5-1988

UWOMJ Volume 57, No. 3

Western University

May 1988

The University of Western Ontario

Medical Journal

HEALTH SCIENCES CENTRE
U.W.O. LONDON, ONTARIO
CANADA N6A 5C1

EDITORIAL COMMENT

The issue of patients suing their doctors is one which is becoming increasingly important, both in terms of its financial implications and, more seriously, in terms of its effects on the doctor - patient relationship. Ths issue will become more and more relevant as we approximate our litiginous southern neighbours.

CMPA premiums have been rising almost exponentially over the last few years. Physicians must allot more and more of their disposable incomes to protection from suits. This income drain is a nuisance, but its effect is minor compared to the devastating effect a legal action can have on a doctor in terms of how he or she views a patient.

It is said that one can identify a doctor who has been sued simply by the things he says about his patients: he is on his guard, he sees patients no longer as people he can help but rather as people who have the potential to hurt him. His attitude undergoes a fundamental change, and his ability to care for his patients must surely suffer.

As of 1985 in the U.S. 67% of Obstetricians had been sued at least once. The Canadian figure is probably lower, but the number of actions against doctors is increasing. As one anaesthetist put it, it is not whether one gets sued, it is when. Doctors, he said, must be prepared for a law suit at all times.

The option of legal action against a physician for damages caused by negligence or incompetence is an important safeguard in our medical system; it allows for financial compensation, for punishment of negligence and for identification of physicians who are careless or who are no longer capable of practising. But this safeguard can be sorely abused.

A Niagara area physician recommended a Glucometer to a diabetic for home glucose monitoring. When he was off for a weekend, the patient died because the on-call physician continued to use the Glucometer, which in retrospect was defective. The family is suing both physicians, despite the fact that the original physician did nothing negligent. The case may be more complex than this, but it points to the alarming propensity of late to sue everyone in sight.

Physicians who have been sued feel angry and betrayed by those they work to help. There is little we can do to fight the tide to sue physicians, but we can be constantly vigilant. We must remember that any patient contact could potentially give rise to legal action.

David Creery
Meds '89

"THE MAKING OF THE PERFECT MED STUDENT"

Whenever I cook Fleischrouladen, one of my favourite German dishes, I find myself confronted with a formidable task. To an observer, frying a few stuffed meat rolls couldn't possibly be that involved, but to me the process is far more complex. With every batch, my culinary reputation is on the line, and it behooves me to try to improve them each time I make them.

It starts with the ingredients. Which package of sliced beef contains the greatest number of appropriately shaped pieces large enough to hold all the filling yet not too exotically shaped? Never mind the fact that my size standards are totally arbitrary, based largely on what's worked in the past — when my money is on the line I want to invest in what I perceive to be the best possible end result.

Next I anguish over pickles. Can I get away with the standard name brand from A&P or would it be worth it for an extra trip to Miracle for some Strubbs? Getting more adventurous, I debate the pros and cons of the honey mustard vs. plain Dijon. The same nit-picking follows for the bacon, the onions, the sherry for the sauce, etc. etc. Depending on whether or not there's an exam coming up, I even debate using round ended toothpicks or the kind that's pointed at both ends, offering the advantage of removal from either end.

The point is that no matter how much I trouble myself over the selection of my raw materials or their assembly (does chopping pickles result in more flavour than slicing?) the Rouladen always turn out just fine. Even the odd-shaped piece of meat that some disreputable butcher always sneaks into the package manages to get successfully cooked. The reason the Rouladen always work out is that the basic recipe is good, and the small nuances of flavour which come from insignificant tinkering are barely discernable after all the simmering is done.

I imagine those responsible for admission standards and curriculum changes at this medical school suffer from a similar predicament. Someone somewhere in charge sincerely believes that a few extra months of problem solving after second year will make a difference in the quality of our education, or that a point system for admissions which rewards those holding degrees will produce better doctors. (If having a degree does confer an advantage, I, with my biochemistry degree, am still waiting raptly to find out what it is.)

I don't understand this obsessive need to try to revise and "improve", especially when such improvements result in things like this year's ICC fiasco. Presumably all these efforts are directed at producing that nebulous entity, the perfectly well-rounded, empathetic, knowledgeable and wise physician in the most cost effective manner possible. Yet somehow the nagging question of why one needs to fiddle so much with a formula that's worked essentially well in the past begs to be answered. "Changing times" explains nothing, seeing as the doctors Western has produced in the past seem to be managing just fine in the face of problems such as increased government control of medicine and the explosion of new medical information.

Medical students themselves are a relatively homogeneous lot with regards to their background, abilities and interests, whether they see it or not. Changing the admission requirements by a year here or there or a course prerequisite or two will in the long haul, I suspect, make absolutely no difference.

Plus ça change, plus c'est la même chose…

Monika Schwab
Meds '90

LETTERS TO THE EDITOR

To Alistair Ingram and Atul Kapur:

I object to your support for socialism in health care.

This is about FREEDOM OF CHOICE, guaranteed by the Canadian Charter of Rights and Freedoms. Those who support the concept of universality in health care should take time to read the Charter - you may find it enlightening.

Most individuals in this province support universality in health care with total disregard to the values which our constitution was designed to protect. Let me explain with an example - a cataract operation.

There are facilities available such that a person may pay approximately $700.00 to have the surgery performed at his/her own convenience in private clinic. The second option is to wait in line several months and have the surgery done in a government hospital for no cost - cost covered by OHIP. Under our socialized system this individual is DENIED their FREEDOM OF CHOICE. Even though this individual by choosing private health care has NOT prevented any other individual from getting their eye operation, and has in fact increased accessibility for those waiting in line, he/she is still denied their FREEDOM OF CHOICE. In fact, with more people putting private money into dialysis, more funds would be available to treat individuals who could not afford the treatment, without government assistance or otherwise.

Most socialists, however, will argue that some people don't have a choice when it comes to funding their health care. Unfortunately, this is true. One has to understand that unfortunately, not being able to make a choice in life is a fact of life, BUT, being, denied the FREEDOM OF CHOICE is a violation of one's liberty. Poverty, starvation, illiteracy, all of which are major health care issues, cannot be resolved by any system of health care whether or not it be private or socialized.

Our socialized government has "offered" to pay our medical bills, but has DENIED us the opportunity to pay for our medical care ourselves IF WE CHOOSE TO DO SO.

If you as an individual accept this concept of government imposed universality then you value the written law of Government legislation much higher than the spirit of the law guaranteed in our Charter of Rights and Freedoms. To go a step further, the criminal in this province is NOT the one who pays for services but rather the one who receives payment for services rendered.

Although today, the proponents for socialism in health care will NOT stand by me and my respect for FREEDOM OF CHOICE; tomorrow when they are denied health care accessibility due to lack of funding, I will be there to defend their right to FREEDOM OF CHOICE.

Andrew Ragula
Meds '89

OPINION

Abortion: What is the Issue?

When I think of the abortion issue, I am never quite sure what people are arguing about. To some it is a matter of personal freedom, to others it concerns the sanctity of life, to yet others it is a question of the quality of life, and to many others it is just a source of grief that they wish would go away. Well, I guess many may have thought the recent Supreme Court decision sort of did the latter i.e. hopefully made it go away, by basically legalizing abortion. They reason now it really doesn't matter what people think, it is there and available to any who chose to exercise the option. Unfortunately, I doubt this to be the case, as neither the government nor the public at large really believe such an emotionally charged issue that has such distinct legal, medical and ethical ramifications will go away that easily. Indeed, it appears that the government is preparing new legislation on the issue and in light of this, perhaps it is timely for us to consider just what are the issues and what is at stake.

I suppose the real crux of the abortion issue, or at least as I see it, is the question of whether or not the fetus is life. If it is life, person, being, whatever term you choose, then to deprive it of the support it receives from the maternal environment is as murderous as depriving a six month old of maternal support. However, if it is not life, rather an invasive neoplastic-like growth, then a woman is well within her rights to relieve herself of it as she would any other possible threat to her health. Having established this as the issue to settle, the question is "Is there a way to answer the question?"

Normally, people go to one or all of three sources to solve questions; namely law, science, and religion and moral teachings. So let us see if they have anything to say on the issue.

Law seems to be uncertain. A fetus can be declared executor or beneficiary of an estate in a will and has all the legal rights of a person outside the womb as far as the law is concerned in this matter. Conversely, this same fetus could be aborted by its mother to "rob" it from its estate, and this is not considered a wrong in the legal sense as the fetus is not a legal person in this area of criminal law. Similarly, the law allows suing a drug manufacturer for damage to the fetus by its product, but it does not allow forcing a mother to stop smoking or drinking during pregnancy although both are certainly as teratogenic.

Science, as represented by clinical medicine, has an equally confused view on the topic. In a hospital one may find an abortion being performed on a 500 g fetus one floor, while on another floor they are using all modern medicine has to offer to save a 500 g premature, and on still another floor they are counselling couples on how to use in vitro fertilization to get pregnant.

The basic scientists are in no more agreement. Some wish to define life in terms of heart activity, others by brain activity, still others by viability outside the womb. Some may even argue it begins with conception, as the fetus is really a "foreign body" within the mother that should be rejected by her immune system but somehow isn't due to the placenta which the fetus develops to protect itself. If such is the case then it is an entity, because it practices one of the most basic activities evolution attributes to all life, namely self-preservation.

Finally, religion or moral teaching is no less divided on the issue. Abortion is acceptable in certain schools of thought and not in others. Some may even argue that morality has no part in this issue, as it is an individual decision, and no one has a right to tell anyone what to do or not to do. Of course, that idea is in itself an outgrowth of the school of thought one might call individualism (whose roots range from hedonism to Hobbes to the modern day me-generation), and, in essence, is as much of a judgement call or directive on how one should live one's life as the ideas expressed by the anti-abortion groups. However, I do believe for the present society such a notion of individualism is the prevalent view, and if you with to argue morality, which I don't at this moment, you have to accept the premises of the group with which you wish to discuss the issue. Thus, moral teachings are seemingly not much help either.

Altogether, it looks like the usual sources are not going to help in solving the question of whether the fetus is life or not. Does this mean that the issue is basically a non-issue i.e. if law, science and moral teachings have no clear view on the topic—then anything goes? I think not. Rather we should look beyond the confusing actions and seeming contradictions of these sources and use the principles that guide them to perhaps illuminate our way.

Now I suppose some may argue my philosopher's bias is showing, but I feel that law and science are really just extensions of the moral teachings or philosophy of a society. Very basically, law is a set of rules that govern people to live in a just and fair way that is in keeping with the moral values of the community at large. Likewise science, which could be defined as the search for objective knowledge, (which may or may not be useful in the promotion of health and well being of the people in a community) is just a branch of philosophy which by definition is the love of all knowledge. Whether you agree or not with this synopsis is immaterial, these are the premises which I will use in order to make the issue easier to deal with in the confines of a few pages.

Thus, if law's purpose is to ensure that all are treated fairly and justly within society, does this help us answer the question? In essence I would say no as the practice of law assumes that it is concerned with regulating the actions of persons within the society, it does not judge directly whether or not they are people. However, law clearly shows us that to be fair and just preponderance of the evidence must be in favour of an action before society acts e.g. guilt beyond a reasonable doubt in criminal law. Therefore, with respect to abortion, because the law is not clear on the definition of life, if society is to err in its law-making or actions, it should err on the side of justice. Just as we do not wish to send an innocent man to death, and as a society chose to abolish capital punishment because the permanence of the action precluded reprieve for the unjustly accused, similarly, we could say we should protect the unborn until we know positively whether or not we are killing a person or just removing a growth.

As far as science goes, its studies in embryology, for example, certainly have shown evidence that the fetus acts as the separate being (as evidenced by its mechanisms of self-preservation or the fact that the zygote with its 46 chromosomes can somehow develop into a complex multicellular being) that we all are, as long as it is provided with a proper environment. Such evidence would tend to support the theory that the fetus is life and thus is entitled to protection from the law. Similarly, medical science is now able to operate on the fetus in utero to solve some of its problems, i.e., to promote its well being. Thus, it is an entity to medicine and entitled to protection from death by the medical profession. However, science has also shown us that perhaps up to 70% of all conceptions spontaneously abort. If Nature has so little regard for this life should we? I think the answer is also in science. Most of these abortions, it is felt, occur because of abnormalities that are incompatible with life. Therefore, the seeming slaughter is not, it is just natural selection. Of course this begs the question, what about the fetus that has obvious abnormalities and yet seems to survive this normal weeding process; can we intervene on Nature's behalf? A good question, but one I don't wish to deal with in this article in any detail, other than to say if perfection is the criteria for birth, i.e. if we wish to restrict access to the world to perfect people only, we are treading on very dangerous ground.

To deal with the question of where abortion fits in with today's prevalent idea of morality, which was earlier defined as individualism, a working definition of individualism is necessary. I suppose most have defined it as a belief that you don't interfere with the actions of another in society to exercise the same freedom. With this definition it is clear that a mother is more than entitled to abort the child if it is threatening her life as the fetus is overstepping its rights by interfering with the mother's life. However, abortions for any other reason (assuming the fetus is an individual) are judged on their merits, namely who will suffer more injustice, the mother by being forced to carry the child or the fetus by having its life snuffed out. The preceding assumption that the fetus would be found to be considered an individual is based on the observation that our present society tries to base its moral actions on objective criteria and assumes all are equal till proven otherwise in order to promote and not stifle individualism. For example, a person is only a criminal when proved so by a court of law beyond a reasonable doubt, and only then is he/she deprived of certain societal rights and freedoms and made to be less "equal". Following this model, we see that unless it can be objectively proven that the fetus is not life, which we already have shown to be as impossible as proving it is, society assumes the fetus is an individual and entitled to all the rights and freedoms of any individual in society.

Clearly, when we consider the issue in the preceding manner it appears that the fetus should be given the status of a being, at least till definitive proof to the contrary, in order to keep within the guidelines of our system of law, science, or moral teaching. However, I realize there still may be a grey area where we may find ourselves having to choose between the mother and fetus, but we should always acknowledge that the fetus is an equal entity. I suppose some may not agree with my conclusions from the evidence presented, but I challenge you to at least consider the implications of supporting one side or the other in light of what happens if we, as a society are wrong in our final decision.

Phil Drijber
Meds '90

Magnetic Resonance Imaging:

Insight into some past, present and future applications in clinical medicine

by Bob Turliuk Meds '88

Introduction

Magnetic Resonance Imaging (MRI) is a diagnostic modality that is increasing in popularity in terms of number of units in place worldwide, and in its clinical uses. It reached a technological level sufficient for clinical imaging procedures in 1982, and has attracted tremendous attention in the medical community, policy makers, and the general population mainly because of its potential for clinical application in the medical setting. There is some concern at present, when such terms as "cost containment" and "cost effeciveness" are discussed at political gatherings and in hospital boardrooms, that we should take time to understand MRI so we can intelligently discuss deployment strategies. This is particularly relevant in London, Ontario as there are MRI scanners at both St. Joseph's and University hospitals since 1983 and 1986 respectively.

History

The background of magnetic resonance dates back to the 1920's and 1930's when several physicists found that the nuclei of elements such as hydrogen had magnetic properties (Rabi et al, 1939) leading to a Nobel prize by Rabi and associates in 1944. In the 1940's it was shown by Bloch and Purcell that when certain atomic nuclei were placed in a magnetic field and exposed to a radiofrequency they emitted a weak signal, again leading to another Nobel prize in 1952 (Bloch and Purcell, 1964). By analyzing the amplitude and frequencies of these signals, the chemical composition of a sample could be deduced. By the 1950's this concept was expanded to permit determination of the structure of organic compounds: this approach was accepted by various disciplines in science including biochemistry, pharmacology, molecular biology, as well as organic chemistry and led to the development of many new drugs used in medicine (Jacobsen, 1987). Even today MR spectroscopy is considered an important tool by researchers developing new drugs.

The application of MR to clinical medicine was first suggested by a medical researcher (Damadian, 1971) who found in rats that the MR properties of tumours were different from normal tissues. In 1973 a group from Aberdeen, Scotland proposed a method of using MR to produce images of the tissues (Lauterbur, 1973). The MR image of the head was produced in 1977 and by 1979 EMI Limited (same company that also produced the first computerized tomography (CT) machines) and Hammersmith Hospital in London, England built a superconducting magnet for MR imaging, producing high quality brain images. The first clinical trials of MR imaging of the brain was published in 1982 (Bydder et al, 1982) about six years after the original clinical trial publications of CT scanning (Stanley, 1976; and Sheedy, 1976)

Principles of Magnetic Resonance

The term magnetic resonance may ring a bell for those physicians who had to take organic chemistry as a prerequisite for admission to Medicine. It may remind them of those days in the laboratory in which they used a magnetic resonance interpretation to help them "name that unknown compound". The imaging technology of MR is largely the domain of physicists, so physicians will not be required to understand all of the technical jargon to interpret an MR image. It does help, however, if one at least understands its basic principles.

Nuclei of hydrogen atoms have been shown to behave like very weak magnets. When a tissue is put in to an intense magnetic field the nuclei tend to line up either in the direction of the field or in the opposite direction; most line up in the same or "parallel direction" (Figure 1). If the tissue sample is subjected to a pulse of radiofrequency (RF) the nuclei can shift from the parallel (same direction as magnetic field sirection) or anti-parallel (opposite direction from magnetic field direction) alignment. The nuclei will have their own frequency that corresponds to the energy difference of the alignment states. When the RF pulse terminates, the nuclei return to the original alignment that they had while in a magnetic field. As they re-align the nuclei give off energy in the form of a weak signal which in fact is a radiofrequency itself. The frequency of the signal reflects the difference in alignment states of the nuclei, the type of nuclei (i.e. character of the tissue), and the strength of the magnetic field. Detection of the frequency emitted from the nuclei provides information as to the chemical composition of the material. This information can be gathered by a detector appropriately placed and displayed graphically one-dimensionally (as in the spectroscopic charts in organic chemistry labs) or in two dimensions with an image. This process of stimulation of a sample with an RF pulse detecting the RF energy is magnetic resonance.

Several parameters can be measured with respect to the hydrogen nuclei. The first is the T1 which describes the time constant for nuclei to realign with the applied magnetic field after stimulation

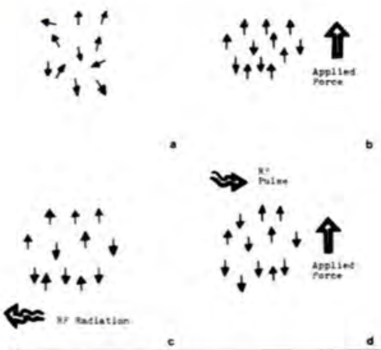

Figure 1.

a) *random oriented nuclei with directions of their spin portrayed by arrows.*
b) *external magnetic field with nuclei lining up in either parallel or antiparallel direction.*
c) *a radiofrequency pulse (RF) is applied in the presence of an applied force. Some nuclei stay in the parallel orientation whereas others switch to an antiparallel direction.*
d) *Nuclei return to original orientation and energy is radiated as a magnetic resonance signal.*

(Adapted from JAMA, Vol. 258, No. 22, 1987)

with an RF pulse. In Figure 1 T1 would represent the time it would take for nuclei to go from their orientation in C to D. Another property measured is the so-called T2 which is a description of the rate of signal loss caused by the interaction of affected nuclei with each other. In Figure 1 if the nuclei are widely spaced apart they are free to return to their original position without hindrance by other nuclei. On the other hand if the nuclei are tightly packed together there will be some interaction on returning to the original position.

To summarize, nuclei of the body are put in a magnetic field. They either line up in the same direction or opposite direction to the applied field. A radiofrequency pulse is applied quickly and then shut off. The alignment of the nuclei is temporarily altered and on returning back to the original alignment the nuclei give off energy. The intensity and duration of the initial radiofrequency pulse can be delivered after the first pulse. One can alter the time interval in between pulses, and also alter the delay between the second pulse and signal reception. In this fashion the so-called T1 and T2 weighted images can be created. By selecting appropriate sequences and delay times, MR images with excellent soft tissue contrast and detail can be obtained. Hydrogen atoms are present in almost every compound in the body including water, proteins, lipids and nucleic acids. Many hydrogen nuclei make no contribution to measurements because their imitted signals (RF) decay so rapidly, especially those held in rigid chemical structures such as proteins and nucleic acids (e.g. bone, blood). Tissue signals in the body come mainly from hydrogen in water in various molecular bonding states modified by the presence of lipid containing structures (Jacobsen, 1987).

It is the hydrogen protons of water and fat that are largely contributing to what is imaged by MR, the contrast determined by their concentration and their inherent properties exhibited when pulsed in a magnetic field. Conventional MR imaging takes several minutes to acquire and can be modified by gating (timing) to a particular phase in a cycle: this is useful for imaging of the heart, lungs, and gut.

Clinical Applications of MR

As of 1988 MR is able to give good resolution for midline structures of the brain, craniocervical junction, neural canal, mediastinum, heart and great vessels, some abdominal and pelvic organs. There are important problems with motion artefact in the thorax and abdomen that are presently being addressed: pelvis, limbs and large joints have been found to produce good MR images because of the lack of motion artefact. Imaging of the liver, kidney and other retroperitoneal structures have improved over the last few years because of some technical advances. Introduction of contrast agents has allowed for detailing vascular structures that without contrast normally produce poor detail.

An MR scanner is composed of four main parts. There is a magnet, a radiofrequency (RF) signal producer, a receiver coil, and a computer. Installation of an MRI unit at an institution involves preparation of a site and installation of radiofrequency shielding. Magnets that generate the magnetic fields come in varying sizes and field strengths, the newer more powerful superconductors needing to be cooled by cryogens to keep them from overheating. Some units are mobile, and thus can be shared between facilities. Prior to entering an MR unit one must empty all pockets of metallic objects. The power of the magnet should not be underestimated. For example in 1985 in Cincinnati, technicians were installing a powerful magnet into a trailer when the forklift carrying a component lost a 50 kg. extension of one if its forks to the magnet knocking one of the technicians inside the magnet chamber six meters across the chamber into a wall. First rescuers felt the effects of the magnetic field on their badges, scissors, and rescue equipment while the magnet was being shut down. The technician suffered lacerations, uncomplicated femur fractures, and a displaced right forearm fracture from the "missile hit" (Fowler, 1985). The patient fortunately recovered uneventfully. Magnetic fields may pose some difficulties in persons with pacemakers, metallic surgical clips and heart valves because of the potential to disrupt the positioning of such structures. Special surgical clips are now being used in patients that are not altered by the magnetic field. University Hospital in London has manufactured a non-ferrous anaesthetic cart which will permit scanning an anesthetized patient while on a respirator.

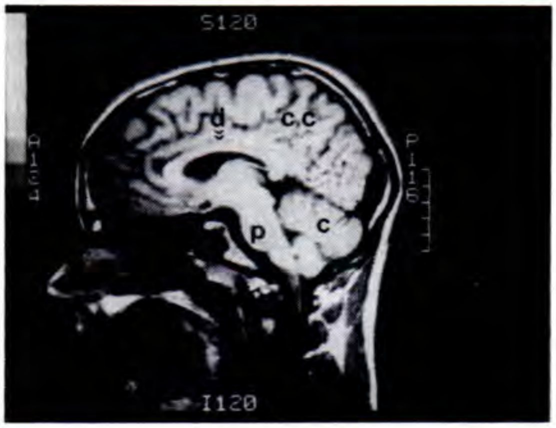

Figure 2.
Sagittal view of the human skull. Note the following structures that are fairly well defined. C: cerebellum. CC: cerebral cortex. D: corpus callosum. P: pons. (Courtesy of Dr. D. Pelz.)

Magnetic resonance imaging at the University of Western Ontario has advanced since the first installation at St. Joseph's Hospital in 1983. Although many areas of the body have been investigated there are several regions of interest that in the literature seem to be prominent in advances. The central nervous system, heart and musculoskeletal system (with reference particularly to the knee) will subsequently be discussed and the role of MR imaging elaborated.

The Central Nervous System

The central nervous system, particularly the brain, was the first area of the body that MR imaging seemed to become accepted as a diagnostic tool. The MR equipment and technology has evolved to give us a superior signal to noise ratio (clarity) and a high degree of contrast between gray and white matter. The lack of bone artefact is particularly useful in imaging the posterior fossa, the craniocervical junction and the cervical canal. Multislice imaging in almost any plane is possible, and the lack of known side effects of MR makes it useful in investigation of infants and children. Figure 2 depicts a sagittal view of the brain using MRI.

Because it was preceded in its development by CT, MR is assessed often in terms of comparison with CT (like a talented older sibling). The high contrast between gray and white matter with MR is particularly useful in white matter disease (i.e. Multiple Sclerosis). The use of MR for stroke or transient ischaemic attack (TIA) is somewhat controversial in 1988, because MR has some limitations in identifying intracerebral haemorrhages compared to CT. However, up to 70% of patients with TIAs have abnormalities demonstrated by MRI but not by CT. In ischaemic infarctions MRI can reveal abnormalities within three hours of CNS symptoms beginning, as opposed to between one and three days with CT (Kinkel et al, 1986). However, in acute intracerebral haemorrhage MRI is disadvantaged because critically ill patients with all of their life support equipment usually cannot be managed in an MR unit..

This appears to be changing and may not be a factor in the future. Also, the MRI image depends upon age and size of the haemorrhage, making interpretation difficult. In an acute situation this uncertainty could make the difference between a good and bad prognosis for the patient.

MR is becoming useful in the diagnosis of brain tumours, acoustic nerve tumours, diseases of orbits and spinal cord. Unfortunately malignant and benign tumours cannot be easily differentiated by MRI or CT in 1988. MR has a disadvantage in that a tumour mass may be difficult to separate from surrounding oedema, although this is improving with use of contrast. The paramagnetic contrast media gadolinium-DTPA can cross the blood brain barrier in the presence of some diseases and highlight a tumour and separate it from the surrounding oedema.

One of the best uses of MRI in the CNS at present is at the cervico-medullary junction and cervical spinal cord, areas which have been hampered in CT by artefact. Cervical MR images are sperior to metrizamide enhanced CT, such that MRI may completely replace myelograpohy for cord injury diagnosis in these regions. Evaluation of cervical and lumbosacral disease is controversial with metrizamide enhanced CT being preferred to MRI in many centres that have equal access to both modalities (Jacobsen, 1988).

The Cardiovascular System

The cardiovascular imaging by MR is one area that has undergone considerable development. Artifacts caused by motion have been commented upon earlier. The use of synchronization or gating of radiofrequency imaging sequences with the electrocardiogram cycle has contributed to the production of good images. Because it is non-invasive, MR has potential to become an important diagnostic tool in the evaluation of heart disease.

MR imaging has been found to be useful in depicting heart anatomy in congenital and acquired disease. For the evauluation of cardiac function (which for cardiologists and cardiac surgeons is considered the most important aspect imaging is hoped to reveal information about) MR has been limited by long imaging times, and low resolution. Left vertricular ejection fraction is the most common parameter used in evaluating left ventricular function. Current methods include echocardiography, radionuclide studies, and more invasive techniques such as contrast ventriculography (via cardiac catheterization). Recently MR imaging techniques have been introduced that permit rapid acquisition of images of the heart, with high resolution.

The new MR imaging is called "Cine MR": as many as 32 images per cardiac cycle can be obtained, at up to four separate anatomic sites. Information is acquired in systole and diastole with wall motion and cardiac valve motion visualized easily. Regions of myocardial infarction are clearly visible and valvular and subvalvular stenoses can be detected. In a recent study out of Duke University (Utz et al, 1987) results of ejection fraction from Cine MR were compared to results obtained from cardiac catherization: the correlation coefficient was 0.88. Figure 3 is a frontal view of the heart produced by this group.

The future of Cine MR as a diagnostic tool depends on a number of factors including the relevancy of the information obtained, the availability and cost effectiveness of other methods of obtaining similar information that MR imaging can provide. Left ventricular (LV) angiography is highly invasive requiring heart catherization, involves exposure to radiation and contrast material. The method of calculating the ejection fraction relies on some geometric assumptions regarding the shape of the left ventricle. Two dimensional echocardiography has often been used for LV function studies but is somewhat limited in that it cannot obtain information about the entire left ventricle, especially at the apex;

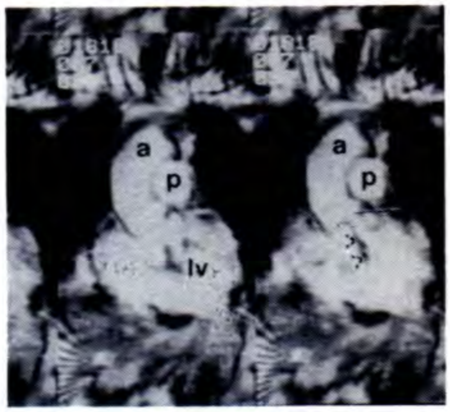

Figure 3.
Frontal view of the heart. A: aorta. P: pulmonary artery. LV: left ventricle. Arrows point to low signal representing a "jet" of blood suggesting aortic insufficiency. (Courtesy of Dr. L. Carey.)

the estimation of ejection fraction may be compromised. Radionuclide studies are thought to be an accurate method of determining LV ejection fraction and it is fairly noninvasive requiring only minimal exposure to radiation. Resolution in terms of time (temporal resolution) is high, but spatial resolution is limited. It is often hard to determine an area of dyskinesis in the left ventricle if the region of interest is say near the left atriu.

Cine MR has high temporal and spatial resolution, not requiring any geometric assumptions. It does have limitations; it is not portable to do bedside imaging of critically ill patients. These patients are perhaps best imaged using echocardiography or radionuclide studies. Patients with pacemakers and cardiac valvular prostheses are excluded from MR studies because of the danger of physical damage or displacement of the structures. Because acquisition of MR is best triggered by the patient EKG, the effects of arrhythmias may compromise the image quality; further work is under way addressing this issue.

In London, Ontario, experimental MR imaging of the heart began in March 1983 (Pflugfelder, 1983) comparing its diagnostic capabilities with other imaging techniques. MR has been found to be useful in diagnosis of congenital heart disease, detecting intracardiac masses such as atrial myxomas, pericardial disease, and cardiomyopathies. Because of the interest in heart transplantation at UWO, MR imaging has been used to detect organ rejection. Despite the interference of the surgical nonferrous clips and sternal wires the results have been favorable. A study conducted at UWO revealed that for grafts imaged more than 25 days after transplantation, MRI appeared to be reliable for assessing the presence or absence of graft rejection (Wisenberg et al, 1987). In a study of 25 patients receiving heart transplant, rejection or non-rejection was monitored by endomyocardial biopsy and studied with MRI: 14 of 15 late rejection events (more than 25 days after surgery) were correctly identified with MRI using the statistical criteria of increases in T1 and T2 weighted images of the new heart. Only one out of 28 images of non-rejecting grafts was incorrectly identified as indicating rejection. Interestingly MRI was not accurate before 25 days presumably due to cardiac changes thought to be related in graft harvesting, transportation and implantation.

The Knee

As noted earlier in this article MR offers detailed imaging of soft tissues, with articular cartilage, ligaments and menisci of structures such as the knee well visualized. In 1985, preliminary results of high resolution MR imaging of normal and pathological knee joints were thought to be encouraging for use of MR as a diagnostic tool in knee injury (Reicher, 1985). New MR machines have allowed for a patient to be positioned and imaging to take place with a minimum of manipulation of the affected knee (so-called surface coil technology). The patient is positioned on the MR examining table so that the symptomatic knee is centered over a receiver that is located in the table cushion. The surface coil MR imaging of the knee has been compared to other diagnostic modalities such as CT, arthrography, and arthroscopy. Preliminary evidence of MR imaging had shown it to be less accurate and less cost effective than CT for meniscal tears (Manco et al, 1987) which dampened initial enthusiasm. However, recent work using MR equipment with higher resolution (using higher strength magnets) has sparked more interest in the modality of MR imaging and the knee. Recent work at University Hospital in London, Ontario correlating internal derangements of the knee has produced preliminary results that are encouraging in the use of MR in diagnosis. Figures 4 and 5 illustrate a normal and deranged knee.

A recent study by a group from the University of Southern California (Jackson et al, 1988) was conducted to determine prospectively if there is a correlation between MRI and actual meniscal pathology as documented at the time of arthroscopy. In many centers, when the clinical diagnosis is straight forward — there are internal derangements of the knee by history and physical — then arthroscopy is done for diagnostic and therapeutic management. For patients where internal derangements are not clearly defined preoperatively some centres may instead use arthrography and CT to supplement the clinical exam and plain x-rays. Some clinicians would argue that arthroscopy may be the diagnostic tool of choice for internal derangements that are unclear. Arthrography has been the preoperative diagnostic procedure of choice for suspected meniscal tears in many centres, but is invasive and has operator dependent accuracy. The USC study examined 155 patients with suspected acute and chronic tears of the meniscus, MR imaged them in addition to conducting arthroscopy. Areas comparted diagnostically were the medial meniscus (MM), lateral meniscus (LM) and anterior cruciate ligament (ACL). It was found that the MRI was a highly sensitive test (sensitivity being percent of patients with an arthroscopically confirmed pathology whose MRI was positive for that pathology) with slightly lower specificity (percentage of patients without a specific lesion at arthroscopy who have a MRI scan for that lesion). The negative predictive value (or percentage of patients with a negative MRI for a certain pathology who do not have the pathology as confirmed by arthroscopy) was very close to 100%. This suggests that a negative MRI scan is a strong indicator that no meniscal or anterior cruciate tear is present. The overall accuracy or percentage of patients correctly diagnosed was about 95%.

Arthroscopy itself has a reported overall accuracy of about 95% for evaluation of menisci and ACL tears (Selesnich et al, 1985) but may in fact be higher due to improved techniques and patient selection. Because arthroscopy often has a therapeutic goal as well, it is difficult to compare the overall effectiveness of it with newer modalities such as MRI which is primarily a diagnostic tool. Arthroscopy is an invasive procedure that has occasional complications (rarely but still can occur as a septic arthropathy) and is not suitable for all persons with derangements of the knee. Presently where available, MRI is being used in the knee when the diagnosis is not straightforward. With decreasing costs of equipment and improved resolution of structures with more advanced technology MRI may someday become the gold standard for the evaluation of acute and chronic knee injuries.

Future of MRI

In 1988 the future of MRI is difficult to predict. As MR imaging of anatomical areas such as the heart, musculoskeletal system, and pelvis becomes more readily accepted scientifically as being important diagnostically, the trend towards imaging mostly the head and spine may be changed. The lack of radiation with magnetic resonance, especially when one considers the extent of radiation CT produces per slice, should be considered as a big plus in favor of MRI especially in younger patients.

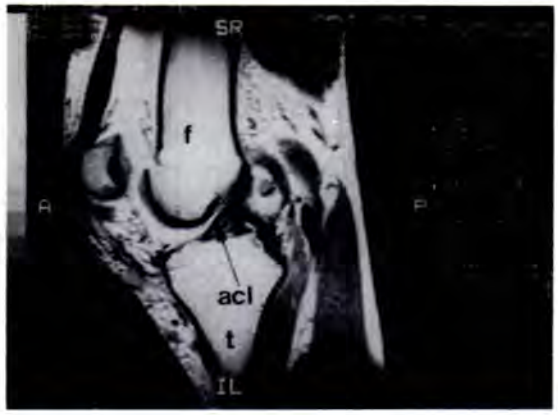

Figure 4.
Oblique view of the normal knee. F: femur. T: tibia. ACL: anterior cruciate ligament. The anterior cruciate ligament has low signal and hence on imaging as black. (Courtesy of Dr. D. Vellett.)

It is interesting to note that over the past few years, new MRI's being installed have been prohibitively expensive, being generally of the super conductive magnet system that tend to be relatively compact and have a high magnetic field. An important concern to purchasers of MRI is protection against premature obsolence. Many present systems have potential MRI capabilities (i.e. spectroscopy, which will be discussed later) that have not been fully explored because the technology required to utilize these capabilities has not been invented yet: recent work suggests that this new technology is on the horizon.

Thus a prediction on the role of MR imaging in the future is based on what we know or expect it to offer in terms of advantages and disadvantages over other diagnostic tools. At present the role of MR spectroscopy in imaging has received limited attention; it is growing and should continue to do so well into the 1990's. Some recent work will help support this prediction. Most MR's use hydrogen (H-1) proton signal for imaging. The potential for study of such nuclei as sodium-23, phosphorus-31 and others such as lithium-7 and fluorine-19 is being presently explored. Since the extracellular concentration of sodium is high, it acts as a good marker, and sodium-23 has been shown to demonstrate cerebral infarction and oedema (Zawadzieki et al, 1987). Phosphorus-31 imaging permits measurements of the metabolic state of tissues in vivo and offers an opportunity to assess tissue viability and metabolic consequences of disease. Both MR hydrogen-1 imaging and MR spectroscopy can theoretically be done with the same instrument, thus offering a unique noninvasive methodology where structure and function can be measured simultaneously with good resolution. A group at the University of Pennsylvania has demonstrated a technique (Schnell et al, 1987) to obtain simultaneous images of two nuclei such as hydrogen-1 and phosphorus-31 or fluorine-19. New techniques towards combinging MR imaging and spectroscopy with versatile computer hardware and equipment will surely emerge soon.

The rapid development of MR technology is typified by the quick ascent of contrast agents from clinical trial to clinical use. It was only in 1984 that the initial experience of gadolinium-DTPA as a contrast agent was described (Carr et al, 1984) which has led to the observations that the enhancement pattern of GD-DTPA in the brain with MRI now parallels iodinated contrast on CT in many cranial pathologies (Bradlet et al, 1987). GD-DTPA is now being used in many centres to outline vascular structures and has been recently tried at the University of Western Ontario radiology facilities.

Finally, any prediction of the future use of MRI should include a comment on limiting factors. In Canada at least, it is probable that MRI will be limited not just by its effectiveness, but also by its costs, particularly economic costs. Unfortunately there is a scarcity of published Canadian data on the costs of running MRI units so costs will be extrapolated from U.S. data. In 1985 the technical charge per patient of a typical MR seeing eight patients per day would be $600 Canadian if the unit were to operate at a break even point (Evans et al, 1985). If the same unit were to see 12 patients per day then the cost per patient would be $400 Canadian per day to operate at a break even point. If the capital cost of MR imagers were to be halved in the future, the technical costs/patient (which include maintenance, insurance, space maintenance and equipment depreciation) could come down to $250 or $300 Canadian per patient at 12 patients per day. If the number of patients processed per day were doubled or tripled per MR unit then technical costs might approach less than $100 per patient imaged. Professional operating costs, namely radiologists and support staff renumeration also contribute to overall costs of use of MR imaging and hence should be added to the technical costs to get the total cost of MR imaging per patient. The economic considerations of MRI appear to suggest that it will be prohibitive in cost, but it should be kept in mind the context of days of hospitalization saved and invasive procedures avoided. Alternatively, a diagnosis made by MR and not another modality could result in the patient having a subsequent invasive procedure. Other diagnostic modalities such as CT, ultrasound and radionuclide scanning will rank as the diagnostic imaging tools of choice until such time that MR proves itself to be more economically cost effective. One should be extremely wary of comparing MR and CT as there are non-economic costs involved, namely fairly concentrated exposures to radiation with CT and not MR.

Conclusion

The description of where MRI has developed from, what it accomplishes presently, and its future application in medicine is far from complete. The diagnostic potential for MRI is already evident in imaging of the brain, heart and such musculoskeletal structures as the knee. Uses of MRI in such anatomical areas as the pelvis, mediastimun and for staging in oncology were not discussed. The possible capabilities of imaging structures and measuring tissue function in vivo simultaneously give it an advantage over many of our present diagnostic imaging tools. The lack of radiation associated with MR imaging makes it attractive for use in younger patients, for those who will receive multiple examinations, and in areas of the body that are considered fairly radiosensitive. Limiting factors to its future application include high technical costs, restrictions on its use such as at the bedside or in people with metallic implants such as heart valves or pacemakers, and its diagnostic accuracy for certain pathologies. We will see in due course where MR stands.

Figure 5.
Oblique view of a knee with an anterior cruciate ligament tear. Curved arrow delineates structure that the ACL courses around. Compare this image with that in Figure 4.
(Courtesy of Dr. D. Vallett.)

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CLASS REPORTS

The Class of '91

By Steve Chesine, Meds '91

We have been told that we are special, and we are. Probably nowhere else in Canada is there such a unique collection of individuals studying medicine. We are, in a sense, pioneers, and we are being watched.

Three people have left us, and although each had their reasons, perhaps some of the reasons reflect on us as a class.

Perhaps we have arrived at a junction where we must now make a choice as a class. It is a choice between forming small closed groups or towards deliberately becoming a powerful, loving nurturing group with a number of open and flexible subcomponents. I personally believe that if such a deliberate positive choice is not made by each of us now, some of us may find ourselves lonely and in trouble next year.

All of us are under pressure, and I for one have not always been as kind and thoughtful as I would like. Perhaps this is true for others as well. The next few years will not be easy, but we can make them easier if we are gracious and generous towards each other. I believe such a choice will make these next three years wonderful years that will give each of us strength for the rest of our lives.

Why are you here?

By Allan Garbutt, Meds '91

Most medical students have, at one time or another, asked themselves why they are here. I have certainly asked myself that, and I suspect some of my classmates have asked themselves many times.

As one of the older members of this class, I believe the question about why I am here has been presented to me in a form that is not asked of my younger contemporaries. It has been posed to me by many of my classmates, by members of the general student population, and even by a few faculty.

Since I have given my reasons individually to many persons, I decided to save some time (a precious commodity at this time of year!) and answer the question for the rest of you. In a nutshell, I am here because I could not imagine anything else that I would rather do.

My decision to apply to medical school followed careful consideration of many factors over literally, several years. Having several months of medical school behind me now, I can say that I am firmly convinced the decision was the correct one. Given that the clinical aspects of first year have given me the greatest pleasure, I am sure that I will still be enjoying medicine many years from now.

Before returning to school, I worked for several years in the environmental consulting field. That was an area I had pointed toward for many years (I hold a Ph. D. in Zoology), but which could no longer satisfy me. It is an old cliche, but I am no longer the person I was at eighteen, when I went into zoology. My desires and interests have changed very significantly over the years.

As a consultant, I spent most of my time on what I could not regard as meaningful projects. Most of my work led to my writing a report that was promptly shelved. It would surprise me if more that a quarter of the projects I worked on actually resulted in concrete action. I found that highly frustrating.

I also became dissatisfied with work that involved little contact with people, and a lot of library research. Even when I did work with others, there was little long-term contact. Most people were contacted once or twice for specific information, and then never heard from or seen again.

A further problem was that environmental consulting is a geographically limited profession. It is generally necessary to be located in a major city near potential industrial or government clients. There is little opportunity to live in a small town, and it is not easy to transfer from one part of the country to another.

When my dissatisfaction reached a critical level, I began examining alternative careers. That examination covered the gamut from professional ski bum to medicine. I was looking for a career that was somehow related to the biological sciences (I have been fascinated with biology since high school), which would provide me with concrete results from my efforts, and which would allow me to work extensively with people.

Similarly, I felt I would be happiest in a field where I could work semi-independently, or as a team leader. I have rarely been content to be follower, as evidenced by my taking on executive positions in the volunteer groups I have been affiliated with.

At the same time, there were practical considerations. It was not advisable to switch into a career with a major surplus of qualified candidates, or in which salary levels were presently so low that I could not hope to recoup the direct and indirect costs of returning toschool. It seemed reasonable to select a career for which there would likely be a demand into the foreseeable future.

A review of possible alternatives soon eliminated fields like computers and engineering. They simply held no appeal to me. While such options as ski lift attendant offered desirable fringe benefits, they didn't seem too practical.

However, medicine was a lure that I could not resist. I felt that I would not be happy until I at least tried to get into medical school. When that decision had been made, I dragged out the old texts and notes, and studied courses I had not looked at in more than ten years, and wrote the MCAT. Simultaneously, I filed the seemingly endless forms, letters, transcripts, and references required by various schools.

It was only when my first round of applications was unsuccessful that I truly knew how badly I wanted in. It was not until my second application that I was ultimately accepted by UWO.

This year's round of courses and exams has shown me that it was a good choice. There have certainly been moments, especially as an exam approaches faster than I think I can learn, when I have asked myself why I am here. That feeling has passed quickly each time, though. Overall, I am having more fun learning more interesting and valuable material than I have ever had befor. Medical school is everything (at least so far) that I thought and hoped it would be.

Reflections of "The Blur"

Monday April 18, 1988 marked the end of an era for the class of '90. With the third ICC exam over we left behind a very special part of our education, a time I like to refer to as: "The Blur." That's the way it was and that's how it should read in the faculty calender: "Year II - Sept. to April, The Blur." None of this benign, pristine-sounding "September 2A, 2B" crap. Before this mystical experience (much like the material it covered) becomes just another hazy, gag-triggering memory let's place our tongues firmly in our cheeks and gaze through the retrospectoscope at the year that never was.

The Blur is that period of time commencing in September of second year and running until the third ICC exam, in April. What makes The Blur so very 'special' is that it begins with exams (carry-over from first year) and it never really lets up until April. With thirty plus hours per week and 13 exams in 29 weeks, well, time really scoots along. When April 19 finally came it was the first time since September of first year that we started classes with a completely clean slate.

Not that we complained much at the time. In fact, we gladly, nay even eagerly, went into that never-never land of second year, like buffalo charging towards the cliffs. Our forebearers had glibly assured us that year two was, "A lot better." That is what I refer to as: The Lie. And we being simple, idealistic dweebs, believed The Lie and entered that revered shrine, UH-B, with heads bowed, ready for the gods to reveal all.

I have to admit, after first year I didn't really understand all this, " Don't let the bastards grind you down" stuff. Enter, The Blur. Today I have a direct line to the crisis centre, my blood pressure is so high I have to wear a spandex necktie, and the company that makes Minoxidil wants me to be their Mr. "before" calendar boy.

True, it hasn't been all bad. We did learn new and exciting things. Who could walk away from a one hour lecture on sputum and not be intellectually aroused? No longer was a headache "just" a headache; now, you could suddenly conjure up a myriad of fascinating scenarios, all of which leading to your imminent demise. Day-by-day, you could check the progress of that expanding, pulsatile mass in your abdomen. Even a simple trip to the washroom became an enlightening fact-finding experience. And who can forget the fun of trying to appear normal, knowing that you had a neuroschizophrenabulemiamanicdepressivoyeuristriconversion disorder? But of course after a few innocent procedures (Total Body CT/MRI, arteriogram, cardiac catheterization, brain biopsy, sperm count, hormone levels, blood transfusion, ECT, prophylactic prostatectomy/orchectomy and artificial heart transplant) well — I knew there was nothing to worry about.

The other problem with second year was that we didn't learn very much practical stuff. Oh sure, we know about things like periventricular leukomalacia and bowling-ball testicle, but that's not what your relatives and friends ask you about. They want to know if peach pit suppositories will really make you more virile, or if they should use mustard plasters for their lumbago. This only helps to fuel my ever-increasing paranoia that, as each year passes, I am only learning how much more there is I don't know. Rather than becoming more educated, I'm actually becoming more ignorant. By the time I'm a staff man, I'll have become a complete imbecile.

Which brings us finally to clerkship. Again, the people a year ahead of us coo,"It's a lot better". Ha! Not again, not this guy. We just went through a year of "It's a lot better". Cramming all the time, all those hours...of course, we did learn a lot. I guess it would be interesting, finally putting it into practice. It is all at our fingertips, I mean, it's fresh in our minds right? I can just see it: correcting Dr. Inwood on some of the finer points of coagulation disorders, giving Dr.Gerace a good chastising over his faux pas in ACLS, bailing out Dr. Drake when he gets into a tight spot in the 'ol cranium. I can see it all now! Fame, fortune, the respect and admiration of the staff. This is going to be the best year...

Warren D. Teel
Meds '90