Does Research Participation Make a Difference in Residency Training?

Jonathan B. Macknin MD, Amy Brown MS,
Randall E. Marcus MD

Received: 25 April 2013 / Accepted: 5 August 2013 / Published online: 23 August 2013
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Abstract

Background The American Board of Orthopaedic Surgery requirements state that an orthopaedic residency must offer at least 5 years of clinical education and some exposure to research. To expose residents to basic research, some programs, including ours, have a research track that allows for 1 year of basic science research. The degree to which research productivity during residency—which may be something that can perhaps be influenced by interventions like research tracks during residency—affects residency graduates' future research contributions is unknown.

Questions/purposes Our research goals were to determine whether (1) residents who published in a peer-reviewed journal during residency were more likely to publish in their careers after graduation; (2) residents who

participated in an elective research year were more likely to publish at least one paper in a peer-reviewed journal during residency; and (3) residents who participated in the research year were more likely to choose academic careers. **Methods** Using questionnaires, online PubMed searches, and office contact, the career paths (academic versus private practice) and publications in peer-reviewed journals of all 122 Case Western Reserve University orthopaedics residents who completed training from 1987 to 2006 were analyzed.

Results Seventy-five percent of residents who published peer-reviewed research during residency continued with peer-reviewed publications in their careers versus 55% of residents who did not publish during residency ($p = 0.02$). No difference in career paths was observed between the Case Western Reserve University research and traditional track-trained surgeons. During residency, however, research track-trained surgeons were more likely to publish in peer-reviewed journals (71% versus 41% of traditional track-trained surgeons, $p < 0.01$).

Conclusions Residents who publish in a peer-reviewed journal during residency are more likely to continue publishing in their future careers as orthopaedic surgeons. Future studies are needed to elucidate the causative factors in the association between publishing in a peer-reviewed journal during training and further contributions later in an orthopaedic surgeon's career.

Each author certifies that he or she, or a member of his or her immediate family, has no funding or commercial associations (eg, consultancies, stock ownership, equity interest, patent/licensing arrangements, etc) that might pose a conflict of interest in connection with the submitted article.

All ICMJE Conflict of Interest Forms for authors and *Clinical Orthopaedics and Related Research* editors and board members are on file with the publication and can be viewed on request. This work was performed at Case Western Reserve University and University Hospitals Case Medical Center, Cleveland, OH, USA.

J. B. Macknin, R. E. Marcus (✉)
Department of Orthopaedics, Case Western Reserve University
School of Medicine and University Hospitals Case Medical
Center, 11100 Euclid Avenue, Cleveland, OH 44106-5043, USA
e-mail: Randall.Marcus@UHHospitals.org;
randall.marcus@uhhs.com

A. Brown
Department of Biology, Case Western Reserve University,
Cleveland, OH, USA

Introduction

One goal of orthopaedic training programs is to inspire some graduates to continue with a career that further contributes to orthopaedic knowledge, whether through

research or commitments to teaching in university-based or other academically affiliated programs. The American Board of Orthopaedic Surgery (ABOS) requires residents in orthopaedic surgery to complete a 5-year postdoctoral training program accredited by the Accreditation Council for Graduate Medical Education (ACGME) [4]. During this training, the ABOS requires “exposure to the evaluative sciences, clinical and/or laboratory research” [4]. Among the ACGME and Residency Review Committee requirements for orthopaedic training programs is the directive to advance the resident’s knowledge of the basic principles of research [1]. This requirement is thought to provide increased understanding of research techniques through experience. It also allows a resident the opportunity to advance the knowledge of orthopaedic science and practice.

Some orthopaedic residency programs offer two residency tracks with one including the addition of a year to focus on research. Our program, Case Western Reserve University, offers two residency training program tracks in orthopaedic surgery. One is the traditional 5-year clinical residency (traditional track) and the other—the Allen Research Fellowship (research track)—offers an additional year of research in a basic science laboratory.

Some other residency programs provide similar research year opportunities, but there is an absence of literature supporting what this year achieves for the residents involved. The main goals of a research year include (1) contributing to the advancement of orthopaedic knowledge; and (2) inspiring an academic career with further contributions to the field. Considering the large amount of funding necessary for these programs, including the salary, benefits, and supporting research projects of the residents as well as the time commitment of the participating residents, it is imperative to examine if the research track achieves these goals and what other effects it may have on residents’ educations.

We therefore sought to determine whether (1) residents who published during residency were more likely to publish again after graduation; (2) residents who opted for an elective research year were more likely to publish at least one paper in a peer-reviewed journal during residency; and (3) residents who chose an optional research year during residency were more likely to have an academic-affiliated practice after graduation.

Materials and Methods

Each academic year, Case Western Reserve University accepts six orthopaedic surgery candidates who are chosen through the National Resident Match Program. Of these six residents, two who are interested in pursuing research in

orthopaedic surgery elect to spend their second postgraduate year in one of the orthopaedic department’s basic science research laboratories. During the orthopaedic rotations of Postgraduate Year 1, the residents are introduced to the clinical and basic scientists within the department. At that time they are given the opportunity to learn about the various ongoing research projects within the department. After this rotation and in conjunction with the Director for Orthopaedic Research, the two research fellows are selected based on the merits of their proposed research projects. These research track residents spend 12 months performing full-time basic science research after their internship year before continuing with the remaining 4 years of the clinical orthopaedic residency. The research track provides the residents with the opportunity to direct a funded, basic science research project under the mentorship of an orthopaedic scientist. This experience allows the residents to gain expertise in musculoskeletal science and an understanding of advanced research techniques, more so than in the traditional track, which, although incorporating research into the curriculum, involves much less protected time for performing basic science research during the residency. Three residents a year were awarded a research fellowship from 1982 until 1997 and two per year since that time. The funding for the research track is provided through endowment funds of the medical center.

To determine the impact of research in residency on future academic contributions and publications, we compared individuals who did publish during their residency at Case Western Reserve University (combining both research and traditional track residents) with those who did not publish during their residency and the likelihood that they would publish at least one peer-reviewed journal article after they completed residency. The subjects included all graduates of the Case Western Reserve University program—48 research track residents and 74 traditionally trained residents—who completed their training in Case Western Reserve University’s orthopaedic training program from 1987 to 2006. These surgeons had been in practice a minimum of 4 years and a maximum of 23 years after the completion of their residency.

In addition, to determine the career outcomes of the two residency tracks, questionnaires were mailed to all graduates. Questions were formulated based on the 2006 study by Bernstein et al. [2]. Our questionnaire asked these residency graduates for their hospital affiliations and asked whether they held a faculty appointment, completed a fellowship, and received research grant funding (Fig. 1). Further confirmation of information regarding all of the Case Western Reserve University orthopaedic residency graduates was obtained through an online search to determine type of practice, faculty appointments, and fellowships. An academic career was defined as a career

Fig. 1 This questionnaire was sent to all orthopaedic surgeons who completed the traditional track residency at Case Western Reserve University Medical School between 1987 and 2006 to determine their career outcome.

1. Current hospital affiliation? _____
 2. Do you have a medical school academic appointment? Yes / No
If yes, what is it? _____
 3. Did you participate in post-residency fellowships? Yes / No
 4. Have you received external funding for your research since you finished your residency? Yes / No
- Sources:
Federal (NIH)	☐
Industry	☐
Regional (Hospital/Medical Center Funding)	☐

Fig. 2 This questionnaire was sent to orthopaedic surgeons who graduated from the research track residency program from Case Western Reserve University (CWRU) between 1987 and 2006 to determine their career outcome.

1. Current hospital affiliation? (If you are a fellow, where will you be next year?) _____
 2. Do you have a medical school academic appointment? Yes / No
If yes, what is it? _____
 3. Did you participate in post-residency fellowships? Yes / No
- Sources:
Federal (NIH)	☒
Industry	☒
Regional (Hospital/Medical Center Funding)	☒
5. When you were matched to University Hospitals/CWRU, was the research year with the Allen Fellowship something you wanted to do? Yes / No
 6. If you redid your residency, would you spend a research year in the lab again? Yes / No
 7. What was your research project during your Allen Fellowship? _____
 8. How did your research-year impact your career? Was it beneficial? _____

with an appointment at an ACGME-accredited orthopaedic residency program for all career-related analyses [5]. In addition, the research track graduates were asked questions about their perception of the value to their subsequent career of this additional year of research training (Fig. 2). The physician's office was also contacted to confirm any current participation in education or research. To quantify the peer-reviewed publications authored by these orthopaedic surgeons, a PubMed search was done for each individual. The number of publications published while in residency was recorded along with any publications after residency, including fellowship. Lastly, to assess the leadership recognition of these surgeons by the orthopaedic profession, their election to membership to the American Orthopaedic Association (AOA) was identified using the AOA membership directory [8].

Statistical analysis was performed on the data collected from the questionnaire, the AOA membership directory, and PubMed searches to determine if (1) residents who publish during residency are more likely to continue publishing after graduation; (2) research track residents publish more during residency; and (3) residency track correlates with career path (academic versus nonacademic practice). The null hypothesis was that publishing in a peer-reviewed journal during residency does not correlate with further publication in peer-reviewed journals after residency. The alternative hypothesis was that publishing in a peer-reviewed journal during residency correlates with future publication in peer-reviewed journals after residency.

Complete data were collected for 97% of Case Western Reserve University orthopaedic graduates (48 research track-trained surgeons and 73 traditional track-trained

residents). The questionnaire received an 82% response rate with 81% (39 surgeons) from the research track and 82% (61 surgeons) from the traditional track. Additional information regarding nonresponders was gathered through a combination of online searches for 17% (21 surgeons) and direct office contact for 14% (17 surgeons). One physician had retired and one could not be located. Data for our primary end point, publication in a peer-reviewed journal, were available for 100% of graduates through a PubMed search.

Probability values were determined using the Pearson's chi-square test or a Student's two-tailed unpaired t-test on an Excel worksheet (Microsoft Inc, Redmond, WA, USA) to examine the goodness of fit. A p value of < 0.05 was considered significant and rejected the null hypothesis, stating that publishing during residency does not correlate with further publications after residency.

Results

Residents who published during residency were more likely to publish again after graduation. Seventy-five percent of all residents who published during residency published at least one more manuscript during their career. This includes two research track physicians who had a total of 61 and 75 publications. In contrast, only 55% of all residents who did not publish during training went on to publish at least one paper during their career. This includes two traditional track physicians who went on to publish 51 and 72 papers after not publishing during residency (odds ratio, 2.52; 95% confidence interval, 1.09–5.85; $p = 0.02$; Fig. 3).

Fig. 3 Likelihood of continuing research after residency: comparison between those who did publish and those who did not publish during residency and then went on to publish during their career. The two different residency tracks are combined to compare the 48% who did not publish during either the research or traditional tracks and the 52% who did publish from both tracks. Orthopaedic surgeons who published during residency were more likely to continue publishing peer-reviewed articles after residency. NIH = National Institutes of Health.

Residents who elected to participate in the research track were more likely to publish during their residency. Seventy-one percent of research track residents published at least one peer-reviewed journal article during residency compared with 41% of traditional track residents ($p < 0.01$). However, surgeons who had completed the research year did not have a higher average number of total career publications than those surgeons who had not completed the research year. The mean number of total career publications by research track surgeons was 9.5 ± 15.1 peer-reviewed journal articles compared with 5.6 ± 11.5 for traditional track surgeons ($p = 0.24$; Fig. 4). Of the orthopaedic surgeons who participated in the research track, 46% continue to engage in research and receive grant funding compared with 38% of the traditional track graduates ($p = 0.38$; Fig. 5).

Case Western Reserve University research track residents were no more likely to become employed in an academic setting when compared with traditional track residents. Both training tracks produced surgeons who were just as likely to go into academic medicine and contribute to research, education, and leadership in the orthopaedic profession. Thirty-four percent of all Case Western Reserve University graduates are on the faculty of an academic medicine center and participate in education and research. Forty-two percent of research track residents have a career in academic medicine compared with 30% of traditional track residents ($p = 0.22$; Table 1). Two research track surgeons (4%), but no traditional track graduates, are department chairs at major academic medical centers ($p = 0.08$). Ten percent of research track graduates have been elected to AOA membership compared with 6% of traditional track residents ($p = 0.29$).

With regard to fellowship training, 87% of all graduating Case Western Reserve University orthopaedic residents completed a subspecialty fellowship. Ninety percent of

Fig. 4 The mean number of publications of peer-reviewed journals for the traditional (TT) and research (RT) track Case Western Reserve University residents is shown for total career, during residency, and after residency.

Fig. 5 Research grant funding, based on orthopaedic surgeons who completed the traditional (TT) and research (RT) track residencies at Case Western Reserve University, is broken down into total, national, industry, and regional funding. NIH = National Institutes of Health.

Table 1 Survey results on the percentage of orthopaedic surgeons, based on the residency track completed at Case Western Reserve University, who went on to have a career in an academic medical

Subsequent appointments during career	TT (%)	RT (%)	p value
Academic medical center affiliation	30	42	0.22
Academic appointment	24	42	0.299
Fellowship subspecialty	90	85	0.699

TT= traditional track; RT = research track.

Case Western Reserve University traditional track orthopaedic residents graduating from 1987 to 2006 completed a subspecialty fellowship.

Discussion

It is essential that the field of orthopaedic surgery continues to evolve through evidence-based research with physician educators capable of teaching residents to continually improve musculoskeletal care for patients. The effects of the ACGME and Residency Review Committee requirements for advancing the resident's knowledge of the basic principles of research is not well elucidated in the current literature, although some studies have begun to explore this important topic [5, 6, 9]. The data presented demonstrate that orthopaedic residents who participated in research leading to publication during their residency were more likely to continue to conduct research and publish during their career. Although residents who had a dedicated research year were significantly more likely to publish during residency and had a larger mean number of career publications, both our traditional and research tracks produced surgeons who were equally likely to pursue

center, hold an academic appointment, and complete a subspecialty fellowship after completing the residency

academic careers and continue to contribute to research, education, and leadership in orthopaedic surgery.

This study had a number of limitations. First, it only covers a 20-year span beginning with graduates in 1987 of the Case Western Reserve University orthopaedic residency program. These graduates had been in practice for only 4 to 23 years at the time of the data collection and orthopaedic surgeons often remain in practice from 30 to 35 years before reaching retirement age. As a result, the data are not complete, because many physicians will continue to participate in education and research and gain new leadership positions as their careers progress. The results presented apply to the early to midcareers of orthopaedic surgeons, but future followup may be warranted. In addition, we divided our peer-reviewed publication data into during and postresidency papers. It could be argued that publications during fellowship may not be indicative of a continued career-long desire to contribute to medical literature. Although research from fellowship is included in the postresidency publication group, the large number of publications postresidency (mean of 4.8 in the traditional track and 7.7 for those in the research track) is suggestive of more than a year's work during fellowship alone. Another limitation of this study is how an academic career

is defined. Although previous publications have used a similar definition, the definition does not capture the subset of physicians who work in private practice but still participate in fellowship training and contributions to peer-reviewed literature [3, 5]. This limitation, however, does not impact the primary hypothesis regarding contributions to medical knowledge through publications because practice type did not influence the data collection of a number of peer-reviewed publications.

Residents who published during residency were more likely to publish again after graduation. Although other literature has suggested this indirectly by showing that residents who publish enter academic careers, our data clearly support this conclusion [3, 5]. The data in this study, however, do not clarify the reason for this. It could be that residents who seek out opportunities to publish are the ones most interested in future careers that involve continued research contributions. An alternative explanation is that once given the opportunity to publish in residency, an interest in further publication in peer-reviewed journals is cultivated. Further investigation into this finding is necessary to determine the variables involved in this correlation.

Participants in the research track are more likely to publish during their residency, although they did not have a higher average number of total career publications when compared with those surgeons who had not completed the research year. Previous literature has shown that participants in a research year have a higher number of publications during residency compared with their peers who did not have dedicated research time [6]. Intuitively, residents with a dedicated year have more available time and resources to devote to research. Although the dedicated year fosters academic pursuits worthy of peer-reviewed publications, these residents were no more likely to pursue academic careers. In fact, all residents at Case Western Reserve University have exposure and opportunity to participate in research. This may explain why postresidency career paths and number of publications were similar between the research and traditional track residents. It has been suggested that an interest in research and academic medicine must be maintained by engaging trainees throughout their training [7]. Although a dedicated research year achieves this goal, the current ACGME and Residency Review Committee requirements for understanding the basic principles of research during residency training also achieve this goal.

Case Western Reserve University research track residents were no more likely to become employed in an academic setting when compared with traditional track residents. A previous publication also concluded that a research year does not influence residents to enter an academic career [6]. However, more recent literature concluded that an increasing number of publications during residency is highly correlated with a career in academic

medicine [3, 5, 10]. A possible reason we do not see this correlation in our data is that the relative success of the traditional track residents compared with the research track residents made this effect too small to discern with our sample size. Seventy-one percent of research track residents published in residency compared with 41% of traditional track residents, whereas 42% of the research track residents had an academic career compared with 30% of traditional residents. The trend toward a higher percentage of academic careers in the research track may become statistically significant when examining a larger sample size with further followup.

Although participation in our research year track at Case Western Reserve University was not shown to increase the likelihood of pursuing an academic career, we believe that programs like this and the research requirements of the Residency Review Committee and ACGME during residency still provide an important function in the education of orthopaedic surgeons. The opportunity to do research during residency, be it during a dedicated year or in addition to clinical responsibilities, aids in the critical thinking of residents and may foster their curiosity to continue exploring unanswered questions in orthopaedic surgery throughout their careers. This is supported by the fact that residents who published during residency were more likely to continue publishing postgraduation. Future work in this area will help further explain the correlations we have described and allow for more effective use of resources in the training of orthopaedic surgeons.

Acknowledgments We thank Ellen Greenberger BA, of the Case Western Reserve University Orthopaedic Residency Administration, Wojbor Woyczynski PhD, and G. Bakeerathan MSc, MPhil, of the Case Western Reserve University Department of Statistics, and Valerie Schmedlen DPM, of the Case Western Reserve University Department of Orthopaedics for their help in the preparation of the manuscript.

References

1. Accreditation Council for Graduate Medical Education. *ACGME Program Requirements for Graduate Medical Education in Orthopaedic Surgery*. Chicago, IL, USA: ACGME; July 1, 2012.
2. Bernstein J, Ahn J, Iannotti JP, Brighton CT. The required research rotation in residency: the University of Pennsylvania experience, 1978–1993. *Clin Orthop Relat Res*. 2006;449:95–99.
3. Crowley RW, Asthagiri AR, Starke RM, Zusman EE, Chiocca EA, Lonser RR, Research Committee of the Congress of Neurological Surgeons. In-training factors predictive of choosing and sustaining a productive academic career path in neurological surgery. *Neurosurgery*. 2012;70:1024–1032.
4. Hurwitz SR, ed. *American Board of Orthopaedic Surgery, Inc 2012 Rules and Procedures for Residency Education Part I and Part II Examinations*. Chapel Hill, NC, USA: American Board of Orthopaedic Surgery, Inc; 2012.
5. Namdari S, Jani S, Baldwin K, Mehta S. What is the relationship between number of publications during orthopaedic residency

- and selection of an academic career? *J Bone Joint Surg Am*. 2013;95:e45.
6. Segal LS, Black KP, Schwentker EP, Pellegrini VD. An elective research year in orthopaedic residency: how does one measure its outcome and define its success? *Clin Orthop Relat Res*. 2006;449: 89–94.
 7. Straus SE, Straus C, Tzanetos K, International Campaign to Revitalise Academic Medicine. Career choice in academic medicine: systematic review. *J Gen Intern Med*. 2006;21: 1222–1229.
 8. The American Orthopaedic Association. *Membership Directory 2008–2009*. Rosemont, IL, USA: American Orthopedic Association; 2008.
 9. Vinci RJ, Bauchner H, Finkelstein J, Newby PK, Muret-Wagstaff S, Lovejoy FH Jr. Research during pediatric residency training: outcome of a senior resident block rotation. *Pediatrics*. 2009;124:1126–1134.
 10. Wu JJ, Ramirez CC, Alonso CA, Mendoza N, Berman B, Tying SK. Dermatology residency program characteristics that correlate with graduates selecting an academic dermatology career. *Arch Dermatol*. 2006;142:845–850.