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Review

Douglas H. Johnson: A tribute

Mark Johnson [a,*], Michael P. Fautsch [b]

[a] Northwestern University, Evanston, IL 60208, United States
[b] Mayo Clinic College of Medicine, Rochester, MN 55905, United States

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It is both a distinct honor and yet a sad task to write a tribute for our very close friend and colleague, Dr. Douglas H. Johnson. One of us (MJ) knew Doug for nearly a quarter century, the other (MPF) for almost a decade. As many of you know, he was a rare individual, one that combined the tenacity, enthusiasm, wisdom and compassion of a dedicated scientist with the sensitivity and balance that we all treasured. Doug Johnson was a father, husband, son, scientist, clinician, traveler and friend to many of us.

1. Douglas H. Johnson: Clinician Scientist

Doug Johnson received his B.A. degree in biology from St. Olaf College, Northfield, MN in 1973 and M.D. from Mayo Medical School, Rochester, MN in 1977. He completed his medical internship and residency in Ophthalmology at the Mayo Clinic before heading to Boston where he did his glaucoma fellowship with Dr. David Epstein at the Massachusetts Eye and Ear Infirmary (MEEI).

Meeting of Dr. David Epstein's lab group. Left to right: Levon Karaguezian, Tom Freddo, Joanne Sateriale, David Epstein, John Anderson, Mark Johnson, Doug Johnson, Mary Patterson, Jean Pei

It was at MEEI where Doug's love of research blossomed. The early 1980s saw a new team approach to the study of the pathogenesis of primary open-angle glaucoma (POAG). In Dr. David Epstein's laboratory biochemists, physiologists, engineers, morphologists and physicians were brought together to apply a new approach to solving this vexing problem. The goal was to achieve a "critical mass" of scientists that might unravel the causes of this mysterious disease. Doug loved this thrilling research environment, particularly the in-depth discussion of research topics, the open exchange of ideas, and the camaraderie of colleagues. This team oriented approach fostered his research and clinical practice throughout his professional career.

While in Boston, Doug first began to consider the possibility of developing a new method of perfusing eyes as part of these

* Tel.: +1 847 467 7143.
E-mail address: m-johnson2@northwestern.edu (M. Johnson).

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investigations into the cause of the obstruction of aqueous humor outflow, characteristic of POAG. Doug felt that there was a need for a new model system. As there was no generally accepted animal model that reproduces the intraocular pressure characteristic of primary open-angle glaucoma without other anterior segment changes, this suggested that human tissue needed to be used in experiments. Doug felt that cell culture was of limited utility, and he emphasized the importance of investigating the behavior of cells in situ. Vascular biology had been advanced by the isolated capillary model but no such model was available for studying aqueous humor outflow.

The best available model was the use of enucleated human eyes, but they were restricted to acute experiments (due to tissue necrosis) and some drugs that were known to affect outflow resistance in living eyes did not so affect enucleated eye (e.g. epinephrine). It was these considerations that led Doug to consider the possibility of organ culture in which anterior segments could be isolated and kept alive by perfusion of mock aqueous humor.

Doug discussed his idea with Dr. Morton Grant (developer of tonography, the method by which outflow resistance can be measure in living eyes, Grant, 1950, 1951). Dr. Grant was supportive of the idea and mentioned that Dr. Murray Johnstone had earlier at MEEI tried such a method, but found that flow through the tissue was dependent on how tightly these segments were clamped and not reproducible.

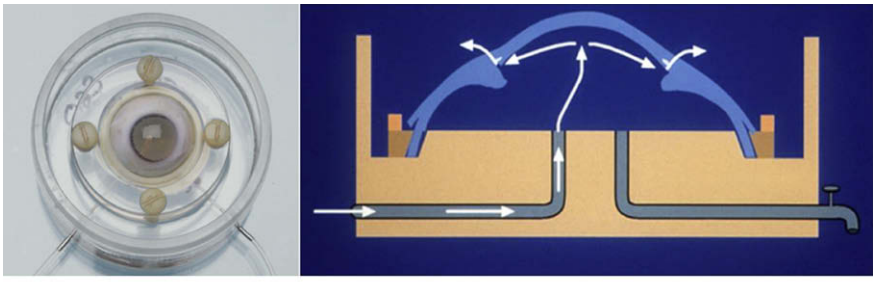
In 1983, Dr. Johnson returned to the Mayo Clinic as a Consultant in the Department of Ophthalmology (where he became full Professor in 1998), and pursued the development of an organ culture technique for the anterior segment of the eye. By 1985, with the aid of Dr. Richard Brubaker and several Mayo Clinic engineers, the perfusion organ culture of human anterior segments was established. In 1987, Doug's innovative idea had become a reality, with the publication of "Human trabecular meshwork organ culture: A new method." (Johnson and Tschumper, 1987). Over twenty years later, the perfusion organ culture of anterior segments is now used internationally to study the effects of pharmacologic agents, growth factors/cytokines, and other molecules on trabecular meshwork function and aqueous outflow resistance. It has been adapted for use with monkey, porcine, and bovine anterior segments and remains the model of choice for studying the conventional outflow pathway in human eyes.

Doug's passion was to understand the morphological architecture of the outflow pathway, particularly that of the trabecular meshwork. He felt that every image, whether taken with light, transmission or scanning electron microscopy, had the potential to teach us something about the function of the trabecular meshwork. He was a careful observer and described similarities and differences between the trabecular meshworks of normal eyes and those found in eyes with primary open-angle glaucoma, pseudoexfoliation glaucoma, pigmentary and steroid-induced glaucoma.

Doug encouraging Cindy Bahler (sitting) and Cheri Hann (standing). For over 15 years, both Cindy and Cheri were Doug's research technicians.

Recently, he described ultrastructural changes that followed nonpenetrating laser trabeculoplasty, where regions of the inner wall of Schlemm's canal and juxtacanalicular connective tissue between laser burns appeared "foamy or expanded"(Johnson, 2007). Doug felt that these "expanded" regions might represent tissue remodeling that served to lower flow resistance through the outflow pathway. He found similar structures under collector channels in normal eyes emphasizing their possible role in fluid flow. At the time when he passed, Doug was involved with characterizing the expanded regions in glaucomatous eyes, where he believed he might find pathophysiologic differences between the trabecular meshwork of normal and glaucomatous eyes, a task he had begun years earlier during an extended working vacation with Professor Elke Lutjen-Drecoll in Erlangen, Germany.

Doug's skill as a careful observer also served him well as a clinician. While evaluating the effectiveness of pilocarpine gel (Johnson et al., 1986), Doug was the first one to notice subtle, but unmistakable changes in the cornea caused by the delivery vehicle. This ability to carefully observe and then analyze data was an important tool that Doug repeatedly took advantage of.



(Left) Top view of anterior segment organ culture apparatus that Doug Johnson developed. (Right) Schematic of fluid flow through organ culture model. (Johnson and Tschumper 1987)

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Doug was a dedicated clinician, and came from a family of physicians; his father Herbert W. Johnson, MD practiced internal medicine St. Paul, MN, and his brother Stephen H. Johnson, MD is currently a practicing ophthalmologist in Newport Beach, CA. It was a pleasure to spend time with Doug in the clinic. No patient had a more caring and careful physician. While Doug's passion was to his research, his devotion was to his patients.

He was curious and wanted to find answers to questions that arose in his clinical practice, particularly why glaucomatous damage continued to progress in some patients even though intraocular pressure was significantly lowered. He spearheaded population-based studies that addressed questions ranging over the incidence of glaucoma, the probability that it would lead to blindness, and whether pigment dispersion syndrome ever converted to pigmentary glaucoma. He wanted to answer these questions both for his own scientific curiosity but also so that he could best inform and treat his patients.

Doug was able to blend his clinical work with his scientific studies. He examined the mechanism by which nonpenetrating glaucoma surgery procedures work to lower outflow resistance and concluded that such procedures unroof and expand Schlemm's canal, probably causing inadvertent ruptures of the inner wall and juxtacanalicular tissue, thus relieving the abnormal outflow resistance of glaucoma. In his own practice, he looked to improve his surgical skills and often tried new technologies such as trabecular stents to see what impact they had on aqueous outflow as well as the histological appearance of the outflow pathway.

In 2005, Doug was awarded the William and Betty MacMillan Professorship in Ophthalmology at the Mayo Clinic in recognition of his many scientific and teaching contributions. He served on the Editorial Boards for Archives of Ophthalmology (1994–2005) and Experimental Eye Research (2004–2006). At the time of his death, he was also a member of the National Advisory Eye Council.

After dinner following a glaucoma review meeting of the American Health Assistance Foundation. Left to right: Doug Johnson, Ross Ethier, David Epstein, Dan Stamer, Rand Allingham, Mark Johnson and Thom Freddo.

Among Doug's most cherished research moments were those involved in scientific discussion with colleagues late into the evening. They were highlights of his trips to ARVO, ICER and other scientific meetings. Doug Johnson was a long-time member of the National Glaucoma Research Scientific Advisory Committee of the American Health Assistance Foundation and served as the committee chair since 1998. As Chairman, Doug made sure that late-night discussions and an open exchange of scientific ideas became an expected part of the annual meeting of this group. Most appropriately, and thanks to a wonderful suggestion from Thomas Freddo (Director of the School of Optometry, University of Waterloo), the American Health Assistance Foundation has now established the Dr. Douglas H. Johnson Award for Glaucoma Research.

2. Douglas H. Johnson: Teacher

Successful scientific investigation involves hard work, creativity, team management and well … some luck. Doug Johnson taught us, and perhaps some of you, that research benefits greatly from objectivity. Doug always felt the hypothesis was the most important aspect of any research project. The best hypotheses were those crafted so that no bias was involved, avoiding personal attachment. Doug understood that you learn from an experiment whether the results support your hypothesis or not. Too many of us become wedded to our hypothesis at the exclusion of good scientific investigation. Follow the clues where they lead, not where you have planned that they ought to go. Doug felt himself a reporter of the truth rather than its architect. He felt that such objectivity could only be maintained if we kept our hypotheses at a distance. Doug succeeded at this goal. How many of us can say the same?

Doug was interested in whatever direction science led him, even though it frequently was not his planned course. Doug once ended an ARVO lecture on the penultimate slide of his presentation with the question "Does the pigmentation pattern in the trabecular meshwork of glaucomatous eyes differ from that of normal eyes?" (his thesis of that investigation). The final slide answered (in small type): "No." How many of us have couched negative results in a comfortable fashion? Doug simply followed the truth.

Doug and his family at Valerie's graduation from Whitman College in 2007. His wife Nancy (left), Valerie (middle) and Emily (far right).

3. Douglas H. Johnson: Husband and Father

In addition to his professional attributes, Doug also had many personal accomplishments. It was important for Doug to have a work-life balance, making sure to spend time with family and friends. Most important in his personal life was his family. Nancy (Nan) Johnson was the love of his life, and he felt the most fortunate man in the world to have found this love. The fruit of this wonderful relationship, Emily and Valerie, share their parent's passion for life and their father's scientific curiosity.

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Doug playing his bagpipes in Edinburgh, Scotland

4. Douglas H. Johnson: The Person

Doug had several hobbies, but none more important than his bagpipes. Doug started playing bagpipes in 2001 and he never stopped. Doug performed with the Rochester Pipes and Drums band in concerts and parades. Individually, he would play for anyone that asked. He performed at laboratory functions, birthday parties, and anniversaries. He even showed up at Cindy Bahler's front door (Doug's laboratory technician for 15 years) to celebrate her 48th birthday, playing "Happy Birthday" on the bagpipes. He performed at the American Glaucoma Society (AGS), not for pleasure, but to make a point that forcibly exhaling against a closed or partially closed airway (valsalva, demonstrated by the bagpipes) can affect intraocular pressure. We recall that for his funeral, Doug wrote a delightful and inspirational piece that was read to us, where he reminded us that bagpipes were to be expected at the event.

Doug also enjoyed traveling. Together with Nan, they traveled the world. Some trips were purely for fun such as travels with Nan, Emily, and Valerie to Europe to explore the Gothic cathedrals, Roman ruins and various wonders of history and nature. His visit to Scotland was highlighted by playing in Pipefest 2005, a fund raiser for cancer research. Over 9000 bagpipers and drummers participated in the event, forming the largest ever pipe band and a place in the Guinness book of world records.

Most of these travels involved scientific pursuit as well, and Doug saw many of his colleagues on these trips. Before a trip they took together to Germany, Mark Johnson had ruptured his right achilles tendon and wore a cast on that trip. Doug frequently told the tale of an excessively heavy suitcase of Mark's due to unnecessary right shoes that need not have been brought. Furthermore, although Mark Johnson asked in a hotel in Erlangen, Germany for separate beds for Doug and him to sleep in (in fluent German so he thought), the presence of a double bed gave Doug more stories to expand upon as the years moved forward (it should be noted that Mark Johnson's recollection of these events varied somewhat from Doug's). However, it might be true that driving through Germany, passing round and round each Zentrum, they looked but could never find the "Zum" castle although they saw signs for it everywhere.

Doug had a wonderful sense of humor, whether on the giving or receiving end. Fortunately for Doug and for the rest of us, humor came naturally to him. Whether at a serious scientific symposium, after dinner talk, in the lab, or simply relating one of his tales to friends, Doug rarely failed to entertain. Many of us enjoyed hearing stories about ourselves, generally learning something new nearly every time he expanded on these special tales.

Doug was also a spiritual person. He taught Bible study for 15 years, helping others interpret what is meant and said in the Bible, and growing ever deeper in his own understanding and faith. In the piece that was read to us at his funeral, he described the basic but essential aspects to living a fun and worthwhile life: exercise, enthusiasm, and exhilaration. In his words "Exercise clears the mind and puts the days problems in perspective; enthusiasm about an enjoyable activity you can't wait to get to; and performing exhilarating tasks that years later you look back at and say wow, that was amazing." He wanted everyone to know that he lived life to the fullest, both personally and professionally. We can only hope that as we look back on our lives, we will be able to do what Doug did, live our lives to the fullest.

5. Doug Johnson: Our Friend

The field of Ophthalmology has lost an outstanding clinician scientist, but more importantly the world has lost a great person and we have lost a great friend. It was always Doug's dream to find the cause of glaucoma. Doug understood that multidisciplinary approaches to glaucoma, particularly POAG, were essential if we were to determine and understand the cause of the disease. It was

Sign to the Zum Castle in Germany that Doug Johnson and Mark Johnson looked for but never found. Photo courtesy of Marco Gößwein, photographer for Dr. Elke Lutjen-Drecoll.

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our privilege as a scientific community to have known Doug and share our exchange of ideas. We miss his cheerful demeanor, positive analysis, and most importantly, his physical presence. We are sure that he would very much enjoy reading the diverse articles that make up this special tribute issue memorializing his many scientific investigations into the pathogenesis of glaucoma.

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