



My 60 years as a clinical anatomist*

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Abstract

This article is the autobiography of Keith L. Moore, PhD, DSc, FIAC, FRSM, Professor Emeritus of Anatomy and Cell Biology at the Faculty of Medicine, University of Toronto.

It is our great pleasure to have the autobiography of a pioneer of clinical anatomy in our journal, IJAV. I (Tunali S.) have been first acquainted with Dr. Moore's great work during my intership in the medical school. Unfortunately, Clinically Oriented Anatomy was not widely accessible in Turkey when I was having my anatomy courses. This late acquaintance (better than never) left an indelible impression on my career. It was amazing to see that complicated anatomical information was put into service in an easy to understand way. Undoubtedly, Dr. Moore had influenced my career choice, even he may not be aware of it. As countless anatomists worldwide, I continually refer his books and suggest them to my students. It is a great honor to publish this article as it may be regarded as a debt of gratitude. Please enjoy the autobiography of Dr. Moore.

Keith L. Moore was born on October 5th, 1925 in Brantford, Ontario, Canada. He worked for over 60 years as a Clinical Anatomist. His books are of major references in the area of anatomy and embryology for medical students and anatomists alike. © *Int J Anat Var (IJAV)*. 2012; 5: 1–4.

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My father, the **Reverend James H. Moore**, was born in London, Ontario, Canada. He was a Presbyterian Minister who graduated from McMaster University (B.A.) in Toronto, Ontario (now located in Hamilton, Ontario). He taught me how to read and write by the time I was 6 years old. My mother, **Gertrude M. Moore**, was an *Associate of the Toronto Conservatory of Music (ATCM)*. She was an excellent pianist, organist and vocalist. They both agreed that I should go to university. Dad wanted me to be a minister and Mom wanted me to do what ever I wanted, but she was adamant that I get a university education.

I was the fourth of their five boys. The family lived in Bethel, Ontario, just southwest of London Ontario, Canada. Shortly thereafter my father accepted a pastorate in Wallacetown, Ontario near St. Thomas, Ontario. Subsequently our family moved to London Ontario and then to Shakespeare Ontario near Stratford. Ministers usually stay for a few years in one place. I attended the *Stratford Collegiate Vocational Institute* in Stratford, Ontario, Canada (1938–1944). I had to hitchhike (travel by getting free lifts) to school for two years before buying an old car.

I joined the **Royal Canadian Navy** in 1944. I was a Sick Birth Attendant (Paramedic) on a Castle Class Corvette (HMCS

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Humberstone) during WWII (1944–1946). The length of the ship was 250 feet and had a crew of 93 seamen, 5 officers and 8 others (such as the cook and paramedic). The medical room was about 8 feet wide and 15 feet long. There were two beds and a desk. I was the only person on board with medical knowledge. I was trained to treat minor diseases and injuries. However the men were in good health, so I did not have to deal with any serious problems. Some men got seasick for five days every time we went to sea. Most injuries were the result of crew fights and falls during rough seas. After we were out to sea, several men showed symptoms of venereal diseases, such as gonorrhoea.

All four of my brothers were in the services (2 in the air force and 2 in the army). I was discharged from the navy in April 1946. By this time my parents had moved to Streetsville, Ontario, southwest of Toronto. Sadly, my father lost his battle with pancreatic cancer, two weeks after I arrived home. I went to high school for three months in Streetsville to upgrade my English and Mathematics. One of the teachers tutored me after school, mainly because she knew I was a naval veteran and was anxious to go to university. In July my mother and I moved to London Ontario where I was planning to go to university. In September 1946, I enrolled in *University College* at the **University of Western Ontario** in London, Ontario. Initially I took a general course that was a mixture of Arts and Science. However I soon realized that I wanted a more scientific education so I took more science courses (botany, biology, genetics, zoology and comparative anatomy).

I graduated with a **Bachelor of Arts (B.A.)**, General Course in 1949. I then earned a **Master of Science (M.Sc.)** in *Anatomy* in 1951 and a **Doctor of Philosophy (Ph.D.)** in *Microscopic Anatomy* in 1954.

My supervisor for my M.Sc. and Ph.D. degrees was **Dr. Murray L. Barr**, a world-renowned neurohistologist and cytogeneticist. I studied sex chromatin patterns in the nuclei of various cells of humans and animals. The **sex chromatin** is a characteristic mass of chromatin in the nuclei of nerve and somatic cells of females of many animals, including humans.

An editorial in the **Canadian Medical Association Journal** described Dr. Barr and his team's research on the sex chromatin (E.G. Bertram, L. Bertram, K.L. Moore and M.A. Graham) as "**the most important Canadian contribution to fundamental medical science since Banting discovered insulin in 1921**".

It was E. G. (Mike) Bertram who first observed the nucleolar satellite in the nuclei of female cats. The term "satellite" was changed to the **sex chromatin** when it was apparent that it was an inappropriate term. The sex chromatin is a condensed X chromosome.

Progress in the understanding of human sex anomalies was accelerated by the development of clinical sex chromatin tests. The first test I developed was the **skin biopsy sex chromatin test**. Small pieces of skin were removed by a plastic surgeon from the upper part of the forearm of males and females. In less than a year, 27 skin biopsies from intersex patients came

to my laboratory from all over the world. This test is rarely used today because it has been replaced by the **buccal smear sex chromatin test** that I developed in 1952. This procedure is easier to perform and avoids the minor surgical operation of obtaining a skin biopsy. The buccal smear technique is simple. The inside of the cheek is scraped with a surgeon's nickel spatula to obtain mucosal scrapings, which are spread out as a thin film on a clean microscope slide, fixed, stained and studied with the oil immersion objective of a binocular microscope. Buccal smear tests are used for the detection of the gender of persons who have ambiguous external genitalia and/or sex chromosome abnormalities. The buccal smear test is used world wide, for example by doctors examining athletes at the Olympics.

The buccal smear test for detecting gender is the single main laboratory test in the management of human intersexuality (hermaphroditism) and sex chromosome aberrations. However, examination of the chromosomes is usually performed if a buccal smear test indicates an abnormal sex chromosome constitution, such as XXY or XXYY in males and XXX or XXXX in females.

After receiving my doctorate, I was awarded a two year **Postdoctoral Fellowship** from the **National Cancer Institute of Canada** to continue my research on the morphology of cell nuclei, with special reference to sex chromatin in human malignant tumors. Later I cultured human chromosomes, with special reference to sex chromosomal abnormalities (e.g., in persons with the Down syndrome, Klinefelter syndrome, Turner syndrome and mental deficiencies). I was the first one to observe that most males with the Klinefelter syndrome have abnormal sex chromosome complements that is XXY instead of the normal XY. Subsequently, I observed 5 males with sex chromatin in their nuclei in the 1911 infants from whom I obtained buccal smears (0.26 %).

In 1956 I was appointed **Assistant Professor of Anatomy** in the Faculties of Medicine and Dentistry at the University of Manitoba in Winnipeg, Manitoba, Canada. I taught gross anatomy and embryology. Although these subjects were taught separately, I integrated them during small group sessions in the gross anatomy laboratory (e.g., subhepatic cecum and abnormal rotation of the gut).

I continued my study of the sex chromatin in humans and developed the **vaginal smear sex chromatin test**, which is used routinely by gynaecologists in cases of primary amenorrhoea and other sex disorders in females. Because of my studies using this test, I was elected **Fellow of the International Academy of Cytology and a Member of the Board of Consultants in the International Academy of Gynecological Cytology**. Dr. G. Papanicolaou, who developed the Pap cervical smear for screening for malignant cells signed the certificate.

In 1959 I was promoted to **Associate Professor of Anatomy** and in 1965, I was appointed **Professor and Head of the Department**. In 1966 W. B. Saunders published a reference book entitled, **The Sex Chromatin**, which I edited. There were

22 contributors; I wrote 6 of the 26 chapters. The widespread applications of knowledge of the sex chromatin, clinically and in research, are described in this reference book.

In 1976, after 20 years at the University of Manitoba (11 years as the Head of Anatomy), I was offered and accepted the **Chair of Anatomy in the Faculty of Medicine, University of Toronto**, Toronto, Ontario, Canada. I was honored and delighted to be invited to this prestigious Chair that was occupied for 26 years by Professor **J. C. Boileau Grant**, a world-renowned anatomist. Through his textbooks, Dr. Grant made an indelible impression on the teaching of anatomy throughout the world. Interestingly, he was Professor and Head of Anatomy in the Faculty of Medicine, University of Manitoba for 11 years (1919–1930), the same number of years that I was the Head (1965–1976).

I have been a member of AAA for 56 years and I believe my main contribution has been to promote anatomy education at the AAA meetings and around the world. I have published 60 scientific papers (including abstracts) based on my research and teaching methods. I am the senior author of 14 textbooks in gross anatomy, embryology, cytology and neuroanatomy. Five of these books are still in print. The 9th edition of my large embryology book, **The Developing Human, Clinically Oriented Embryology**, is translated into 14 other languages. The 8th edition of my smaller embryology book, **Before We Are Born**, Essentials of Embryology and Birth Defects, has been translated in 8 other languages.

The 6th edition of my gross anatomy book, **Clinically Oriented Anatomy**, has been translated into 9 other languages. The 4th edition of my smaller book, **Essential Clinical Anatomy**, has been published in several languages. The 2nd edition of my **Color Atlas of Clinical Embryology** was published in 2000.

My best friend **Marion**, wife for 57 years, and mother of our 5 children earned her **Bachelor of Arts** in 1977. She did most of the typing of my publications and books. At first she typed them on an IBM Selectric typewriter. Later she mastered the use of a computer for later editions of my books. She also reviewed all my manuscripts and made helpful suggestions for improvements. When I made mistakes, she tactfully mentioned them. For fun I would say, "I am not perfect"! She would respond, "You don't need to keep proving it"! Her unconditional support, understanding, and good humor are sadly missed.

As a classically trained anatomist and dedicated teacher, I have taught anatomy and embryology for 60 years and have traveled around the world (Australia, Brazil, China, Costa Rica, Ecuador, Egypt, Great Britain, Japan, Mexico, Russia, Saudi Arabia, South Africa and Turkey) to give anatomy and embryology lectures on the clinical correlates of anatomy and embryology. Wherever I go, I always emphasize that:

To learn anatomy without a sound knowledge of gross anatomy and embryology is like sailing a ship without a navigator's map; in either case there is likely to be serious consequences.

"You will remember some of what you hear; much of what you read; more of what you see, and almost all of what you experience and understand fully".

For twelve years, I was an embryology consultant for three medical dictionaries, "Stedman's Medical Dictionary; Stedman's Medical Dictionary for the Health Professions and Nursing, and Dorland's Medical Dictionary. I was also a reviewer for part of the embryology section of the 40th edition of Gray's Anatomy. Although I retired in 1991, I have not relaxed very much. I am always working on new editions of my books, attending anatomy meetings worldwide and giving guest lectures. I enjoy meeting students and autographing their books. I have taught in the gross anatomy laboratories for several days for about 10 years at the Albert Einstein College of Medicine in the Bronx, New York, and have held numerous other visiting professorships around the world.

I have received many honors and awards, but I was really surprised when I was told that I would be the **first recipient of the Henry Gray/Elsevier Distinguished Educator Award**, the AAA's highest award for human anatomy education. The nominator said: *"Keith is an individual of nearly legendary status among anatomists around the world... He has had a monumental impact on anatomical education, not only at a national but also at an international level."*

The Chair of the Award Committee who presented the award said: "His books were like a breath of fresh air for faculty and students alike. Structures and developmental processes were no longer viewed in isolation from practical application, things to be memorized to exceedingly fine detail, but were presented within a clinical context that became the famous blue boxes and taught to a level of detail useful for clinical practice... His contribution to anatomy education around the world has been profound and continuous, and will be an enduring legacy."

Other notable associations, honors and awards are listed below.

Member of the Canadian Association of Anatomists since 1954; former Secretary and later President.

Member of the American Association of Anatomists since 1956.

Consultant in Anatomy and Embryology, Honorary Attending Staff, Children's Hospital, Winnipeg, Manitoba, Canada, 1959–1976.

Member of the Advisory Board of the journal *Acta Cytologica*, 1960–1990.

Member of the Board of Consultants of the **International Academy of Gynaecological Cytology** since 1961.

Member of the Senate of the University of Manitoba, Winnipeg, Manitoba, 1966–1976.

Fellow of the International Academy of Cytology (FIAC) since 1968.

Member of the Executive Committee of the Senate of the University of Manitoba, Winnipeg, Manitoba, 1970–1976.

American Medical Writers Association Award for excellence in medical publications as represented by his book "The Developing Human", 1974.

American Medical Writers Association Awarded Honourable Mention for his book *Clinically Oriented Anatomy*, 1981.

Founding member of the American Association of Clinical Anatomists; Vice President and later President, 1983.

J. C. B. Grant Award, the highest honour given by the Canadian Association of Anatomists in recognition of "*meritorious and outstanding scholarly accomplishments in the field of anatomical services*", 1984.

Fellow of the Royal Society of Medicine (FRSM), London, England, 1985.

Associate Editor of the Clinical Anatomy Journal since 1986.

Member of the National Board of Medical Examiners of the United States of America, the first Canadian to be appointed to this prestigious board. The certificate was presented "*in appreciation of the valuable contribution to the work of the board and the preparation of examinations for American and Canadian Medical schools*", 1988–1992.

Member of the Federative International Committee on Anatomical Terminology for 20 years, the only Canadian ever appointed to this prestigious committee. The aim of this committee is "to present the official terminology of the anatomical sciences after consultation with all 55 members of the International Federation of Associations of Anatomy, thus insuring a democratic input to the terminology". The terms

are translated into several languages so that all anatomists and doctors can use the recommended terms, 1989–2009.

American Medical Writers Association First Place Award for medical books in the Physicians Category as represented by the book *Clinically Oriented Anatomy*, 1993.

Honoured Member of the American Association of Clinical Anatomists (AACA), the highest honour given by the association for scholarship and service. The recognition is for "*outstanding contributions to the field of Clinical Anatomy, epitomized by his many textbooks on clinically-oriented gross anatomy and embryology, and many years of dedicated service to the AACA and its journal, Clinical Anatomy*", 1994.

Very Eminent Professor Award in Commemoration of 100 Years of Independence of Panama and the School of Medicine Panama City, Panama 2003.

Fellow of the American Association of Anatomists. This Fellowship honours distinguished members who have demonstrated excellence in science and overall contributions to the medical science, 2008.

The University of Costa Rica, Faculty of Medicine in San Jose designated Dr. Moore as a "**Maestro De La Anatomia De America**", 2008.

Honoured Member of the Italian Society of Anatomy and Histology in recognition of his scientific and academic curriculum, 2009.

Honorary Degree, Doctor of Science (DSc) from The Ohio State University, Columbus, Ohio, USA, 2012.

R. Benton Adkin Service Award, 2012.