The History of Radiosurgery in ... Canada

A current snapshot of radiosurgery (SRS) in Canada would yield a picture equivalent to most developed countries, but the early history of SRS in Canada is unique with hospital built equipment and decisions made on the fly.

Canadian radiosurgery began in 1986 at McGill University. André Olivier, a neurosurgeon at the Montreal Neurological Institute (MNI), recognized the need to offer SRS to patients with inoperable arteriovenous malformations. There was a fortunate convergence of talent and equipment at the MNI and McGill University (Quebec), with Ervin Podgorsak (a physicist who conceived the dynamic rotation method of linear accelerator (linac) radiosurgery), physicist Terry Peters and his student Bruce Pike (who developed the treatment planning software), and the Tipal family (whose instrument company made the Olivier-Bertrand-Tipal (OBT) stereotactic frame).

The standard linac-based method for delivering high radiation dose accurately to a small target was the multiple non-coplanar converging arc method, but Podgorsak conceived the idea of rotating the treatment couch (in an arc parallel to the floor) and the linac gantry (at right angles to the patient rotation) simultaneously. This causes the entering beam to trace a single very long arc like the seam of a baseball, and results in dose fall-off outside the spherical radiation shot as steep as by any other method. A spherical target could be radiated with this method in less than 15 minutes, and irregular targets conformed by multiple shots.

My own (MLS) involvement with radiosurgery began in September 1987 when I was attending a traumatology meeting in Montreal and was invited by a colleague to watch a treatment at the Montreal General Hospital. On returning to Toronto, I approached Derek Jenkin, the head of radiation oncology at the Sunnybrook Health Sciences Centre (Toronto), and he produced a file of correspondence between him and Podgorsak. We resolved to implement the McGill system in Toronto. For a total of approximately $100,000, Peter O'Brien and Bruce Gillies motorized the treatment couch and linked it to gantry rotation with electronic interlocks. We also acquired an OBT frame and the McGill treatment planning software. We treated our first patient in June 1988. We later got the idea to take out the flattening filter, making the system run 2.8 times faster, and the time treat an isocenter was reduced to as little as 5 minutes.

In the early days, it seemed that no treatment ever went completely smoothly. For example, in 1991we were treating a man with a thalamic AVM. Our practice at the time was to do the radiation planning on the basis of the digital subtraction angiogram (DSA) and an enhanced CT scan. For DSA we had a Philips system that archived the images on 8 inch floppy discs (does anyone remember or even know of 8 inch floppy discs?). We had an in-house program to read the 8 inch floppies on my office personal computer. I would then record the transferred images onto 5 1/4 inch floppies, and take the 5 1/4 inch floppies to the planning computer. As we were making the intra-arterial DSA injections we discovered that the 8-inch floppy drive on the DSA equipment wasn't working. We could see the images on the screen, but there was no obvious way to transfer them to the planning computer. Here we were with a man with a stereotactic frame on, a catheter in his carotid artery, and a question of --What to do? We hit on the idea to transfer the man to the CT scanner, and with the scanner running hand-inject the contrast into the catheter. We had intense opacification of the target and were able to

successfully radiate the AVM. We later used the same technique to treat a tiny intrapontine AVM. It also became our standard technique for children, whose imaging is acquired under general anesthetics, obviating a difficult transfer to a remote MRI scanner. Another issue that we had to face was whether the accuracy of our system was as good as standard methods. In order to determine this, we designed and built a lucite phantom that was subsequently produced commercially and marketed as the Lucy phantom (picture below).

After McGill and Sunnybrook, virtually all the systems installed in Canada were commercial ones. Sadly, the dynamic rotation method, a very good idea in my (MLS) view, never attracted commercial support and is no longer in use. Today there are linear accelerator based radiosurgery units in Vancouver, Calgary, Hamilton, Ottawa, Montreal and Halifax from a variety of suppliers. As a brief description of the acquisition of technology: the Vancouver radiosurgery program implemented a cone-based system in 1997. The first of many Canadian micro multileaf collimators (mMLC) was installed at the Princess Margaret Hospital in Toronto in 1999. In 2000, mMLC units were introduced at McGill and in London, Ontario. The London system used a mask immobilization system, portal imaging and real-time optical guidance and dynamic rotation. By 2002, radiosurgery had begun at the Nova Scotia Cancer Centre in Halifax using a mMLC system. The Calgary radiosurgery unit, in operation for 3 years with a cone-based linac system, acquired the BrainLab Novalis system in 2004 and was the first dedicated radiosurgery linac in Canada. In 2003, Canada's first Gamma Knife, a model 4C with an automatic positioning system (APS), was installed in Winnipeg, Manitoba. In 2004, the second gamma unit was installed in Sherbrooke, Quebec. This was followed by another 4C at the Toronto Western Hospital, and then in 2007 the newest Gamma Knife unit, the Perfexion, was installed at the Princess Margaret Hospital, Toronto. More recently, Cyberknife units have been installed in Canadian centres. In 2009 the first patient was treated in Canada with a CyberKnife unit at the Université de Montréal. CyberKnife units have subsequently been installed in Hamilton and Ottawa.

An important event in organizing Canadian SRS was the founding of the Canadian Radiosurgery Society (CaRS). Zelma Kiss and John Wong, neurosurgeons at the University of Calgary, organized the inaugural meeting in Banff in March, 2005. The first invited guests were Dave Larson of San Francisco and Sam Ryu of Detroit. There have since been 3 more meetings, organized by Michael Schwartz of the University of Toronto, by David Roberge of McGill University and by Alia Norman of Memorial University in St. John's, Newfoundland. A fifth meeting is in the works, to be hosted by Michael West at the University of Manitoba. The society provides a forum for interaction among neurosurgeons, radiation oncologists and physicists who do radiosurgery in Canada.

Radiosurgery in Canada continues to grow in terms of availability and technology, and future directions include the use of image-guided SRS, frameless brain SRS, and MRI guided focused ultrasound. As technology continues to evolve at a rapid pace, the next decade of SRS in Canada will be exciting and "mind blowing". Canada is a candidate country for the 2013 International Stereotactic Radiosurgery Society meeting, the candidature is led by Arjun Sahgal and Michael Schwartz, and reflects the contribution Canada has made to the field of SRS.