthopedic educators need to ensure that our novel curricula and our tests correlate with quality of surgery. This paper shows that not only does a resident's performance on the ASSET improve with additional surgical training, but it also correlates with traditional metrics for competency. Although the results of this study may not be generalizable, the ASSET allows for its use as a way for programs to demonstrate the progression of their learners as part of the ACGME milestone requirements.

Even so, however, such an assessment is only part of the competency picture. It is necessary to realize that although a resident may have a "competent" ASSET score, this alone does not necessarily indicate the surgeon is proficient or prepared for the operating room. It simply means that the surgeon is competent in the specific, technical aspect that the assessment measured. This tool is unable to address training outside of the arthroscopic component of surgery. Therefore, the ASSET should be complemented with other aspects of surgical study and a competent arthroscopic curriculum to further technical skills and to ensure complete preparedness for a given procedure.

In conclusion, the ASSET appears to be a viable, feasible, valid and reliable way to assess a resident's technical abilities in a diagnostic knee arthroscopy. We believe the ASSET can be used by programs to document the arthroscopic skill development of their residents over time and thereby would allow programs to demonstrate progression in technical skill by their residents as required by the ACGME milestones.

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SUPPLEMENTARY INFORMATION

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.jsurg.2019.05.010.