

Assessment of Arthroscopic Training in U.S. Orthopaedic Surgery Residency Programs

A Resident Self-Assessment

Michael P. Hall, M.D., Kevin M. Kaplan, M.D., Christopher T. Gorczynski, M.D., Joseph D. Zuckerman, M.D., and Jeffrey E. Rosen, M.D.

Abstract

Background: There has been an increasing number of arthroscopic surgeries performed in general orthopaedic surgery practice, as well as a rapid evolution of arthroscopic techniques. The objective of this investigation was to assess the adequacy of arthroscopic training in U.S. orthopaedic residency programs from a resident and program director perspective.

Materials and Methods: The study was performed with a mail-in survey to orthopaedic surgery residents and program directors. Out of 151 programs contacted, we received responses from 24 program directors (15.9%) and 272 residents (11.1% of 2447 possible residents in years 2 through 5 in 2006). Program demographics and resident and program director assessments of arthroscopic surgical training was obtained from the questionnaire. Assessment of open surgical techniques was used as a control. The responses from fifth-year residents (83 of a possible 612 in 2006 (13.6%)) and program directors were used for detailed analysis.

Results: Only 32% (27/83) of fifth-year residents felt there was adequate time dedicated to arthroscopic training, compared to 66% (16/24) of program directors ($p < 0.01$). Thirty-four percent (28/83) of fifth-year residents felt as prepared in arthroscopy as open techniques, in contrast to 58% (14/24) of program directors, who felt fifth-year residents were appropriately prepared in arthroscopic techniques ($p = 0.03$). The amount of surgery that residents are allowed to perform correlated significantly ($p < 0.01$) with confidence levels.

Conclusions: Fifth-year residents who were surveyed felt less prepared in arthroscopic training, compared to open surgical procedures. Program directors surveyed over estimated confidence levels in fifth-year residents performing arthroscopic procedures. To ensure that graduating residents are appropriately prepared for the current demands of a clinical setting, it may be necessary to reexamine residency requirements to ensure adequate practice in developing arthroscopic surgical skills.

Michael P. Hall, M.D., is a Resident in the Department of Orthopaedic Surgery, NYU Hospital for Joint Diseases, NYU Langone Medical Center, New York, New York. Kevin M. Kaplan, M.D., is at the Jacksonville Orthopaedic Institute, Jacksonville, Florida. Christopher T. Gorczynski, M.D., is from Hudson Valley Orthopaedic Associates, Catskill, New York. Joseph D. Zuckerman, M.D., is the Walter A. L. Thompson Professor and Chairman, New York University School of Medicine, Department of Orthopaedic Surgery, NYU Hospital for Joint Diseases, NYU Langone Medical Center, New York, New York. Jeffrey E. Rosen, M.D., is Chairman of the Department of Orthopaedics & Rehabilitation Medicine, New York Hospital Queens, New York-Presbyterian Hospital System, Flushing, New York.

Correspondence: Jeffrey E. Rosen, M.D., Department of Orthopaedics & Rehabilitation Medicine, New York Hospital Queens, 56-45 Main Street, 4th Floor South, Flushing, New York 11355; rosenje@nyp.org.

Arthroscopy of the knee remains one of the most commonly performed procedures by orthopaedic surgeons in the United States.¹ The American Academy of Orthopaedic Surgeons (AAOS) 2005-2006 Census survey identified arthroscopy as a component of nearly 50% of 13,679 responding surgeons' practices.¹ A recent American Board of Orthopaedic Surgeons (ABOS) analysis reported the most commonly performed procedures by board examination applicants in 2003.² Four of the top six procedures involved knee or shoulder arthroscopy. With the rapid evolution of technology, arthroscopic procedures such as rotator cuff repairs, labral repairs, and ligament reconstructions have become commonplace across the U.S. With the number and complexity of these arthroscopic procedures increasing, there is greater concern regarding the adequacy of arthroscopic training during residency.

Table 1 Mean Fifth-Year Resident Responses (Scaled 0 to 6) with Standard Deviations

Arthroscopic Procedure	Degree Allowed to Perform (0-6)	Confidence Performing Alone (0-6)	Confidence Compared to Performing Primary TKA (0-6)
Knee			
Diagnostic	4.75 ± 0.66	4.82 ± 0.52	4.24 ± 0.92
Loose body removal	4.70 ± 0.73	4.74 ± 0.56	4.09 ± 0.92
Partial meniscectomy	4.67 ± 0.74	4.69 ± 0.60	4.01 ± 0.96
Microfracture	4.12 ± 1.12	4.33 ± 0.97	3.73 ± 1.09
Lateral release	3.76 ± 1.24	3.70 ± 1.08	3.30 ± 1.16
ACL tunnel creation	3.85 ± 1.02	4.10 ± 0.96	3.23 ± 1.13
Meniscal repair	3.35 ± 1.39	3.37 ± 1.10	2.65 ± 1.19
Shoulder			
Diagnostic	4.52 ± 1.89	4.55 ± 0.83	3.78 ± 1.13
Subacromial decompression	4.28 ± 0.97	4.37 ± 0.92	3.52 ± 1.54
Loose body removal	4.24 ± 1.17	4.29 ± 1.06	3.54 ± 1.20
Bankart repair	2.94 ± 1.28	3.01 ± 1.26	2.31 ± 1.08
Arthroscopic knots	3.32 ± 1.47	3.44 ± 1.45	2.68 ± 1.25
Rotator cuff repair	2.94 ± 1.37	2.93 ± 1.39	2.30 ± 1.19

The Residency Review Committee for the Accreditation Council of Graduate Medical Education (ACGME) currently does not specify the length or nature of arthroscopic training required during the 5-year orthopaedic surgery residency.³ Although there has been debate regarding certification, there is no objective testing to evaluate arthroscopic competency at the completion of training.^{4,5} Teaching arthroscopic skills is thought to be inherently more difficult than skills performed in open cases, given the nature of the technique and instrumentation.⁶⁻⁸ The setting of arthroscopy requires ambidexterity and sound visual-spatial coordination, as three-dimensional structures are represented in two-dimensional images. Under current work-hour restrictions, residents must now potentially learn these skills with less than optimal operating room time and experience.^{9,10}

The objective of this study was to examine arthroscopic training from the perspectives of both the residents and program directors. We hypothesize that residents do not feel as well trained in arthroscopic surgical techniques as they do for open techniques at the completion of residency training.

Materials and Methods

A survey was conducted to evaluate the opinions of current residents and program directors regarding resident training in arthroscopy. The surveys were mailed to residents (potentially 2447 residents, year 2 through 5) and program directors at 151 programs in February 2006. An email follow-up survey was sent shortly afterward.

The questions included a request for information regarding the characteristics and demographics of the program, current year of training, months of dedicated training in arthroscopy, and months of training to date. Residents were asked to estimate the total number of arthroscopic knee and shoulder cases, as well as open hip, knee, and shoulder cases that they had completed.

Questions were then asked regarding various open and arthroscopic hip, knee, and shoulder procedures. These questions evaluated the degree (ranked 1 to 5) to which the participants were allowed to perform the procedure, the confidence they had in performing the procedure independently, and to estimate that confidence compared to a standard primary total knee replacement. The program directors answered questions in reference to their current fifth-year residents.

Statistical methods were applied to responses using the GraphPad INSTAT statistical package (version 3; GraphPad Software, San Diego, California). Analyses were performed with statistical significance defined as $p < 0.05$.

Results

Out of the 151 programs contacted, we received 296 responses from 42 (27.9%) programs. Responses included 24 program directors (15.9%) and 272 residents (11.1% of a 2447 total of residents, year 2 through 5 in 2006¹¹). Twenty-six programs were associated with an academic center, while 16 were considered community programs; there were no military programs. The average number of residents per year in the responding programs was four (range, 2 to 12). Responses were received from 83 (13.6% of 612 in 2006¹¹) fifth-year residents. Those surveyed in this study were affected by work-hour restrictions during their third through fifth year. Total responses from program directors and fifth-year residents were used for detailed analysis of the data (Table 1).

Sixty-six percent (25/38) of fifth-year residents, having trained between 5 to 10 months in arthroscopy, felt they had enough dedicated arthroscopy time, compared to 20% (9/45) of those training 0 to 4 months ($p < 0.001$; $rr = 2.4$). Fifty-five percent (21/38) of fifth-year residents, training at least 5 months, also stated they felt as adequately prepared in arthroscopy as they do with primary total knee replacement.

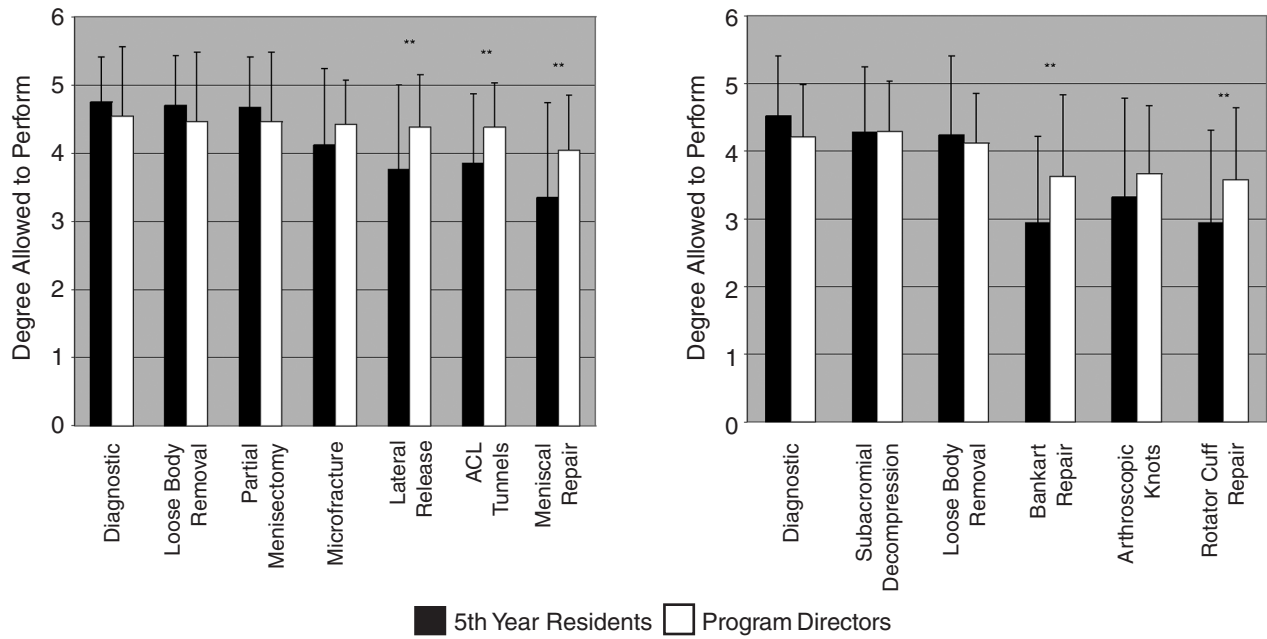


Figure 1 A, Degree allowed to perform arthroscopic knee procedures. Those with (**) were found to have a statistically significant difference (Lateral release: $p = 0.022$; ACL tunnel creation: $p = 0.037$; Meniscal repair: $p = 0.023$). **B**, Degree allowed to perform arthroscopic shoulder procedures. Those with (**) were found to have a statistically significant difference (Bankart repair: $p = 0.021$; Rotator cuff repair: $p = 0.036$).

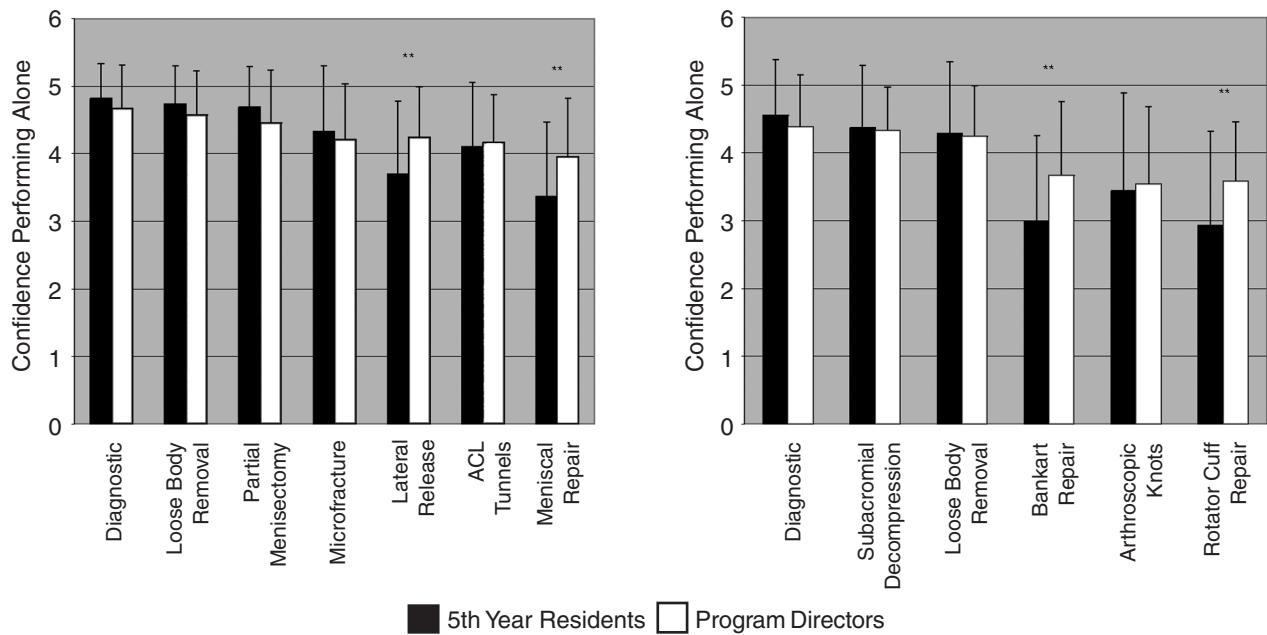


Figure 2 A, Confidence performing arthroscopic knee procedures alone. Those with (**) were found to have a statistically significant difference (Lateral release: $p = 0.04$; Meniscal repair: $p = 0.0475$). **B**, Confidence performing arthroscopic shoulder cases alone. Those with (**) were found to have a statistical significant difference (Bankart repair: $p = 0.021$; Rotator cuff repair: $p = 0.032$).

This is in contrast to only 17% (8/45) of those training 0 to 4 months ($p < 0.001$; $rr = 2.3$).

In terms of the volume of arthroscopic knee surgeries, 60% (27/45) of fifth-year residents performing more than 100 cases reported having enough dedicated arthroscopy time. Forty-four percent (20/45) of fifth-year residents performing

more than 100 cases felt as prepared with arthroscopy as they did with open procedures. In arthroscopic shoulder surgery, 68% (13/19) of fifth-year residents performing more than 75 cases reported they had enough arthroscopic training, while 47% (9/19) felt as prepared with shoulder arthroscopy as with open procedures.

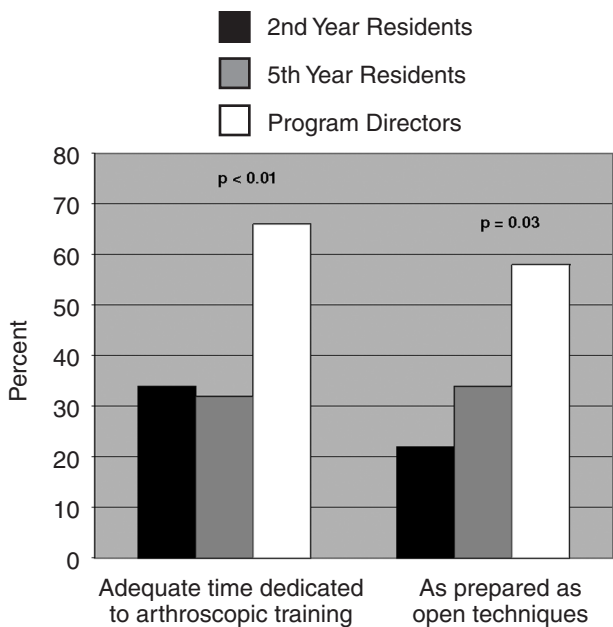


Figure 3 Comparison of resident and program director responses. P values between 5th year residents and program directors are shown.

In comparing those arthroscopic procedures, in which fifth-year residents reported that they were allowed to perform versus those which the director thought they were allowed to perform, there was a significant difference in the following procedures: lateral release, anterior cruciate ligament (ACL) tunnel creation, meniscal repair, Bankart repair, and rotator cuff repair (Fig. 1). Furthermore, in comparing those procedures that fifth-year residents felt confident performing alone versus those that the director thought they could perform alone, there was a significant difference in all the aforementioned procedures except ACL tunnel creation (Fig. 2).

An analysis of individual procedures also provided further insight regarding our hypothesis. Considering arthroscopic rotator cuff repair, 58% (19/33) of fifth-year residents who reported that they were allowed to perform a larger proportion of the procedure (4 and 5 on the survey scale) felt as well trained in arthroscopy, as compared to a primary total knee replacement. Five percent (2/38) of those permitted to perform less (1 and 2 on the survey scale) of the procedure felt as well prepared ($p < 0.01$).

Overall, only 32% (27/83) of fifth-year residents thought there was adequate time dedicated to arthroscopic training, compared to 66% (16/24) of program directors ($p < 0.01$). Thirty-four percent (28/83) of fifth-year residents felt as prepared in arthroscopy as they did with open techniques. In contrast, 58% (14/24) of program directors felt their fifth-year residents were as adequately prepared in performing arthroscopy as open techniques ($p = 0.03$) (Fig. 3). There were no differences observed between academic and community programs.

Discussion

In 1982, Sweeney discussed the difficulty of teaching arthroscopy at the resident level.¹² Over the past two decades, keeping pace with arthroscopic technology has been difficult for practicing orthopaedic surgeons, let alone residents. The learning curve in performing arthroscopic techniques is significant and recently has been demonstrated in arthroscopic rotator cuff repair.¹³ Analysis of one surgeon’s first 10 cases demonstrated a mean 80 minutes of additional operative time, when compared to cases 91 through 100. Although a learning curve exists with all surgical procedures, it appears that more experience is necessary to acquire the technical skills and familiarity in performing arthroscopy, as compared to open techniques.

This study supports the hypothesis that graduating orthopaedic residents may not be adequately trained in arthroscopy. The majority of fifth-year orthopaedic residents felt less prepared performing arthroscopic procedures than open procedures, in contrast to the belief of most program directors. Although they felt better prepared with the greater number of arthroscopic cases performed, the proportion of a procedure that residents were allowed to perform was more important than the actual number of cases with which they were involved.

The amount of arthroscopic experience required for adequate resident training is unknown.⁵ The only published criteria addressing competence is that of the German Speaking Association of Arthroscopy, which requires 50 diagnostic arthroscopies, 120 partial meniscectomies, and 80 ACL reconstructions to become an instructor.¹⁴ The Arthroscopy Association of North America (AANA) does not specify competence, but requires at least 50 arthroscopic cases per year to maintain active membership.¹⁵ The American Board of Orthopaedic Surgery (ABOS) requires one year of fellowship training in sports medicine and 75 arthroscopic cases in one year to be eligible for subspecialty certification in sports medicine.¹¹ Interestingly, the AANA has conceded that completion of an orthopaedic residency does not guarantee competence in arthroscopy.¹⁶

In a recent study from Ireland, Leonard and colleagues surveyed 40 orthopaedic residents and 50 orthopaedic attending surgeons regarding the number of cases it takes to become proficient in four basic arthroscopic knee procedures.¹⁷ They found that estimation by residents and attending surgeons who perform arthroscopy were similar for diagnostic knee arthroscopy (mean 40 vs 45, respectively) and partial medial meniscectomy (mean, 63 vs 70, respectively). However, partial lateral meniscectomy (mean, 90 vs 72, respectively) and ACL reconstructions (mean, 120 vs 90, respectively) were overestimated by residents when compared to attendings. Attendings who did not perform regular arthroscopy, defined as more than 50 cases per year, tended to estimate almost one-half the number of cases required.

O’Neill and coworkers devised a similar survey of U.S. orthopaedic department chairmen and sports medicine fel-

lowship directors.⁵ They found a wide variation of opinion in the number of repetitions required to achieve adequate training in five basic arthroscopic procedures. For example, the number of cases for proficiency in arthroscopic partial meniscectomy ranged from eight to 250. Similar to the previous study, those who did not perform regular arthroscopy tended to underestimate the amount of experience needed for proficiency by almost one-half.

The most telling result of the present study was the fact that only one-third of fifth-year residents felt they had adequate arthroscopic training, as opposed to two-thirds of program directors. Program directors repeatedly overestimated the amount of arthroscopy that fifth-year residents were allowed to perform, in addition to their ability to complete these procedures independently. While difficult to compare the assessment of others to self-assessment, this discrepancy represents a possible deficit in resident training worthy of further investigation.

The lack of confidence in arthroscopic techniques may also be a contributing factor to the rising number of orthopaedic surgery residents entering into sports medicine fellowships. In 2007, 155 out of 611 (25.3%) graduating residents took fellowships in sports medicine, compared to 117 of 609 (19.2%) in 2004.¹⁸ Since 1990, the percentage of orthopaedic surgeons with fellowship training in sports medicine has increased from 8.8% to 27.5% in 2006.¹ Given the increasing complexity of arthroscopic techniques, fellowship training may become necessary to perform these procedures in practice.

According to our data, residency curriculums may need to be reevaluated. Many residency programs have now incorporated night float systems to comply with work-hour regulations, further limiting potential time spent in the operating room. Unless hands-on experience in the operating room is increased, residents may be forced to acquire more experience on their own. Increasing resident privileges, however, was recently shown to increase operating room costs, as well as possible lost income for the attending surgeon.¹⁹ Some programs have utilized cadaveric arthroscopy labs to improve arthroscopic skills, but few programs have consistent access to this resource.²⁰ A possible answer under investigation is virtual reality simulators. Simulators for both knee and shoulder arthroscopy have been created and are currently being evaluated at several large academic centers across the U.S.²⁰⁻²⁵ Although early results appear promising, the ability to provide and standardize this resource across the U.S. will be challenging.^{20,23,26}

The primary limitation of the present study was its low response rate. It is difficult to propose generalizations about all 151 orthopaedic residency programs; however, our data provides valuable insight into a current discrepancy in the beliefs of residents and program directors. The use of an email-based survey initially may have increased our survey return and should be considered for future study. Although data was collected regarding the number of cases performed

and the number of months of training, we acknowledge that it is impossible to draw conclusions secondary to the inherent differences in resident skills and case participation. The lack of data collected regarding the presence of sports medicine fellows and cadaveric arthroscopy labs is another possible limitation. Both could have an effect on resident arthroscopy experience. Finally, as with all surveys, results are based purely on opinion and interpretation is dependant on the accurate reporting of respondents.

In conclusion, the required volume of practice and experience with arthroscopic surgery to become proficient is undefined. According to our results, fifth-year residents feel less prepared in arthroscopic training compared to open procedures, and program directors overestimate confidence levels with arthroscopic techniques. It may be necessary to restructure residency requirements to ensure adequate training in developing arthroscopic surgical skills. Precise definition of these skills is essential, as is an increase in hands-on experience, utilization of cadaveric labs, and virtual reality simulators in order to properly train orthopaedic surgery residents.

Disclosure Statement

None of the authors have a financial or proprietary interest in the subject matter or materials discussed, including, but not limited to, employment, consultancies, stock ownership, honoraria, and paid expert testimony.

References

1. Orthopaedic Practice in the US 2005-2006: Final Report, Prepared by Watkins-Castillo S. Department of Research and Scientific Affairs. Rosemont, Illinois: American Academy of Orthopaedic Surgeons, 2006. Available at: <http://www.aaos.org/research/stats/2006opus.pdf>. Accessed October 30, 2009.
2. Garrett WE, Swiontkowski MF, Weinstein JN, et al. American Board of Orthopaedic Surgery Practice of the Orthopaedic Surgeon: Part-II, certification examination case mix. *J Bone Joint Surg Am.* 2006;88(3):660-67.
3. Residency Review Committee: Orthopaedic Surgery Program Requirements 2007. The Accreditation Council for Graduate Medical Education, Chicago, Illinois, 2007.
4. Bergfeld JA. Issues with accreditation and certification of orthopedic surgery fellowships. *J Bone Joint Surg Am.* 1998;80:1833-6.
5. O'Neill PJ, Cosgarea AJ, Freedman JA, et al. Arthroscopic proficiency: a survey of orthopaedic sports medicine fellowship directors and orthopaedic surgery department chairs. *Arthroscopy.* 2002;18:795-800.
6. Anastakis DJ, Wanzel KR, Brown MH, et al. Evaluating the effectiveness of a 2-year curriculum in a surgical skills center. *Am J Surg.* 2003 Apr;185(4):378-85.
7. Miller WE. Learning arthroscopy. *South Med J.* 1985;78:935-7.
8. Pedraza HM, Stetten ML. Arthroscopy education. *Orthopedics.* 1987;10:1601-3.
9. Irani JL, Mello MM, Ashley SW, et al. Surgical residents' perceptions of the effects of the ACGME duty hour requirements

- 1 year after implementation. *Surgery*. 2005;138(2):246-53.
10. Zuckerman JD, Kubiak EN, Immerman I, Dicesare P. The early effects of code 405 work rules on attitudes of orthopaedic residents and attending surgeons. *J Bone Joint Surg Am*. 2005;87(4):903-908.
 11. The American Board of Orthopaedic Surgery website: Available at: <http://www.abos.org/ModDefault.aspx?module=Diplomates§ion=SportsOver>. Accessed October 31, 2009.
 12. Sweeney HJ. Teaching arthroscopic surgery at the resident level. *Orthop Clin North Am*. 1982;13:255-61.
 13. Guttman D, Graham RD, MacLennan MJ, Lubowitz JH. Arthroscopic rotator cuff repair: the learning curve. *Arthroscopy*. 2005;21:394-400.
 14. AGA-Mitteilungen Nr. 2/2000. Kriterion zur erlangung des titels "aga-instruktor." *Arthroskopie*. 2000;13:256.
 15. Arthroscopy Association of North America web site. Available at: <http://www.aana.org/membership/category.html>. Accessed January 2008.
 16. Arthroscopy Association of North America: suggested guidelines for the practice of arthroscopic surgery. Rosemont, Illinois, 1993.
 17. Leonard M, Kennedy J, Kiely P, Murphy PG. Knee arthroscopy: how much training is necessary? A cross-sectional study. *Eur J Orthop Surg Traumatol*. 2007 Jul;17(4):359-62.
 18. Accreditation Council of Graduate Medical Education, Department of Orthopaedic Surgery: Program statistics. Chicago, Illinois, 2008.
 19. Farnworth LR, Lemay DE, Wooldridge T, et al. A comparison of operative times in arthroscopic ACL reconstruction between orthopaedic faculty and residents: the financial impact of orthopaedic surgical training in the operating room. *Iowa Orthop J*. 2001;21:31-5.
 20. Cannon WD, Eckhoff DG, Garrett WE, et al. Report of a group developing a virtual reality simulator for arthroscopic surgery of the knee joint. *Clin Orthop Relat Res*. 2006;(442):21-9.
 21. Mabrey JD, Gillogly SD, Kasser JR, et al. Virtual reality simulation of arthroscopy of the knee. *Arthroscopy*. 2002;18(6):E28.
 22. Gomoll AH, O'Toole RV, Czarnecki J, Warner JJ. Surgical experience correlates with performance on a virtual reality simulator for shoulder arthroscopy. *Am J Sports Med*. 2007 Jun;35(6):883-8.
 23. Megali G, Tonet O, Dario P, et al. Computer-assisted training system for knee arthroscopy. *Int J Med Robot*. 2005 Sep;1(3):57-66.
 24. Ceponis PJ, Chan D, Boorman RS, et al. A randomized pilot validation of educational measures in teaching shoulder arthroscopy to surgical residents. *Can J Surg*. 2007 Oct;50(5):387-93.
 25. Vitale MA, Kleweno CP, Jacir AM, et al. Training resources in arthroscopic rotator cuff repair. *J Bone Joint Surg Am*. 2007 Jun;89(6):1393-8.
 26. Pedowitz RA, Esch J, Snyder S. Evaluation of a virtual reality simulator for arthroscopy skills development. *Arthroscopy*. 2002;18:1-6.