Kappa Delta Young Investigator Award to Ankle Researcher

By: Terry Stanton

Robin Queen, PhD, FACSM, recognized for work exploring gait mechanics and osteoarthritis
Shoes led Robin Queen, PhD, FACSM, to wonder about the ankle and to focus her research career on that joint. For her work so far and for the research efforts she currently leads at Virginia Tech, Dr. Queen will receive the 2017 Kappa Delta Young Investigator Award, to be presented at the AAOS Annual Meeting this month.

Dr. Queen's research is centered on solving mysteries in the interrelationships among ankle osteoarthritis (OA), ankle arthroplasty, and ankle fusion. She is also concentrating on the effect of these conditions on gait mechanics and the implications for clinical care.

She explains that her initial work in graduate school was in footwear—specifically in running shoes. "People ask, well, how did you go from running to looking at ankle replacement patients? she said. "For me, it was really a passion for understanding the ankle joint itself. In helping runners get into the right footwear, I had seen a lot about the varying degrees of complexity that the ankle brought to the way I had to work with and design shoes."

With her PhD in biomedical engineering from the University of North Carolina, she transitioned to Duke University, an institution known for foot and ankle surgery and research. "I started asking very basic questions about foot typing and shoes and things like that," Dr. Queen said. "The foot and ankle surgeons said, 'Well, we're working a lot with these patients with ankle arthritis.' I thought what better place to understand ankle mechanics than in the most debilitated form of the disease, in the ankle that's not functioning. What does that do to the rest of the lower extremity? I was fascinated that these patients went for 10 or 15 years in pain with very limited mobility and what that meant long-term."

Novel at every stage
In a letter of endorsement to the Kappa Delta Awards Committee, Stefan Duma, PhD, director of the Virginia Tech School of Biomedical Engineering and Sciences, summarized Dr. Queen's accomplishments. She has, he wrote, "developed a complex and high-impact research program over the past decade.

"Her work began with specific examinations of joint and gait function (along with studies of the impact of athletic shoes and of increased weight) and continued to grow and expand. She chose to focus on the ankle because of its clinical importance, the deep and thorny mechanical and engineering problems associated with treatment of ankle arthritis, and the importance of ankle function to whole-body mechanics and locomotor costs. Her work at every stage has been novel."

Dr. Queen came to Virginia Tech in 2015, after 11 years at Duke, where much of her work was done in collaboration with clinical colleagues. At Virginia Tech, Dr. Duma wrote, Dr. Queen "has developed and launched a state-of-the-art lab and has already begun data collection on newly funded projects with graduate, undergraduate, and medical students involved in her research."

In the introduction to the manuscript she submitted to Kappa Delta, Dr. Queen observed, "The current treatment options for end-stage ankle OA include total ankle arthroplasty, ankle fusion (arthrodesis), and ankle distraction arthroplasty, yet it is unknown which or if any of these is an optimal treatment in the context of return to normal activities and long-term function. In short, although many treatments relieve pain, they do not always improve patient mobility and quality of life. The improvement of patient outcomes and quality of life has been the focus of our group for the past decade and we have made great strides moving from examining specific aspects of ankle function to understanding systemic locomotor changes that provide insights into both causes and potential treatments of ankle OA."

Her research, she explained, aims to "quantify the impact of ankle OA and the total ankle replacement on gait mechanics." She has sought to do so by taking "an explicitly holistic and mechanical approach to assessing ankle pathology." Recently, she and her group have expanded their studies to "explore broader measures of physical performance and energy recovery," with results that have "revealed unexpected patterns and sequelae to treatment."

The work she described in the manuscript ranges from "examining the impact of ankle OA on gait mechanics and balance to exploring the impact of coronal plane tibiotalar malalignment and concomitant surgical procedures on gait mechanics as well as exploring patient-reported outcomes following total ankle arthroplasty."

Her studies in patients with ankle OA "demonstrated for the first time the extreme levels and range of gait and balance dysfunction present in this patient population and also explored how the joint affected by lower extremity OA (hip, knee, ankle) causes altered movement and loading patterns not just to the painful joint, but throughout the entire lower extremity on both the ipsilateral and contralateral side."

She focused on the effect that ankle arthroscopy has on both walking mechanics and balance (Fig. 1). She and her colleagues also explored the effects of lower extremity joint OA and surgical treatments, specifically at the ankle, on overall walking mechanics, pendular motion of the lower limb, and energy recovery, all of which relate to patient mobility and locomotor costs.
Beyond pain relief

"Through this novel work we determined that relieving pain alone is not enough to restore normal walking mechanics and balance," she wrote. "We also discerned some underlying causes, including limited ankle range of motion and balance deficits that are associated with continued activity limitations after surgery, and pathways for treatment that would help patients restore normal locomotion. Although total ankle arthroplasty does reduce pain and improve patient outcomes, it is clear from this work that surgery alone will not restore physical function. Therefore, we must begin to consider additional therapeutic interventions aimed at restoring balance, ankle range of motion, and movement symmetry to improve long-term health and function."

In discussing her work, Dr. Queen stressed that discovering how to improve the less-than-ideal outcomes achieved with ankle arthroplasty is a major goal. She asked, "When we treat ankle OA with an ankle replacement, did that really improve the way that the patient moved ultimately, or was it just an expensive pain-relieving procedure? We know that doing an ankle replacement does decrease pain and, in most cases, the patient-reported outcomes improved. We also see that although patient-reported outcomes improve, physical function, walking mechanics, and walking speed don’t necessarily improve following surgery or at least don’t improve to the level of an age-match control."

Initially, she believed that when she studied the gait in ankle replacement patients, she would see what occurs with knee or hip replacement: "You do the surgery and you see an improvement in the way that the patient moves. I was quite surprised that the first study we did demonstrated no improvement in mechanics."

This observation led to a series of studies seeking to understand, "Was something in terms of balance driving the gait mechanics? I still am trying to piece together what is that one component that therapy or manual medicine or something else can change in these patients to improve their outcomes. We’ve focused on some simple things like balance, restoring symmetry between the operated limb and the nonoperated limb and taking a more holistic approach."

"We understand that degeneration at any of the joints doesn’t just affect that joint or even that limb," she continued, "but the entire system. In looking at how to improve outcomes, we need a broader focus, not just what’s happening at the ankle but really retraining the way patients move across the entire lower extremity and not just on the operated limb."

Asked to translate her body of work into a message for clinicians, Dr. Queen said, "The two biggest things that I would say is that tracking and understanding a patient’s balance are important for understanding a patient’s outcomes. How well patients balance statically does affect the way that they walk and move. It’s an easy measure to assess in the clinic. The second measure would be walking speed, which can also be obtained in the clinical setting."

Surgeons and therapists, she said, should seek to assess not just a patient’s passive range of motion in the ankle and “what the patient can do sitting on the table in the clinic. They should really assess the ankle motion during gait, during locomotion” (Fig. 2).
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Dr. Queen’s disclosure information can be accessed at www.aaos.org/disclosure (http://www7.aaos.org/education/disclosure/options)

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