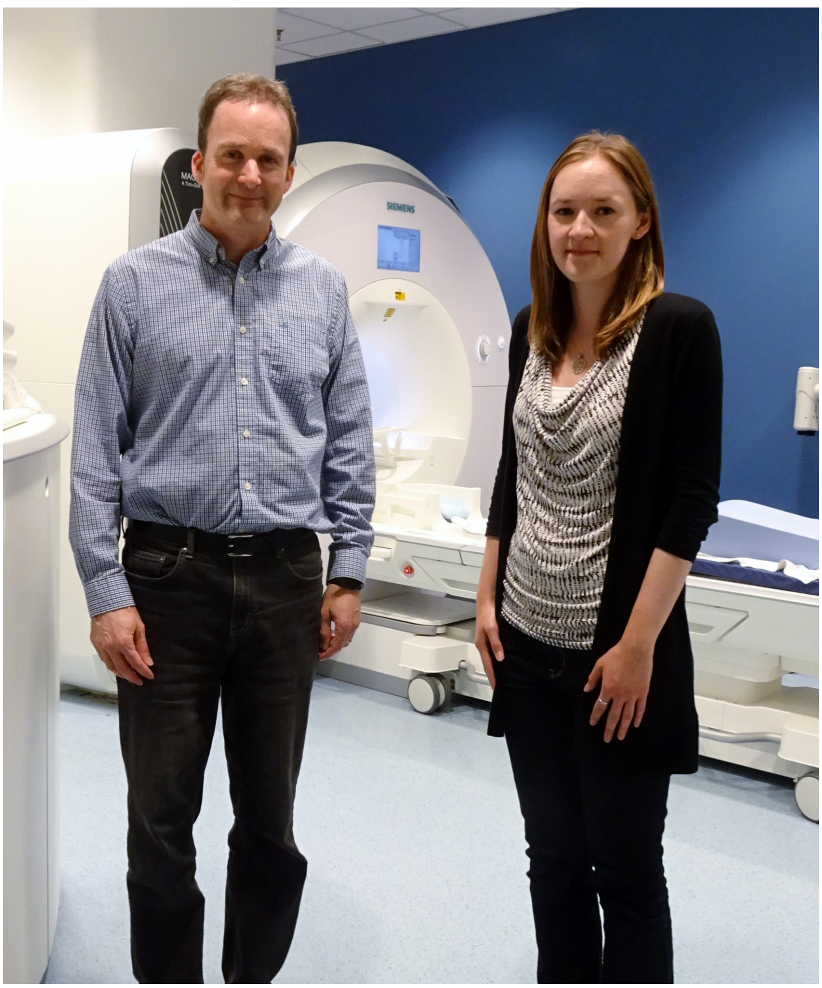
Accuracy and sensitivity of simultaneous T_2/B_1 mapping

INTERVIEW BY **ATEF BADJI** AND **NIKOLA STIKOV**

EDITOR'S PICK FOR MAY

Among the Editor's picks for May comes a paper from the department of physics at the University of Alberta in Edmonton, Canada. In their work entitled, "Transverse relaxation and flip angle mapping: Evaluation of simultaneous and independent methods using multiple spin echoes", Kelly McPhee and Alan Wilman evaluated transverse relaxation (T_2) and flip angle maps derived from Bloch simulations and Extended Phase Graphs (EPG). We conducted this interview with Kelly on a beautiful Sunday afternoon at the Honolulu convention center during the annual ISMRM meeting.



Alan Wilman and Kelly McPhee

McPhee, K. C. and Wilman, A. H. Transverse relaxation and flip angle mapping: Evaluation of simultaneous and independent methods using multiple spin echoes. *Magn Reson Med.* 2017;77: 2057–2065. doi:10.1002/mrm.26285
http://onlinelibrary.wiley.com/doi/10.1002/mrm.26285/full

MRMH: How did you come to work in MRI?

Kelly: I participated in University of British Columbia's (UBC) Co-op program during my undergrad, during which I joined the BC Children's hospital working with Dr. Bruce Bjornson on a fMRI research project. I then met Alan (senior author of this paper) through connections I made at that time and he was also the second reader on my undergraduate thesis. He offered me a position to do my Master's in his lab, but I wanted to stay in Vancouver. Two years later, I contacted him again and joined his lab to do my PhD.

MRMH: Can you please give us a brief summary of the paper?

Kelly: We are exploring the accuracy and sensitivity of simultaneous T_2/B_1 mapping methods via two different models for fitting multi-echo spin echo experiments, namely Bloch simulations and Extended Phase Graphs (EPG). The main difference between the two is that the Bloch simulation approach calculates the slice profile exactly, whereas the EPG approach approximates it. We used simulations, phantom, and human brain experiments to determine findings. We found that EPG and Bloch approaches provided similar T_2 results in most cases, though they are systematically different. The Bloch approach, and EPG with SLR slice profiles provided the best T_2 values. However, when T_2 and B_1 are simultaneously fit, EPG fitting provides highly inaccurate B_1, although T_2 is adequate. This is due to the slice profile approximation used by EPG. We also found that providing an accurate B_1 map to the EPG algorithm leads to further inaccuracies in T_2, thus a B_1 map should not be provided to the EPG approach. In contrast, the Bloch approach is effective either as a simultaneous fit, or with provided B_1 map. The Bloch approach is much less susceptible to noise when an accurate B_1 map is provided, and we recommend using a separately measured B_1 map when it is available. However, if the provided B_1 map is inaccurate, errors will be introduced.

MRMH: For B_1 mapping you used FSE, which is inherently T_2 weighted. There are other B_1 mapping techniques (AFI, EPI-SE) that might be better candidates. What is the benefit of simultaneous T_2/B_1 fitting?

Kelly: There are a number of B_1 mapping methods that all produce reasonable results. A double angle method with fast spin echo was easy to implement, and we added a correction for slice profile. The benefit of simultaneously fitting B_1 and T_2 is that in data sets that lack a B_1 map, accurate fitting can still be performed. For example, this is very common in retrospective data, where a B_1 map was not acquired.

MRMH: What should people do to get a good T_2 map that is not affected by B_1?

Kelly: If your B_1 value is correct, you can input it into a Bloch based simulation method, but if you don't have a B_1 map, or if you are not sure if there is a bias in your B_1 map, you can do a simultaneous fitting approach. If using the EPG model, simultaneous fitting of T_2 and B_1 should be performed. In terms of code access, Marc Lebel released basic fitting code for the EPG method described in his 2010 MRM paper in a 2012 ISMRM abstract (p2558). I have not released code for the Bloch based method yet, but I would like to release it at some point, when I have the time to make it user friendly.

MRMH: How do you see this being relevant to basic/clinical researchers ?

Kelly: T_2 is a fundamental tissue property that varies in disease states. If we can measure it precisely, we can begin to uncover subtle variations in the individual or in group studies. The first step in this process is to be as precise as possible with minimal error, by measuring T_2 correctly by accounting for stimulated and indirect echoes. If you are trying, for example, to examine changes in a group of patients over time by comparing their T_2 maps, but your scan parameters are different across patients and scanners, then, if only exponential fitting is used, you will end up with biases that could make it impossible to compare these datasets. However, if you use any of these methods correctly and consistently, the EPG method or the Bloch based method, you will have better results.

MRMH: What would you like to do next?

Kelly: Regarding T_2 mapping, I think that if you properly model your sequence, you can unravel all the biases from your slice profile, flip angle, etc, and remove them to get your actual T_2 map. I am also developing a method for T_1 mapping, which I am presenting at this year's ISMRM meeting (E-poster 3712). Certainly, my goal is to make quantitative MRI reproducible so we can combine results across scanners for multicenter studies. ■

Kelly McPhee during a trip to Jasper, Alberta.