PROCEEDINGS

ST VINCENT'S CLINIC, SYDNEY

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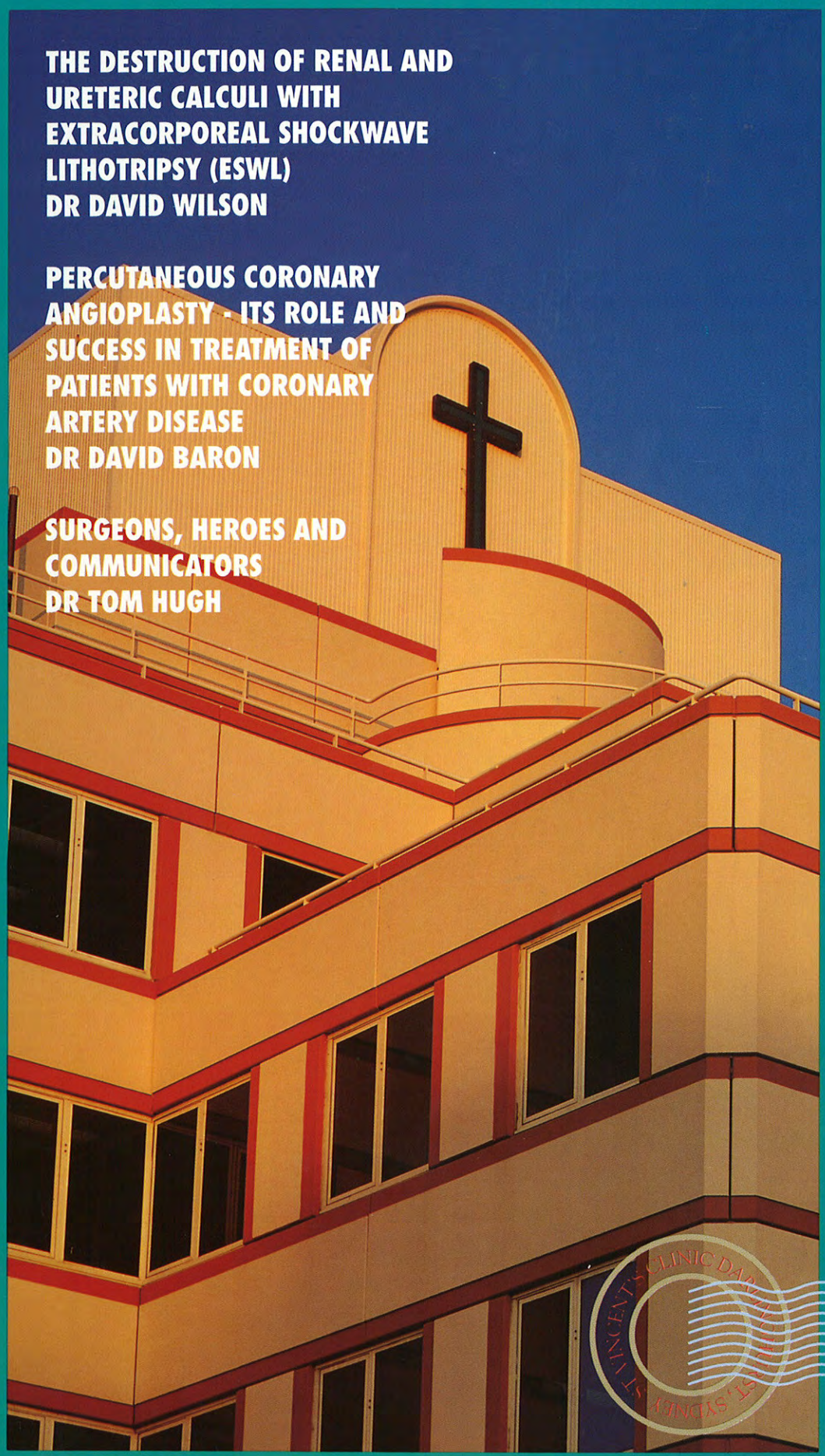

THE DESTRUCTION OF RENAL AND URETERIC CALCULI WITH EXTRACORPOREAL SHOCKWAVE LITHOTRIPSY (ESWL)
DR DAVID WILSON

PERCUTANEOUS CORONARY ANGIOPLASTY - ITS ROLE AND SUCCESS IN TREATMENT OF PATIENTS WITH CORONARY ARTERY DISEASE
DR DAVID BARON

SURGEONS, HEROES AND COMMUNICATORS
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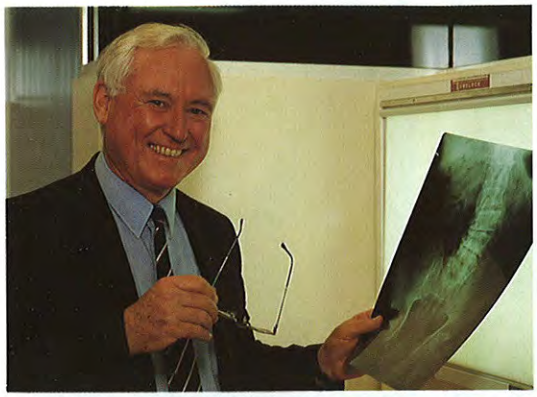

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St Vincent's Clinic Foundation

There are copious new developments in modern medicine, many of which derive from fundamental laboratory research.

However their ultimate place in therapy depends upon clinical research, including detailed outcome studies of actual patient care. The value of the latest treatment and procedures can only be tested by clinical practitioners. The numbers of patients and the amount of data needed for useful information requires the collaboration of doctors who engage in formal outcome measurement that is specific, identifiable, reproducible and capable of the probability testing that distinguishes valid conclusions - the test for publication in medical journals.

This is one of the goals of the new St Vincent's Clinic, which is staffed by a collaborative group of about 220 specialists aiming to provide the highest standards of patient care that are attainable - and at the same time to collect available data for clinical research. The physical facilities of the new clinic are ideal for this role with the provision of numerous clinical laboratories and seminar rooms for the continuing education of staff.

Although government and other research bodies give some financial support for basic laboratory work for full-time researchers, there is sparse funding for the prosecution of clinical studies conducted in the course of patient care, upon which evaluation of all new treatment modalities depends.

The St Vincent's Clinic Foundation has been created to meet this important need (with appropriate legal status and tax deductibility for donations) and we seek your support to ensure that our aims are fulfilled for the clinical advantage of all patients.

If you would like to become a member of the Clinic Foundation please telephone (02) 332 6222.

EDITORIAL

Dr John Roarty

MEDICAL EXECUTIVE OFFICER

The logo of the St Vincent's Clinic is depicted as three triangles, intermingled with one another. This symbolises the aims and objectives of the Clinic – excellence in patient care, education and research. The Board and Medical Council intend to publish some of the activities of the Clinic particularly in relation to education, and report the outcomes of seminars and post-graduate educational workshops.

In this inaugural issue, Dr David Baron describes recent advances in the treatment of coronary artery disease by percutaneous coronary angioplasty. He outlines the procedure in detail and discusses its role and success in this non-surgical approach to myocardial infarction. Heart disease is still one of the major causes of death in Australia and any advance in the early detection of coronary disease and its management by the treatment outlined in Dr Baron's article is extremely important, particularly if major open-heart and by-pass surgery can be either delayed or even avoided altogether. The figures from the National Heart Foundation of Australia Registry indicate the importance of this new method of treatment. Advanced techniques were demonstrated at an Angioplasty Workshop at the Clinic in March last to 150 Cardiologists of the Australasian and Pacific areas.

Dr David Wilson describes the current attititude of urologists to the treatment of renal stone disease. Whereas in the past, kidney and ureteric calculi required major open surgery for their removal, the introduction of shock wave lithotripsy has revolutionised the treatment of this disease with enormous benefits to the patient. Instead of a major surgical undertaking and stay in hospital of a week or more, the patient can now have a kidney stone removed on a day-only basis without anasthesia. Dr Wilson has outlined the current method of the treatment of this disease at St Vincent's Clinic, indicating the great advantages with minimal risk.

Dr Tom Hugh has written an account of his assessment of some of the giants of medicine and surgery in the past, "Surgeons, Heroes, Communicators". This is an historical article and it is most appropriate that it is included in this first edition of the Proceedings because this is, in effect, history in the making. This first publication, Volume 1, No. 1, and subsequent issues, will report the Clinic's activities and results of new advances in therapy.

With the formation of the St Vincent's Clinic Foundation, many projects are now underway researching numerous aspects of the causation and management of disease. Results of this research in many disciplines will be published in future issues.

Dr David Wilson

The Destruction of Renal and Ureteric Calculi with Extracorporeal Shock Wave Lithotripsy (ESWL)

David Wilson, M.Sc., (Minn), F.R.A.C.S., F.A.C.S., is Chairperson of the Department of Urology, St Vincent's Hospital, St Vincent's Private Hospital and Clinic.

HISTORY

In 1974, C Chaussy et al in Munich, Germany, were the first to investigate the use of extracorporeal shock wave lithotriptoscopy (ESWL) as a non-invasive tool for the treatment of renal calculi.

They developed a machine called a lithotripter, which generates shock waves extracorporeally. These shock waves are focused and transmitted through the body to produce disintegration of a calculus at the focal point. After six years of experimental work, they felt that the system could be used clinically. From February 1980 until March 1982, they treated 206 patients.

Chaussy and co-workers showed that it was possible to break up calculi into debris and small fragments less than 1mm - the majority of which passed within seven days following treatment, with minimal side effects. They showed that long term renal function actually improved following treatment and removal of calculi.

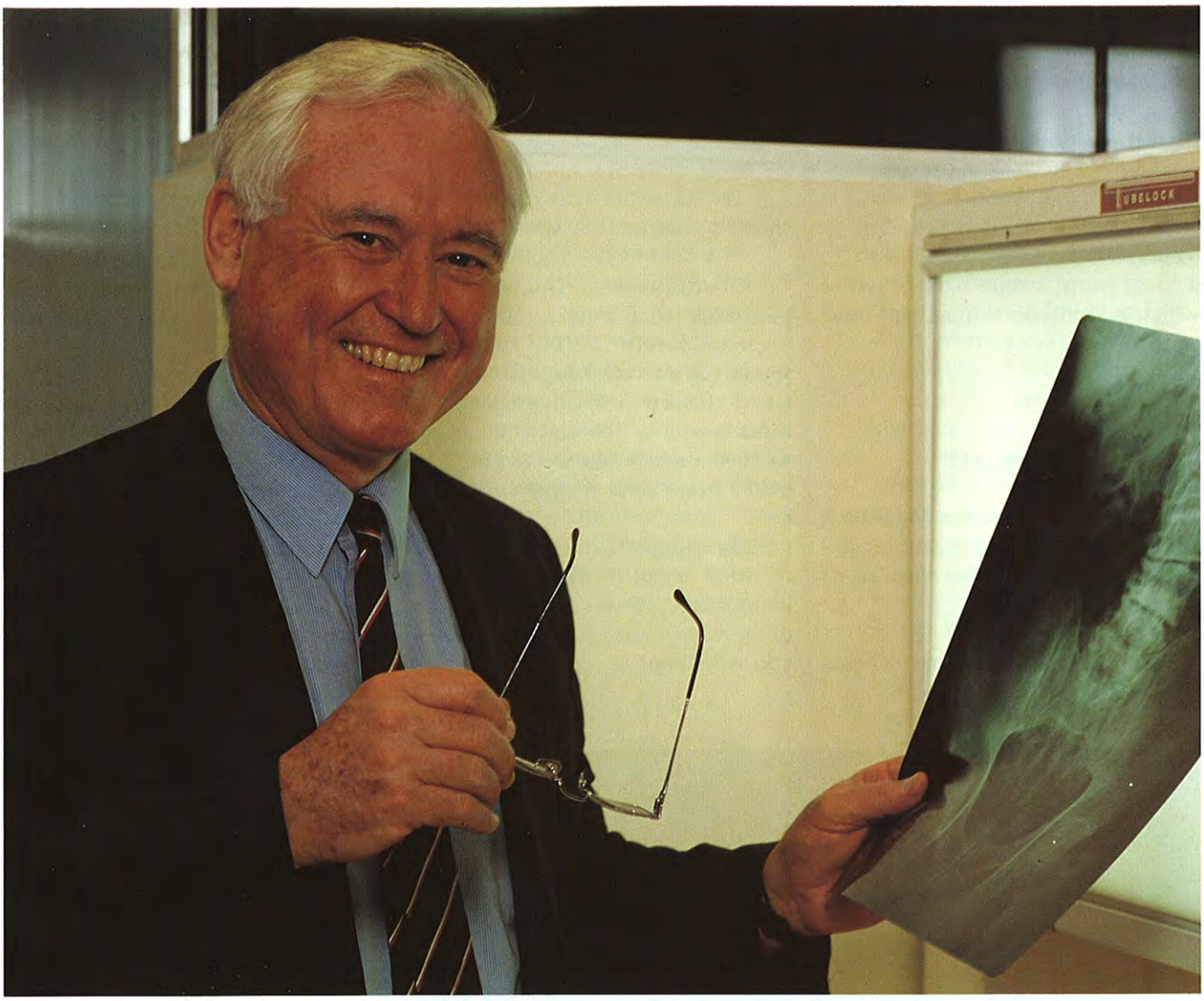
Initially, treatment took 90-120 minutes before the spark gap electrodes had to be replaced several times, but with improved materials, the electrodes needed to be replaced once only and the treatment time was reduced to 30-45 minutes.

General anaesthesia was used on the initial 14 patients and then a change was made to epidural anaesthesia.

The average hospital stay at first was 7.5 days, and this subsequently was reduced to four days.

PROGRESS

Over the past decade, there have been many changes in the



design of lithotripters, resulting in improvements with imaging techniques, the use of ultrasound, and finer focusing of the shock wave so that only the calculus receives the focused shock wave - thus reducing renal trauma and haemorrhage which occurred with early generation machines.

More importantly, the new third generation machines as they are now called, require no anaesthesia, and little, if any, analgesia or sedation. Treatment lasts for 45 to 60 minutes and the patient can proceed directly home after treatment.

Very sick patients can undergo treatment without risk, as there are none of the risks associated with anaesthesia.

Even if a repeat treatment is required, this is of minimal inconvenience to all involved.

Lithotripsy is now a walk-in, walk-out, day-only procedure, and apart from the urologist, a minimum staff of one technician and a nursing sister run the service.

In February 1993, St Vincent's Clinic installed the new EDAP LT02 lithotripter, one of the most sophisticated and latest in technological development of third generation lithotripters.

We are in the new era in the management of renal and ureteric calculi and many time-proven surgical procedures for the treatment of calculi are outmoded by this new form of non-invasive therapy.

This article reviews the development of lithotripsy over the past decade, and looks at the demand for such services in the future.

LITHOTRIPTER CONSTRUCTION

There are three basic types of energy source in the powering of lithotripters:

Spark-gap (electrohydraulic) - similar to a spark plug used in a car.

Piezo-electric - ceramic tiles activated by a current, vibrate and create an ultrasonic shock wave.

Electro-magnetic - similar to a loud speaker in a Hi-Fi sound system.

The aim of all three energy sources is to deliver a shock wave to a focal point at 600 bars pressure which is sufficient to fragment renal calculi.

SPARK GAP

All first generation machines (Dornier, Technomed, Direx and many others) use this source of shock wave.

An electrical discharge occurs between two electrodes. This causes a rapid vaporisation of water between the electrode gap, producing an underwater shock wave.

An Ellipsoid dish focuses the shock waves onto the stone.

Disadvantages: The spark gap increases from 2mm to 3mm after approximately 700 shocks producing a tenfold dispersion at the focal point and necessitating replacement of the electrode as up to 2000 shocks may be required to treat a stone. This is costly.

Shock waves must be coupled to the R wave of the ECG as low energy shock waves from dispersion of the waves can cause extrasystoles and arrhythmias.

Treatment head

It is not possible to generate rapid bursts of shocks.

ELECTROMAGNETIC

The Siemens Lithostar and Storz lithotripter use this energy source and Dornier is changing to its use.

This energy system can be compared to a loud speaker underwater.

A generator triggers an electrical impulse through a coil causing vibration of a metal membrane which produces the shock wave. A cigar shaped focal point 4x30mm is produced, as the centre of the metal membrane has greater movement than at its periphery. Like the spark-gap energy source machines it is unable to produce a rapid sequence of shock waves without overheating or burning out.

At present two shocks per second are generated and a cooling system for the gun has to be used. The average number of shocks per patient is in the order of 1100, and the gun requires replacement after 100,000 shocks.

PIEZO ELECTRIC

EDAP, a French company, has pioneered this technology, and has extensive patents on the technology. Wolf, a German company, makes the 'Piezolith' now under licence from EDAP.

In the new EDAP LT02 treatment head, there are 105 piezoelectric ceramics arranged in a spherical dish, activated and synchronised by 15 independent, electrically operated generators.

The focal point of the shock

wave is at the exact centre of the sphere.

The piezoelectric ceramics are long lasting - up to 10 years.

The Shock Wave

Each of the above energy sources produces its own specific shock wave.

FEATURES OF SPARK-GAP AND ACOUSTIC SHOCK WAVES

Shock waves produced by spark gap and acoustic sources have some detrimental and limiting features, namely:

- Low frequency components can cause problems such as damage to tissues at the interphase between tissue and gas, and are more likely to produce tissue damage when passing through bowel with gas in it and lung with air pockets. This is not seen with piezoelectric shock wave from the EDAP LT02.

- Parasitic pulses - a slow build up of the shock wave occurs as it advances, producing a so called 'parasitic sonic pulse'. This causes a slower change of resonance on impact against a calculus and diminishes the effect of the shock wave. Parasitic pulses are not seen with the pirzoelectric shock wave from the LT02.

- A spark gap system uses a high pulse energy which first of all produces larger fragments which are then reduced in size by successive shock waves. Passage of large fragments can cause problems.

- Gas bubbles produced by spark gap and acoustic generators limit the frequency of production of shock waves, and it is therefore impossible to increase the rate of shock waves to more than two per sec with these machines compared to eight per sec with the LT02.

- Low pressure waves and dispersion of the shock wave can trigger arrhythmias and extrasystoles, especially while treating calculi in the upper pole of the kidney, when it is necessary for the shock wave to be triggered by the ECG.

It is not necessary to have ECG monitoring and triggering of the shock wave with the LT02. Spark gap and acoustic lithotripters have a much larger focal point with the possibility of more extensive tissue damage.

PIEZOELECTRIC - LT02

The LT02 lithotripter produces atraumatic shock waves. A high tension signal from the generator to the piezo ceramic elements in the LT02 produces a predominantly unipolar, transient, high-energy water sonic direct pressure pulse, without a preceding parasitic pulse which interferes with the stone crushing pulse.

Optimal shock waves need to be sharp and not preceded by parasitic sonic pulses.

Advantages of the LT02 piezoelectric shock wave are summarised:

- There are no low frequency components which cause damage to tissue, and the exact focal point and absence of significant dispersion of shock waves reduces the risks of injury to surrounding tissues and tissues in the path of the shock waves. Low frequency components to the shock wave can cause tissue damage at an interface between gas and tissue, eg: bowel and lung.

- It does not affect cardiac function and is well tolerated by elderly and sick patients as well as children. There are no low pressure waves or dispersion of the shock wave which can trigger extrasystoles, especially whilst treating calculi in the upper pole of the kidney. There is no need for the shock wave to be triggered by the ECG.

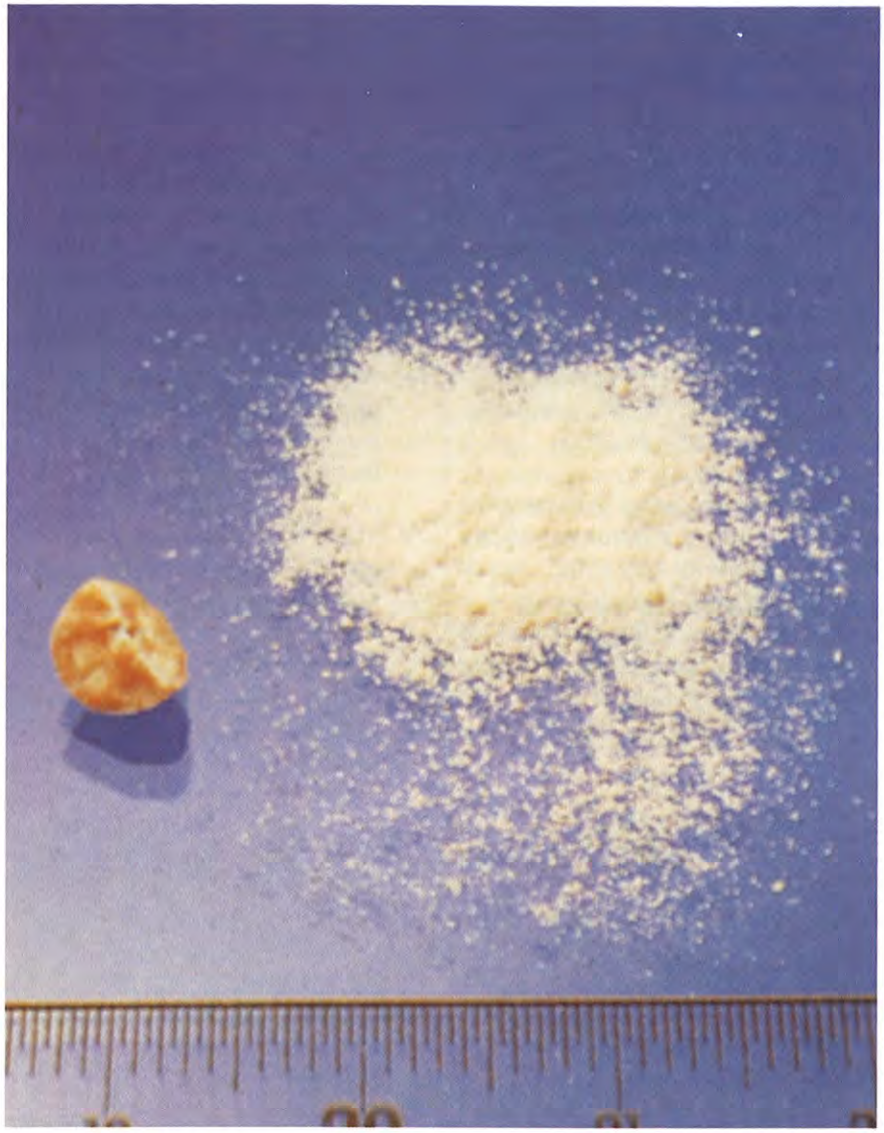
- There is no lengthy pressure phase which always accompanies a bubble producing sonic transmission from spark gap or acoustic source with a spherically shaped expanding shock wave. This essential difference in the generated pulse and its short duration of one nanosecond explains why practically no pain is felt during treatment and no anaesthesia is required.

- Almost all the energy is concentrated at the focal point on the stone, reflected or bounced off it, so the body tissue behind it is acoustically less stressed.

- The frequency of the shock wave can be varied during treatment as no gas bubbles are formed. Practical rates used are 5-10 pulses per second compared to a maximum of two per second with spark gap or acoustic sources, which are limited by the formation of gas bubbles.

- The intensity can be varied. If the patient experiences pain the intensity can be reduced. Rapid bursts with an increase in intensity can also be used to speed up stone fragmentation.

- The duration of the shock wave is exceptionally short, with a



Eroded calculus

rise time less than 30 nanoseconds. Due to their extremely short duration, these shock waves create microscopic fissures that rapidly reduce the stone to fine particles by an erosion process.

Sharp, high energy peaking waves have a rapid change in resonance on impact of the shock wave against the stone. By using lower pulse energies the surface stone can be eroded so that in the case of large stone masses a break in treatment may permit the passing of the already eroded particles, avoiding the creation of large rough fragments which can be difficult to pass.

TRANSMISSION AND FOCUSING OF THE SHOCK WAVE

The shock wave is readily transmitted through fluid.

As the body tissues are predominantly composed of water, a focused shock wave will move through the tissues to the focal point where its maximum energy will be concentrated and applied to the targeted stone.

With the first generation Dornier machine, the patient is lowered into a bath of water using a gantry, which can be cumbersome when the patient is anaesthetised and especially if the patient is heavy.

With the Wolf lithotripter, coupling is made by immersing the area of skin over the kidney in a water dish which is surrounded by a ring cushion.

Second and third generation machines have the energy source housed in a focusing dish which is covered by a membrane and filled with water which acts as the transmitting fluid.

An ultrasound oily type jelly is smeared over the skin before coupling to provide contact between the patient's skin and the membrane to allow the shock wave to pass into the body.

If there is poor coupling an energy discharge (cavity) effect will occur at the skin level with the patient experiencing pain or bruising, and shock wave transmission will be poor.

STONE LOCALISATION

Two modalities of imaging are used for localisation and treatment of a calculus.

Ultrasound

A real time ultrasound scanner is used which can detect a 2mm stone. It is easy to learn but has the disadvantage that bones (ribs) in the way may make localisation difficult. Fat patients also transmit ultrasound poorly.

Ultrasound has advantages in that it is safe for patient and staff and will localise non opaque stones. The stone is visualised continuously

during treatment. The focal point is allowed to move over the stone with respiratory excursions (which may be up to 1 - 2cm) with a prolonged pause in expiration.

X-Ray

The majority of lithotripters use X-ray imaging as their main and sole method of imaging and localisation of calculi. The older piezoelectric lithotripters relied solely on ultrasound. Both modalities of imaging are needed.

The EDAP LT02 uses both X-ray and ultrasound 'in line' making it a truly third generation machine. Ultrasound is used for almost the total procedure so that exposure to X-ray irradiation is negligible.

OTHER FACTORS TO CONSIDER IN THE SELECTION OF A LITHOTRIPTER

Noise, re-treatment rate, cost of operation, maintenance costs, availability of service and 'down time' need to be considered when purchasing a lithotripter.

PRESENT STATUS OF RENAL CALCULUS DISEASE AND LITHOTRIPSY IN NSW

Extracorporeal shock wave lithotriptoscopy (ESWL) has made a major impact on renal stone treatment and is being used to treat 80 to 90 % of stones in several countries. The Australian Health Technology Advisory Committee reported in 1991 that ESWL was the least costly method of treating renal stones.

The Committee did not support any increase beyond seven ESWL units in Australia.

In fact six units would be able to treat the estimated annual caseload of 4,800 to 6,400 for Australia, with capacity to spare.

St Vincent's Clinic installed the new EDAP LT02 on the 15th February 1993 (replacing the Direx spark gap lithotripter). At the time of printing, more than 260 patients have been treated with very good results and negligible morbidity. It is a third generation lithotripter and one of the most advanced lithotripters available.

It has the following major advances over any other lithotripter:

- 'In line X-ray' and ultrasound for the localisation and visualisation of calculi during treatment, allowing the operator to switch from one imaging modality to the other without moving the patient.
- Treatment for the majority of calculi is carried out with the ultrasound imaging so that the patient receives minimal X-ray irradiation.
- No anaesthesia is given.
- This lithotripter has a fine focus which avoids damage to surrounding tissues.
- Calculi are broken into 'sand like particles' which are readily passed in the urine, and post treatment problems are rare.

Because of its accuracy and fine focal point of 2mm, this lithotripter has also been used for treating parotid and submandibular duct calculi.

SURGEONS, HEROES, COMMUNICATORS

An address given to the John Loewenthal Club in response to the award of the John Loewenthal Medal, May 1992

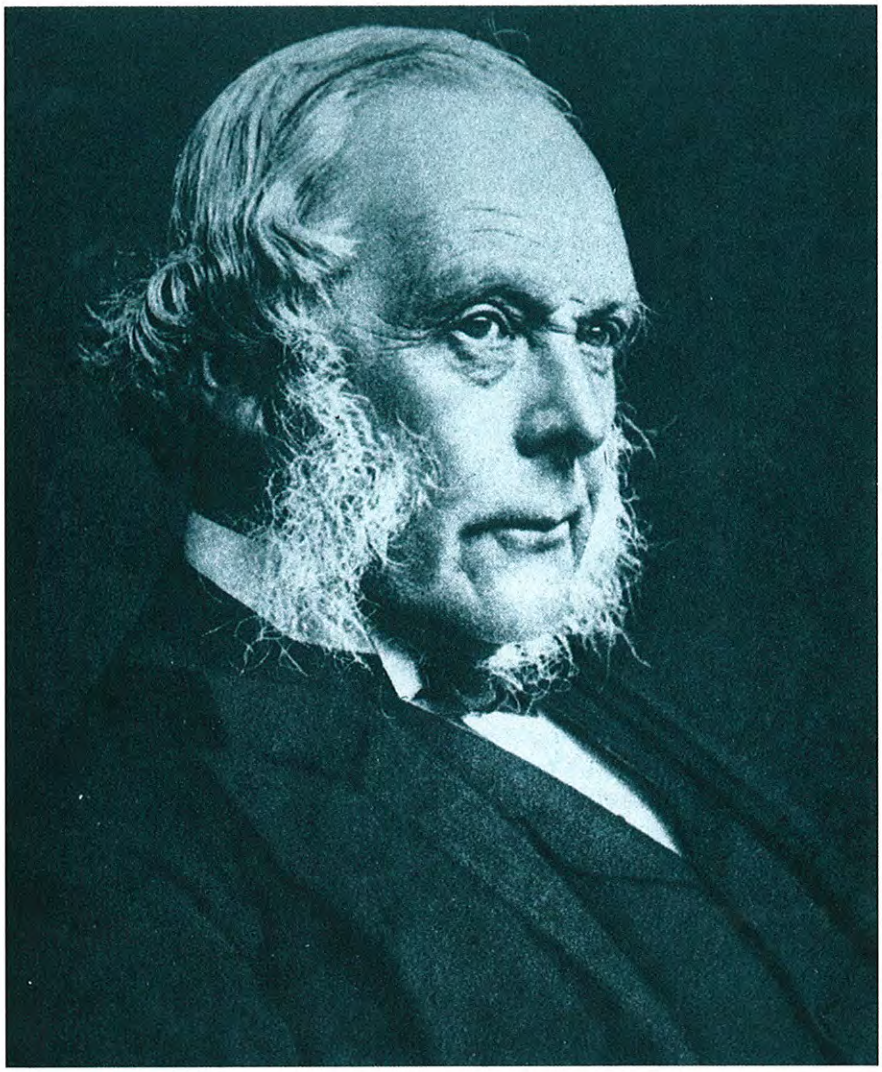
Dr Thomas B Hugh

There are many great figures in the history of surgery, but some seem to catch the imagination so effectively that they assume heroic stature and become a source of inspiration. Each of us has our favourites, but I invite you to visit a few of my personal surgical heroes whose ability to communicate their enthusiasm seems to me to have been outstanding. They are also connected with each other in a tenuous chain threaded through the history of modern surgery, with links to our own College of Surgeons right down to the present time.

The starting point, of course, has to be Joseph Lister, widely regarded as the father of modern surgery. The headlines of his day expressed it well: 'the man who made surgery safe'. Lister was the son of John Lister, a London wine merchant, who was also a Quaker. Lister's father was a gifted amateur maker of microscopes, who helped Hodgkin describe the microscopic appearances of Hodgkin's disease; this wine merchant was also the co-author of a paper describing for the first time the correct shape of the human red cell. Joseph Lister was, therefore, introduced to scientific activities very early and was greatly encouraged in his own research by his father, with whom he corresponded regularly throughout his surgical life.

Tom Hugh, F.R.C.S., F.R.A.C.S.,
Surgeon, St Vincent's Hospital.

Joseph Lister was a medical student at University College Hospital, this being the only medical school which was non-sectarian, and which would therefore accept someone who belonged to the Society of Friends. University College is still occasionally described as 'that place in godless Gower Street'. One of his teachers at University College was the physiologist Sharpey, who took a keen interest in his bright student, and who recommended that he visit Sharpey's friend James Syme, a surgeon in Edinburgh. On graduation, Lister went to Edinburgh on what was to be a short visit. Syme's house surgeon was on leave; Lister took the temporary post and ended up staying in Scotland for 20 years. Syme, who had been a chemist before he was a medical student, and who devised a method of dissolving rubber in naphtha, producing a solution which was used by a man called MacIntosh to make waterproof



linen for raincoats, was one of the outstanding surgeons of the day.

Lister immediately began to exert a powerful influence on those around him in Edinburgh. His personality was radiant and serene, and to read his biography is to ache with regret at never having known him. There exists a remarkable photograph of Lister as a house surgeon, equivalent to registrar, with his dressers, equivalent to today's interns. This conveys a powerful impression of the person they already called 'The Chief' and to whom the dressers are obviously devoted. In this photograph can also be seen George Hogarth Pringle, one of the dressers, who later came to Australia, and who worked as a surgeon in Parramatta, where he died in 1872. He introduced Listerian principles to Australia. Many of us recall our own days as one of an eager and hopeful band of hospital residents like those seen in this photograph, bound together by the pleasures of discovery and learning, and also by the fears and uncertainties of hospital work. Compare the far greater horrors faced by Lister and his contemporaries. They had little control over disease; in particular, sepsis was an ever-present nightmare which frequently robbed them of surgical success by causing the death of the patient.

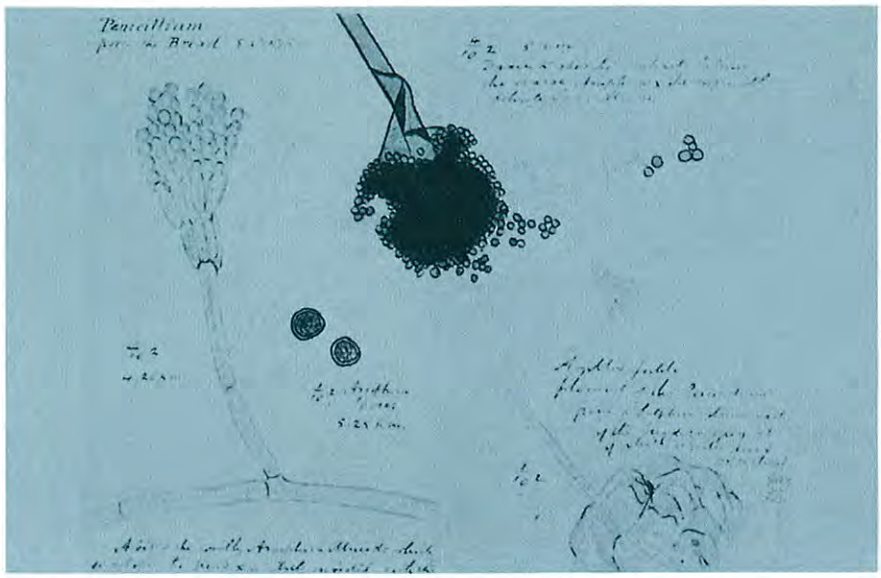
In 1856 Lister married Syme's daughter, and in 1860 he was made professor of surgery in Glasgow. In 1865 he read Pasteur's papers on the germ theory of disease, and in the same year made his first use of carbolic acid, after hearing of its application in the Carlisle sewage works to reduce odours. In 1867 his first paper on 'antisepsis' appeared in the *Lancet*. The antiseptic method was based on the theory, revolutionary at the time, that wound sepsis was not due to 'spontaneous generation' but was

Above: Joseph Lister - Right: Lister as a House Surgeon in Edinburgh, surrounded by his dressers. In the middle rear is G. H. Pringle, who came to Australia and died in Parramatta in 1872

caused by externally introduced microbes.

Lister's work has often been misunderstood. His method aimed at preventing contamination of the wound right from the beginning. Although it is often regarded as a separate and distinct approach from the aseptic method, in reality the concept was identical, both being based on the germ theory of disease, the major difference being that Lister used chemicals instead of heat to disinfect instruments. Accepting that the method was imperfect, he also used antiseptics in the wound to kill organisms there. Although the carbolic spray is often regarded as central to his method he did not start to use it until 1869, and abandoned it less than 10 years later. He later expressed regret that he had ever introduced it, as it was so obviously imperfect.

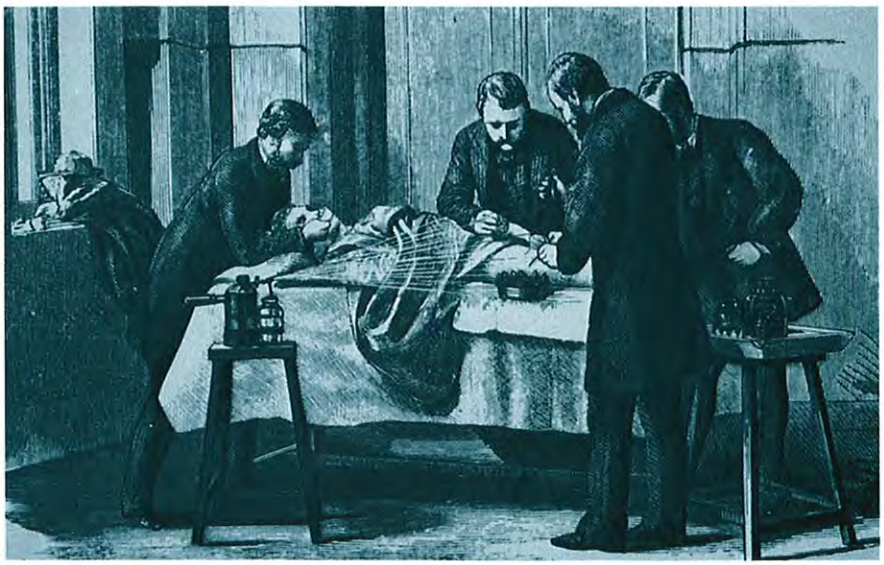
It is difficult for us to comprehend the magnitude of Lister's achievement. In 1867, when Volkmann was appointed chief of the surgical clinic in Halle, no-one had dared to operate there for a full three months because of fear of fatal sepsis, and Volkmann considered closing the hospital completely. Lister's work came just in time to prevent the closure of many hospitals throughout Europe.



Drawing of penicillium notatum from Lister's notebook

In 1872, in one of those fascinating by-paths of history, as part of his extensive experiments in bacteriology Lister studied a fungus-penicillium notatum - which he found growing on bread. He made an experiment which to us over a century later is electrifying in its portent - he attempted to ascertain 'whether the growth of fungi renders the liquid a less favourable nidus for bacteria'. To read this is like witnessing someone groping in a dark cavern and wondering whether their hand will strike the light switch. Unfortunately he was diverted into a totally erroneous conclusion that bacteria actually grew out of fungal mycelia; humanity therefore had to wait another 70 years for penicillin.

Lister's carbolic spray in action



In 1869 Lister was made Professor of Surgery in Edinburgh, but in 1872, realising that his message was not gaining widespread acceptance, and that he had to convert England if he wished to convert the world, he looked towards a position in London. He was eventually appointed Professor of Surgery at Kings College Hospital in 1877, where he stayed until his retirement. There, by dint of repeated lecturing and writing, and because of a band of devoted disciples, his message gradually gained acceptance. Medicine is slow to change, and even towards the turn of the century there were many unconvinced surgeons who refused to accept antiseptic principles. Among these was Billroth in Vienna, who remained disbelieving to the end of his career.

The greatness of Lister's work on the germ theory is such that we tend to forget his other important inventions, which include chromicised catgut and the use of

tubes for drainage, fixed in place with a safety pin. There is a famous story which relates how, uncharacteristically, he omitted the safety pin when he drained an axillary abscess for Queen Victoria at Sandringham. Lister remembered his error on the way back to London, and had the special train carrying him turned around so that he could remedy his mistake.

Lister undoubtedly had an obsessional personality, which some might regard as essential for surgical success. I am fortunate to possess Lister's own copy of a monograph which he delivered at the International Medical Congress in London in 1881. It is annotated in his own hand, and I was puzzled by vertical lines he had drawn on the title page until I realised that these drew attention to the slight lack of centering of the titles; the lines were doubtless drawn for the benefit of the printer. Lister would certainly have insisted that this minor blemish was corrected.

By 1881, when he presented this paper at the World Congress, he was famous. At that meeting he persuaded Pasteur and Koch, who were present, and who had not spoken to each other for a decade since the Franco-Prussian war, to shake hands.

Lister became the first surgeon ever elevated to the peerage. His name soon became literally a household word, attached to many nostrums of which he would not have approved, of which 'Listerine' is a contemporary example. Interestingly, this throat gargle contains not carbolic acid, but benzoic acid, an antiseptic the use of which was suggested to Lister by Charles Darwin, of evolutionary fame, who took a keen interest in his work.

Lister experimented with many other antiseptics, and with numerous forms of dressing, to find the ideal one which would exclude bacteria from the wound. Medical students affectionately made fun of his many-coloured antiseptic solutions, and in the Kings College Hospital pantomime of 1887 they sang this ditty:

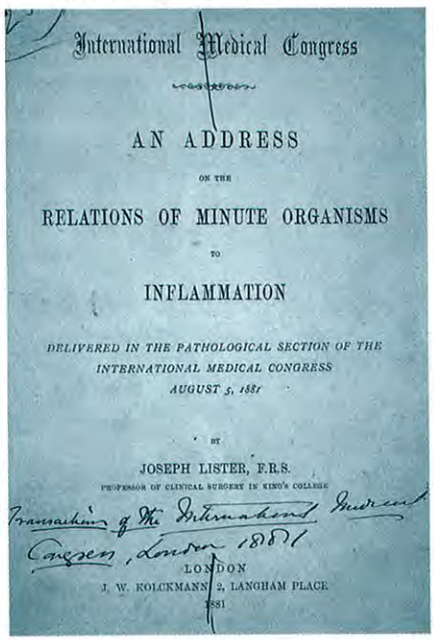
Lister doing rounds at Kings College Hospital. One of the house surgeons in this photograph is possibly Hamilton Russell, a foundation Fellow of the RACS

'There is a worthy baronet who once took up the cause
of Antiseptic Surgery and Antiseptic gauze.
First there was a yellow one, then there was a blue,
Then there was a red one, and a white one too.
Next there was a violet one, so we thought he'd go,
Right through all the colours of the bright rainbow'.

In the end he found that a dressing made of layers of muslin with an outer layer of water-proofing macintosh was ideal, and this principle is still used in many dressings today.

The person who grasped most effectively the surgical opportunities offered by Lister's work was Berkeley Moynihan, my next surgical hero, who was born in the very year that Lister made his first experiments with carbolic acid. The son of a captain in the British army, of Irish extraction, Moynihan was an accomplished scholar and sportsman from an early age. He graduated in London but returned to his birth-place of Leeds where he became house-surgeon to Mayo Robson. His great

Frontispiece of Lister's monograph presented at the International Medical Congress in 1881. Note the centering lines made by Lister for benefit of the printer



International Medical Congress

AN ADDRESS

ON THE

RELATIONS OF MINUTE ORGANISMS

TO

INFLAMMATION

DELIVERED IN THE PATHOLOGICAL SECTION OF THE INTERNATIONAL MEDICAL CONGRESS AUGUST 5, 1881

BY

JOSEPH LISTER, F.R.S.

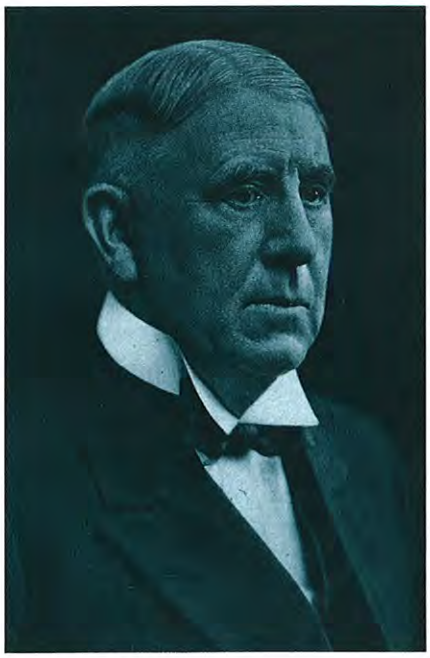
PROFESSOR OF CLINICAL SURGERY IN KING'S COLLEGE

Transactions of the International Medical Congress, London 1881

LONDON

J. W. KOLCKMANN, 2, LANGHAM PLACE

1881



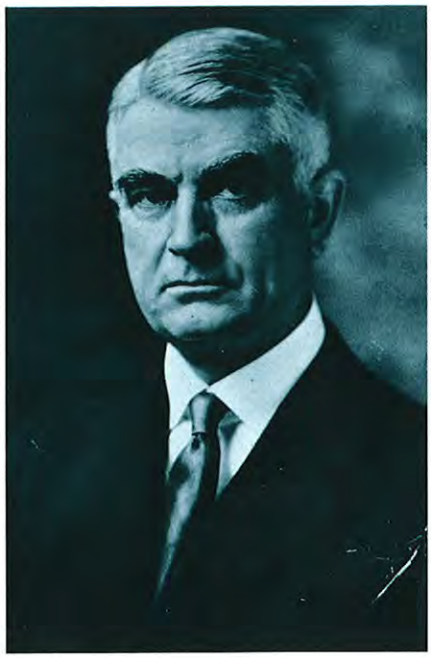
Berkeley Moynihan

abilities were recognised early and he was soon made Resident Surgical Officer at the General Infirmary in Leeds.

Moynihan then worked with the most popular and outstanding surgeon in Yorkshire at the time, Thomas Jessop. Moynihan became a Fellow of the Royal College of Surgeons of England and MS (London) in 1893, and in 1895 married Isobel Jessop, daughter of his surgical mentor, thus imitating Lister. A year later he was appointed assistant surgeon to the Leeds General Infirmary, and soon made a mark as an extremely dexterous operator. He was also observant, and, of course, contributed much to our knowledge of the pathology of gallstones and of the relatively new disease of duodenal ulceration. However, Moynihan was not a great original thinker, and had enough vision to recognise this. His favourite quote is an accurate assessment of his work: 'I have gathered me a poesy of other men's flowers, and nothing but the thread that binds them is mine own'.

He was, however, a very successful communicator both personally, as a speaker, and in his writing. His book on abdominal operations is still worth reading. One of his great contributions to British surgery was the founding, in 1912, of the *British Journal of Surgery*. This met with little support from the leading surgeons of the day, especially from Sir William MacEwen in Glasgow, who was decidedly cool to the idea, and who told Moynihan that there was 'little in British surgery of any value, and precious few who could write about it'. Moynihan went ahead nevertheless and made a point of including a flattering article about MacEwen in the first issue. MacEwen promptly wrote to him "if this is the kind of journal you had in mind I am sure it will be a success'.

Moynihan also saw how disunited provincial surgeons were, and how poorly received they were in London. Thomas Jessop had told him of his own bitter experience as a young man when he was denied entrance to the operating rooms at St Bartholomew's Hospital when he wished to see some work there. Moynihan became convinced that provincial surgeons had to unite for their own benefit; as a result, Moynihan was responsible for the formation in 1920 of the Association of Surgeons of Great Britain and Ireland.



William J. Mayo

Moynihan strongly believed in travel as a means of surgical communication, and developed many surgical friends in Europe, and in the United States, where he became especially friendly with the Mayo brothers. The first of his many visits to the Mayo Clinic was in 1903. Lister was Moynihan's great hero, and, like his hero, Moynihan was also elevated to the peerage, becoming only the second surgeon to receive this accolade.

While Moynihan was exploiting the benefits of Listerism

The General Infirmary at Leeds in Moynihan's time

in England, the Mayo brothers, one of whom is my next surgical hero, were doing the same in America. Their father, W. W. Mayo, was an exceptionally gifted doctor and taught his sons, Charles and William, the craft and art of medicine from an early age. William J. Mayo said in 1925: 'We were reared in medicine as a farmer boy is reared in farming. We learned from our father'.

William J. Mayo was sent by his father to acquire a formal medical training at Ann Arbor, where he graduated MD in 1883. He travelled extensively to see new techniques and in 1885 learnt the details of Listerian antiseptic surgery from Dr Arpad Gerster, who worked at the Mt Sinai Hospital and at the German Hospital in New York. Dr Gerster happened at the time to be writing a small book on antiseptic surgery (this later became a 'bible' much valued by Mayo), and the eager lad from the midwest was pressed into service as a temporary assistant, and therefore appears in some of the photographs in the book. I was able to locate a copy of Gerster's book (it had belonged to Robert Scot Skirving) in the RACP library in Sydney. The photographs showing an eager, fresh-faced, and absorbed Will Mayo are a fascinating glimpse of the learning phase of one of the greats of surgery.

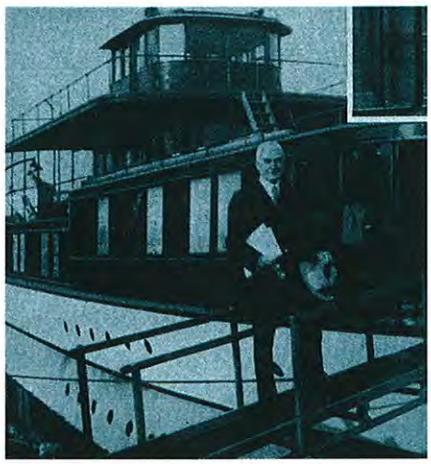
Photograph from Dr Arpad Gerster's book on Antiseptic Surgery (1887). Dr Gerster is in the right foreground and a youthful Will Mayo is in the background.

RMS 'Niagara' photographed about 10 years after W. Mayo's voyage

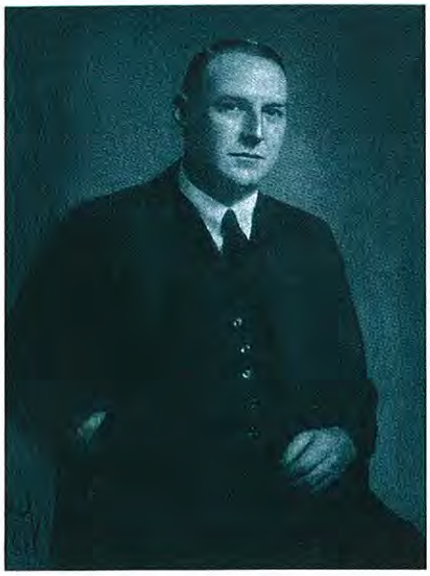
Will Mayo also, like Moynihan, believed greatly in the value of travel as a means of communication. He crossed the Atlantic 30 times, and, remarkably for those days, came to the Antipodes.

The journey by William Mayo to Australia and New Zealand in 1924 must go down in history as a magnificently seminal surgical voyage. Although planned originally as a private visit, Mayo was accompanied by Franklin Martin, the Director-General of the American College of Surgeons, and several other American surgeons; they wished to enquire into the state of surgery in Australia and New Zealand. They came by sea on the liner RMS 'Niagara', leaving from Vancouver and calling at Hawaii, Auckland, Melbourne and Sydney. What they saw impressed them, and in turn they inspired a number of Australian surgeons, particularly Hugh Devine, with the thought of forming their own surgical organisation. Devine and several other Australian and New Zealand surgeons were invited by Dr Martin the following year to attend the American College of Surgeons, and Devine went on to visit Mayo in Rochester, Minnesota. The history of the Royal Australasian College of Surgeons contains a good description of Devine's conversation with Mayo on board the Mayo steamer on the Mississippi river in 1925. Mayo said 'My boy, go home and found your own College and make it fit into your own Australasian conditions'. Devine became the prime mover in the formation of the College on his return to Australia, and Will Mayo must therefore be regarded as the godfather of the RACS.

Will Mayo boarding his steamer on the Mississippi River



During his visit to Sydney Will Mayo met and watched the work of my next surgical hero, Norman Royle, an orthopaedic surgeon at



Norman Royle

Lewisham Hospital, who had also been appointed Surgeon to outpatients at St Vincent's Hospital in 1917.

Royle had an extraordinarily innovative and inquiring mind. As is now well known, he developed, in conjunction with the anatomist John Hunter, the concept of surgical division of the sympathetic nerves to the lower limbs in the hope of reducing muscular spasticity in patients with cerebral palsy. Royle had been a physical training instructor before he became a medical student, and had developed great control over the individual muscles of his body. He lectured on the anatomy and function of muscles, and in front of the amazed students he would strip to a pair of leopard-skin tights and display individual muscles such as the anconeus, or a single rectus abdominis, ending the lecture by holding a dinner plate between his scapulae. He gave body language a rather special meaning.

His work in anatomy brought him into contact with that legend of the University of Sydney Anatomy Department, John Irvine Hunter. Although not a surgeon, John Hunter had that same divine spark of genius and enthusiasm that is seen in surgical heroes. Hunter came from the country town of Albury to become a medical student, and at University was coaching men in third year when he was in second year himself. He graduated in 1920, having taken every prize in the medical course from second year onwards, a feat never before recorded. Within nine months of his graduation he was appointed Associate Professor of Anatomy in Sydney; three years later he became Challis Professor of Anatomy. During this time he managed to fit in his internship at Royal Prince Alfred Hospital in the university vacations. He was a charismatic lecturer and a very successful communicator, and doctors came from all over Sydney to hear him speak about anatomy. Apparently he had a charming personality and enormous enthusiasm for his subject, which, according to Sir Douglas Miller, caused him almost to froth at the mouth with excitement during his lectures. He and Royle worked out the anatomical basis and surgical approach for sympathectomy. One of Royle's early operations was painted by George Lambert (who had been an Australian war artist) in the first ever illustration of lumbar sympathectomy. This historic

Illustration from Norman Royle's book on muscle function. The author is the subject.

John Irvine Hunter

painting was donated recently to the RACS by the Royle family and now hangs in the NSW State Committee office in Albion Street, Sydney.

Mayo spent a day with Royle and Hunter, and was so impressed that he had them invited to fill the prestigious position of joint Murphy orators at the American College of Surgeons meeting in 1924. There was great, if chauvinistic, media interest in the achievement of Royle and Hunter at the time, and in the prestige they attracted in the United States.

At the Mayo Clinic, Adson and Brown in the neurosurgical department, at the urging of W. J. Mayo, took up the concept of sympathectomy, and Adson made the crucial observation of its value in vascular disorders, thus launching the procedure into its present-day role in improving blood flow and reducing sweating in the limbs. Although Royle and Hunter's apparent demonstration of the value of sympathectomy in paraplegia was not vindicated by later studies, their original contribution in developing sympathectomy cannot be denied.

The trip to America was disastrous for Royle and Hunter personally, as both acquired an influenza-like illness, which led to Hunter's death in England a week after he arrived there in 1926. Royle returned to Sydney with Parkinsonian symptoms and subsequently suffered poor health until his death in 1944.

As part of his trip to the Antipodes William Mayo also visited the Otago Medical School in Dunedin, then a small and remote city in southern New Zealand. He was so impressed with the medical school that he asked the Dean, Sir Lindo Ferguson, whether he could do anything to assist them. It was suggested he might establish a Fellowship for New Zealanders at the Mayo Clinic, a suggestion Mayo willingly accepted.

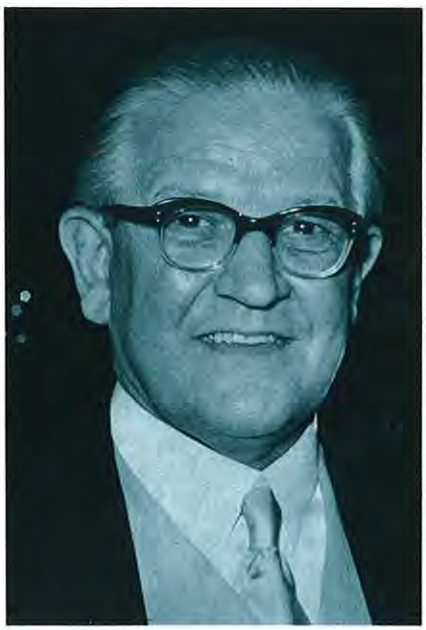
While the Mayos and Moynihan were building their world-wide reputations in the early part of this century, my next surgical hero, Archibald McIndoe, the son of a jobbing printer, was a small boy growing up in Dunedin. He was a very bright school student, and made a deep impression on his University teachers in Otago before he graduated in 1923, one year before the Mayo visit. He was appointed the first New Zealand Mayo Fellow, and at the end of 1924 travelled to the Mayo Clinic in Rochester, Minnesota. He started work in pathology and research, but, under the tutoring of the Mayo brothers, soon became a skilful abdominal surgeon. He developed an operation of hepatic artery ligation for the treatment of liver metastases, and presented a paper on this in Chicago at the American College of Surgeons meeting in 1930. Moynihan was present, and a week later made a visit to Rochester where he saw McIndoe operate. He invited him to come to London with a view to becoming the first Professor of Surgery at the planned postgraduate medical school. In

First illustration (by George Lambert) of lumbar sympathectomy as performed by Norman Royle in 1921.

1932, without any further correspondence with Moynihan, McIndoe took his wife and child to London only to find that the supposed appointment did not yet exist. This diverted him into plastic surgery, to the immense benefit of that specialty in Great Britain and indeed the world.

In 1939 he established a plastic surgery unit at East Grinstead Hospital as part of the preparations for the coming war, and rose to fame through his management of airmen burnt in the Battle of Britain. His patients and his followers were devoted to him, and in 1942 the RAF

Archibald McIndoe



ex-patients formed the famous Guinea Pig Club, which still supports surgical research today. In 1947 he was knighted.

Thus this tenuous thread growing out of the surgical opportunities provided by Lister's work, and beginning with William Mayo's antipodean voyage, led to the formation of the Royal Australasian College of Surgeons, the launching of sympathectomy, and indirectly, through the link of Mayo with Moynihan and McIndoe, to the full flowering of British plastic surgery. The Mayo belief in the importance of travel and personal contact as a means of surgical communication was never more strikingly vindicated.

What made these men successful communicators? It was not necessarily their skill as orators - of them all, Moynihan was really the only one with the golden tongue. Lister had a stammer, McIndoe was abrupt and abrasive, and William Mayo had a homespun down-on-the-farm speaking style. What made them effective communicators was their contagious enthusiasm, and this quotation about McIndoe by one of his trainees is very pertinent: 'Almost everything about McIndoe is unforgettable but most vividly I remember his enthusiasm - infectious enthusiasm - for whatever he was doing.'

All of these surgical heroes had a vision; as if, in the words of William Mayo, they looked 'through a half-opened door into the future, full of interest, intriguing beyond my power to describe'.

At the present time, when surgery is weighed down by bureaucratic and political interference, we need more than ever to ignite that divine spark of enthusiasm in our young successors, to communicate to them the vision of the surgical heroes.

Dr David Baron

PERCUTANEOUS CORONARY ANGIOPLASTY: Its role and success in treatment of patients with coronary artery disease

ABSTRACT

Percutaneous transluminal coronary angioplasty (PTCA) is a practical cost-effective therapy for selected patients with stable or unstable angina pectoris. Patients with acute myocardial infarction may be best served at least initially with thrombolytic therapy.

The immediate overall success rate is 91% including subtotal (94% success) and total (72% success) obstructions. The success rate has gradually improved from 88% to 91% over the past five years (National Heart Foundation of Australia Registry).

The coronary artery bypass surgery rate for failed PTCA was 2.2% vs 12% ten years ago. The mortality rate is 0.3% and the acute myocardial infarct rate is 1.5%.

Technical advances and a large experience have made PTCA a safe procedure with a high success rate.

David Baron, F.R.A.C.P., Cardiologist, St Vincent's Hospital.

INTRODUCTION

Vascular stenoses and occlusions are a common cause of morbidity and mortality in Australia and other western countries. Development of coronary angiography has made it possible to visualise the extent of vascular disease in the coronary circulation. Charles Dotter[1] was the first to dilate an arterial stenosis using a rigid dilator in the ilio-femoral system to increase antegrade blood flow.

Andreas Gruentzig[2] in 1974 elaborated on this technique by using a specially designed balloon-tipped catheter which could be passed across a stenosis and inflated to a pre-determined size with liquid contrast medium under pressure. Subsequently these balloons were miniaturised and used in the coronary circulation.

Between 1977 and 1980 the original Greuntzig catheter was further improved by attaching a short flexible guidewire to the catheter tip and having a second lumen which could be used to monitor distal pressure in the artery and inject contrast medium distally. Further technical improvements ensued with a guidewire extended throughout the length of the dilation catheter in a coaxial system allowing the wire to be advanced, withdrawn, steered or reshaped during the procedure with a greater degree of safety to the integrity of the arterial wall[3].

Improvements in balloon materials have allowed a lower profile for access to smaller distal vessels and permit higher inflation pressures (up to 16 atmospheres). Improvements in guidewire technology have allowed better steerability and less friction. The development of the 'monorail' system, whereby only the distal part of the balloon is coaxial with the guidewire allows for easier

exchange of balloons and greater mobility of the guidewire[4]. Guidewires and balloon dilatation catheters are tracked to the coronary artery by a delivery system or guiding catheter.

ANGIOPLASTY PROCEDURE

Patients undergoing elective coronary angioplasty are usually admitted to hospital the day before the procedure although increasingly these procedures are performed at the time of diagnostic catheterisation. The patient is given prior medication with calcium blocking agents and low dose aspirin.

Access to the coronary arteries is usually via puncture of the femoral artery, with the guiding catheter manipulated to the origin of the appropriate coronary artery. For angioplasty involving the right coronary artery a temporary pacemaker wire is inserted at the apex of the right ventricle via a sheath in the right femoral vein. When the guiding catheter is in position 10,000 to 15,000 units of heparin are administered intravenously. Baseline angiograms are performed to ensure there has been no change in the artery to document any adjacent side branches and to calibrate the vessel so that an appropriate balloon size can be selected. A flexible guidewire usually 0.014 inches is passed through the guiding catheter into the coronary artery, steered across the stenosis and positioned in the distal part of the stenosed vessel (Figure 1). The balloon is subsequently inflated using a high-pressure inflation device, typically between six and 10 atmospheres, although sometimes higher pressures are required for rigid lesions. The maximum pressure should be at least two atmospheres higher than the 'yielding' pressure. The patient is monitored throughout for symptoms ECG changes, blood pressure and heart rate. Frequently the duration of the pressure inflation is limited because of ischaemic chest pain or objective evidence of myocardial ischaemia. In this case repeated shorter inflations may be required until the artery is satisfactorily dilated. Additional lesions may be dilated according to a preset plan. Repeat angiograms confirm the effect of the balloon dilatation. The effect of the heparin is allowed to wear off before the arterial sheath is pulled and either manual or mechanical pressure applied to the femoral artery by a clamp. If the dilatation is less than ideal, either because of dissection or haziness at the dilatation site, then intravenous heparin may be continued overnight. There is a range of other devices and techniques, eg, prolonged inflation using perfusion balloon catheters and intracoronary stenting which can improve the appearance of the dilatation if the result is suboptimal. Six hours after the femoral arterial sheath is withdrawn the patient may ambulate. Discharge is usually on the first day after the procedure.

Increasingly total obstructions are also being attempted, although the results are less satisfactory both acutely and in the long term. There is a high incidence of long term closure. Equipment to tackle total obstructions includes the 'magnarail' system where the guidewire has a stiffer metallic shaft and a smooth 'olive' tip, this being supported by a

'probing' catheter to gain access across difficult total occlusions.

It is the practice at St Vincent's to have surgical backup in case of acute closure of the vessel or other complications.

INDICATIONS

Clinical Indications

The indication for coronary angioplasty is symptomatic ischaemia or objective evidence of ischaemia due to a coronary artery stenosis (usually of 70% or more luminal diameter) which is amenable to dilatation with balloon catheter. Most patients will have chronic stable angina but a small percentage of patients may have 'silent' ischaemia. Approximately 50% of patients with unstable angina are suitable for angioplasty particularly if revascularisation can be limited to dilating culprit lesions rather than attempting a complete revascularisation. In many cases balloon dilatation of the 'culprit' lesion is performed as an extension of the diagnostic procedure at the same sitting[5]. Patients with unstable angina and multi-vessel disease may have additional stenoses dilated at a separate sitting. In acute myocardial infarction angioplasty is directed towards the infarct-related artery, either a total occlusion or significant stenosis. Most institutions would manage patients with acute or impending myocardial infarction with thrombolysis particularly as the recent Global Utilisation of Streptokinase and tPA for Occluded Arteries (GUSTO) trial shows a low mortality and satisfactory risk profile rather than urgent angioplasty. There have been three major trials where early angioplasty was performed within two hours of the administration of thrombolysis: Thrombolysis and Angioplasty in Myocardial Infarction (TAMI)[6]; The European Co-operative Study Group (ECSG)[7] and Thrombolysis In Myocardial Infarction (TIMI IIA)[8].

In each of these studies tissue plasminogen activator (tPA) was the thrombolytic agent used and angioplasty was attempted within two hours of administration of thrombolysis. Patients treated with early intervention were compared with patients who had angioplasty later in their hospital stay. A common finding was a high incidence of bleeding as femoral artery puncture was carried out at the peak of thrombolytic activity. In all studies left ventricular ejection fraction was not significantly different in the two groups. Further there was an increase in in-hospital deaths in the immediate angioplasty group. If the three trials are summated the in-hospital death rate was 31/447 for those treated with immediate angioplasty compared with 16/476 for those treated with delayed angioplasty (Table 1).

Deferred coronary angioplasty was the subject of the TIMI IIB study in patients who had tPA followed by mandatory angiography/angioplasty as an 'aggressive' protocol in all patients before hospital discharge versus a more conservative approach where angiography/angioplasty was performed on the basis of symptoms with objective evidence of clear-cut ongoing myocardial ischaemia[9]. The end point of this study was survival at six weeks and patients were assessed within this period for re-infarction, left ventricular ejection fraction (LVEF) and evidence of residual myocardial ischaemia. Results (Table 2) show very similar death rates and myocardial re-infarction rates. Similarly, there were no differences in LVEF at six weeks. However, there was an improvement in exercise ejection fraction and a lower incidence of exercise-induced myocardial ischaemia in the 'mandatory' angiography/angioplasty group.

The role of PTCA in cardiogenic shock complicating acute myocardial infarction has not been finally determined but there is evidence that revascularisation with successful thrombolysis may be just as successful. There is no doubt that successful dilatation of the infarct-related artery proves hospital survival (71% versus 29%)[10]. The problem is the low success rate for dilatation of the infarct-related artery in the presence of cardiogenic shock which may be as low as 62%[11].

Furthermore, the mortality rates after failed angioplasty in cardiogenic shock are remarkably high and may approach 39%[12].

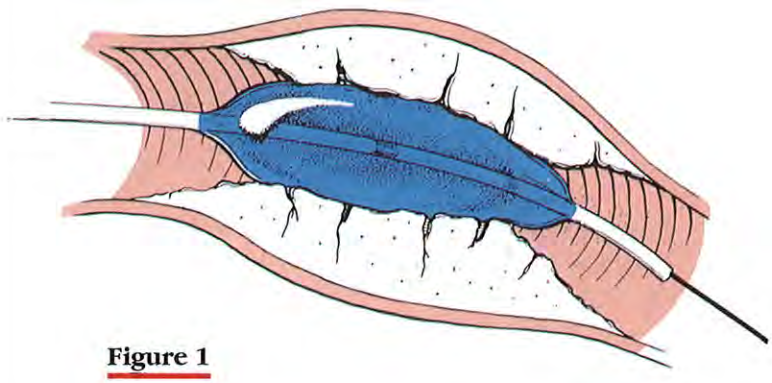


Figure 1

A balloon catheter, over a flexible guidewire, dilating a coronary artery stenosis.

Thrombolysis can also be given more readily and is potentially less costly[13].

Coronary Anatomy

Of prime importance for successful angioplasty is the coronary anatomy. The main criterion is lesion morphology. Also to be considered are the arterial morphology, the location of the lesion and the presence or absence of collaterals (Table 3). An ideal lesion for angioplasty is a short, concentric, smooth, non-calcified stenosis in the anterior descending coronary artery without any side branches on a straight segment of the vessel with some supportive collaterals.

Increasingly, PTCA is being performed in patients with multi-vessel disease where lesion morphology predicts a moderate to high success. Multi-vessel disease imposes several difficulties compared to patients with single vessel disease. The procedure clearly takes longer and involves greater exposure of radiation and volume of contrast medium with its attendant morbidity. Should abrupt vessel closure occur in more than one artery then there is greater risk of widespread myocardial ischaemia. There is a higher failure rate in that not all significant coronary stenoses may be successfully dilated. Finally there is a greater chance of restenosis. Attention should be directed towards 'culprit' lesions primarily with a careful strategy of what the sequence of dilatation should be with a plan of action should there be a suboptimal result. This may cause further dilatations to be deferred ('staged' procedure), additional intervention such as stenting, or referral for bypass surgery[14].

Generally speaking unless each individual stenosis is ideally suited for angioplasty the patient is best referred primarily for bypass surgery.

Previous Bypass Surgery

Angioplasty may be indicated in stenoses which have developed in native vessels which have not been bypassed, which have developed distal to the graft insertion, and for stenoses located in the body of the graft itself.

Success rates are good particularly for stenoses which occur at the distal anastamosis and beyond.

However, two factors have to be considered when undertaking angioplasty in a patient who has had previous bypass surgery. First, while the chance of success is no different to that of angioplasty in a native artery the patient is at slightly greater risk in the event of complications. Patient selection is therefore important because of the longer period of time required to get the patient onto bypass. Secondly, the restenosis rate within the body of vein grafts is comparatively high, possibly as high as 50% within six months. In this situation consideration should be given to alternative interventional procedures such as stenting or repeat bypass surgery.

Table 1

EARLY VS DELAYED CORONARY ANGIOPLASTY AFTER tPA FOR ACUTE MYOCARDIAL INFARCTION

	TAMI	ECSG	TIMI IIA
NUMBER OF PATIENTS	197	367	389
HOSPITAL MORTALITY			
EARLY (8%)	4/99 (4%)	12/183 (7%)	15/195
DELAYED (5%)	1/98 (1%)	5/184 (3%)	10/195
LVEF			
EARLY	0.53	0.51	0.53
DELAYED	0.56	0.51	0.49

tPA = tissue plasminogen activator; TAMI = Thrombolysis and Angioplasty in Myocardial Infarction; ECSG = European Co-operative Study Group; TIMI = Thrombolysis in Myocardial Infarction; LVEF =Left Ventricular Ejection Fraction.

COMPLICATIONS

In the process of achieving an adequate dilation of the stenosed artery, plaque is disrupted to allow recanalisation of the vessel. A 'controlled injury' is produced which may result in acute occlusion due to an arterial dissection or acute thrombosis. Limited non-occlusive dissection is fairly common, does not usually interfere with antegrade blood flow and usually heals by endothelialisation within six weeks.

Table 2

RESULTS OF IN-HOSPITAL 'MANDATORY' CORONARY ANGIOPLASTY vs 'ELECTIVE' ANGIOPLASTY IN TIMI IIB*

	DEATH	AMI	LVEF DURING EXERCISE	EXERCISE INDUCED ISCHAEMIA
'MANDATORY' N = 1636	5.2%	5.9%	+3.3%	12.8%
'ELECTIVE N = 1626	4.7%	5.4%	+2.3%	17.7%'

TIMI = Thrombolysis In Myocardial Infarction.
* At six weeks after tPA

Abrupt Closure

Patients with less than optimal stenoses which are dilated are more subject to abrupt closure, usually due to dissection of the artery where an intimal flap is raised and obstructs antegrade flow. Acute thrombosis or localised vasospasm may occur. Approximately 4% of patients have abrupt closure which occurs within 30 minutes of final dilatation. In this event the patient is treated with intracoronary nitroglycerine to relieve any spasm. Failing this the vessel may be reopened by re-dilatation with a success rate of 50%. Prolonged inflation with a balloon catheter may result in adherence of the intimal flap to the arterial wall.

Occasionally a perfusion balloon catheter (which allows antegrade flow to the distal artery during balloon inflation) is required for prolonged inflation of up to 30 minutes[15]. Failing this an intra-coronary stent may be deployed in the artery to maintain patency. This last procedure however prolongs hospital stay, requires intensive anticoagulation for the first five days and warfarin therapy for a total of three months. An alternative to stent insertion is emergency bypass surgery which contributes heavily to the 0.4% mortality associated with elective coronary angioplasty[16].

Restenosis

The major drawback of coronary angioplasty at present is restenosis[17] in the artery. In approximately 20% of patients clinical evidence of myocardial ischaemia reappears usually within three to six months after balloon dilatation. Prospective angiographic studies show the restenosis rate may be up to 40% but in approximately one third of these patients there is only partial restenosis and they remain symptom free. The predictors of restenosis include previous total occlusion, severe baseline stenosis, incomplete dilatation, unstable angina, ostial stenosis, male gender and stenosis of the left anterior descending coronary artery[18]. The presence of a limited dissection is said to be associated with a higher long term patency rate. Restenosis is more frequent in vein bypass grafts whereas the internal mammary artery approximates that of native vessels. Restenosis may be managed by repeat angioplasty[19] or insertion of an intravascular stent. With the use of repeat angioplasty for management of restenosis and because of progressive disease in other locations approximately 12% of patients undergoing initially successful dilatation will require bypass surgery within the next five years. A number of agents have been trialled to prevent restenosis, including anti-mitotic agents, anti-platelet agents, anti-inflammatory agents and pharmacological blockers of platelet-derived growth factor. None have shown any clinical benefit[20].

Non-Cardiac Complications

Elderly patients with pre-existing renal disease, diabetes or nephrotoxicity may be a problem. It is important to make sure that these patient are well-hydrated at the time of the procedure. It is our practice to administer intravenous normal saline during the procedure. Although non-ionic contrast medium is better tolerated by patients from the symptomatic and arrhythmia point of view there is no evidence that this results in a lower incidence of renal toxicity. Acute renal failure should it occur is usually reversible[21].

Neurological complications are rare and usually result from dislodgement of thrombus, injection of air into the circulation or trauma to the ascending aorta with dislodgement of atheromatous plaque. Occasionally hypotension during the procedure can cause neurological deficit. The combined incidence of neurological complications is approximately 0.2% [22].

Dissection of the aorta is a very rare complication of cardiac catheterisation. Limited dissection heals spontaneously and may require a different route of access for continuation of the procedure. This complication is more likely to occur in elderly and hypertensive patients

where the arteries are tortuous and atheromatous. Occasionally there can be internal bleeding into the retroperitoneal space, the bleeding site being the iliac artery or aorta. Entry site complications include bleeding, thrombosis, false aneurysm formation and the creation of arteriovenous fistula. Thrombosis of the femoral artery is exceedingly rare and requires thrombectomy surgically in all cases. False aneurysm formation and bleeding are more common and are caused by an unsealed puncture site when the sheath is removed. With false aneurysm a pulsating mass is often felt over the femoral artery or laterally. Ultrasound examination of the femoral artery confirms the diagnosis and can give some indication as to the size of the false aneurysm. The Accuson ultrasound machine can seal false aneurysms in up to 50% of cases by direct application of prolonged probe pressure over the exact arterial puncture site. Success is more likely the earlier the false aneurysm is detected. Similarly an arteriovenous fistula may be occluded by compression although occasionally surgical repair is necessary if a large shunt is present.

THE AUSTRALIAN EXPERIENCE

The last registry report from the National Heart Foundation of Australia for coronary angioplasty was in 1991. Angioplasty success is defined as a reduction of all coronary artery lesions to less than 50% luminal diameter and a reduction in diameter of at least 20%. There should also be no angina or complications at the time of discharge from hospital (Coronary Angioplasty in 1991. A Report of the National Heart Foundation of Australia pp 1-17). There were a total of 5,726 procedures performed an increase of 17% over the 1990 figures. The average number of angioplasties per unit was 286. In 1993 540 angioplasties were performed at St Vincent's Hospital, an increase of 12% on the 1992 figures (473).

Eighty-two per cent of these procedures represented 'new cases'. Eighteen per cent of patients had previous angioplasty, approximately half of these within the preceding 12 months. If angioplasty had been performed less than 12 months previously the repeat procedure was in the same artery in 80% of cases compared with 58% of repeat procedures where the previous angioplasty was performed more than 12 months ago.

The overall figures 'by lesion' revealed a 91% success rate (5,894 of 6,481 arteries attempted). Eighty-eight per cent of arteries dilated were subtotal occlusions and 12% were total obstructions. With subtotal occlusions the success rate is 94% compared with 72% in total occlusions. There was a small number of patients who had dilatation of a vein graft with a success rate of 92% overall (132/144). Success by artery is highest in the anterior descending coronary artery with partial occlusion (95%), circumflex artery (95%) and right coronary artery (91%). Similar figures for total obstructions were 73%, 70% and 72%.

Over the last five years (1987-1991) the overall success rates have been 88%, 89%, 90%, 91% and 91%. Complications include failure of coronary angioplasty requiring bypass surgery, acute myocardial infarction and mortality. The requirement for bypass surgery following failed angioplasty has fallen over the years. In 1991 the bypass rate for failed angioplasty was 2.2%. Approximately two-thirds

Table 3

ANATOMIC CONSIDERATIONS FOR CORONARY ANGIOPLASTY

	IDEAL	LESS IDEAL
LESION LOCATION	LAD, RCA, LCX,	LEFT MAIN, OSTIAL
LESION MORPHOLOGY	SHORT (<1cm)	LONG
	CONCENTRIC	ECCENTRIC
	SMOOTH	IRREGULAR
	NON-CALCIFIED	CALCIFIED
	NO THROMBOSIS	THROMBUS
	>70%	<70%
	NO BRANCHES	SIDE BRANCHES
ARTERY MORPHOLOGY	PROXIMAL	DISTAL
	STRAIGHT	TORTUOUS
COLLATERALS	PRESENT	ABSENT

LAD = left anterior descending artery; RCA = right coronary artery; LCX = left circumflex artery.

of these were failed angioplasty with complications requiring urgent bypass surgery and one third were failed angioplasty without complication. The need for emergency bypass surgery has declined significantly from initial early experience in line with world wide trends (Figure 2).

In 1986 the myocardial infarction rate during angioplasty was 8.6% and in 1991 was 1.5% The mortality rate peaked in 1983- 84 at 1.10% compared with 0.31% in 1991. At St Vincent's Hospital the operation rate for failed angioplasty was 2.2% in 1993 which represents an 8% reduction in the operation rate for the preceding 12 months.

THE ST VINCENT'S HOSPITAL WORKSHOP

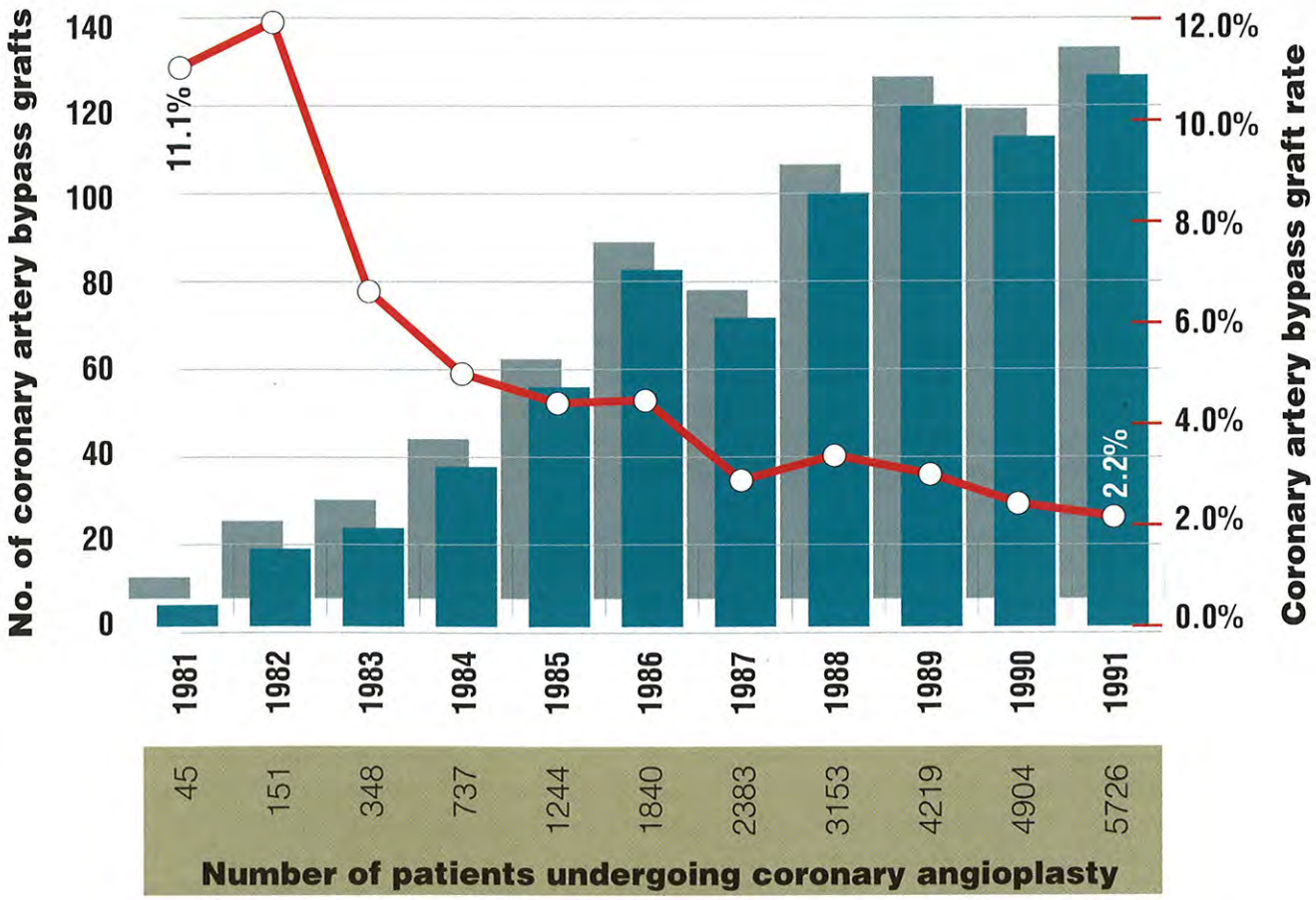
An Angioplasty Workshop demonstrating advanced interventional techniques was held at St Vincent's Hospital and Clinic campus on March 25 and 26, 1993. The course was fully subscribed, with guests including Dr Bernhard Meier (Switzerland), Dr Gary Roubin (USA) and Nicholaus Reifart (Germany). The course directors were Drs John Morgan, David Baron and Paul Roy. Many registrants were from overseas including New Zealand, Singapore, Malaysia, Indonesia, India and Thailand.

Advanced techniques were demonstrated including directional atherectomy, intracoronary stenting, opening of total obstructions, balloon mitral valvotomy and closure percutaneously of patent ductus arteriosus.

During the course both catheterisation laboratories were in simultaneous use with microwave beaming of live proceedings to the Function Room at St Vincent's Clinic before an audience of interventional cardiologists.

Figure 2

NUMBER OF PATIENTS UNDERGOING CORONARY ANGIOPLASTY AND FAILURE RATE REQUIRING CORONARY ARTERY BYPASS GRAFT 1981 – 1991



NEW DEVELOPMENTS

Equipment and Catheters

A variety of stents are now available from the self-expanding stent (Medivent) to the balloon expandable stent (Gianturco-Roubin, Wiktor and Palmaz-Schatz). New developments include materials which are less thrombogenic, a smaller surface area of stent material in relation to surface area of the artery, heparin-impregnated stents and stents which allow for greater flexibility in tortuous small and distal arteries. For smaller stenoses for example Palmaz-Schatz have developed a stent which is half the length of a standard stent (8mm versus 17mm).

Laser angioplasty has not lived up to its initial expections. The principle of laser devices emitting infra-red and ultra- violet light is used to deliver high energy at stenotic sites via fibre optic catheters. Besides ablating the plaque this usually results in injury to adjacent tissue and thrombotic charring induced by heat[23]. The shorter wave length excimer laser [24] (wave length less than 0.3μ) is said to ablate plaque with less surrounding injury to tissue. A similar effect to using short wave length laser can be achieved by fast pulsing high energy lasers of longer wavelength (Nd:YAG 1.06μ). Laser angioplasty is still experimental, with a low success rate (approximately 30%) and high complication rate, including vessel perforation.

There is the problem of flexibility and miniaturisation of the fibre optic probe and angulation and movement of the coronary artery. The power used to ablate the stenotic plaque is also difficult to control. The incidence of restenosis is not significantly different compared with balloon angioplasty. A variety of chemical and pharmacological agents have been used to try and ameliorate restenosis. Antiplatelet agents such as aspirin and dipyridamole have proved ineffective despite a favourable effect in some animal models. Immunosuppressives, anti-inflammatory agents, corticosteroids, prostacyclin analogues, omega-3-fatty acids and pharmacological blockers of platelet-derived growth factor have also proved ineffective.

Mechanical prevention of restenosis including debulking techniques such as directional atherectomy and rotational ablation using a high-speed guide wire directed diamond-coated drill have not proved effective. While these devices have their own merits and limitations they have not so far proved beneficial at preventing restenosis.

A new catheter has been developed to remove freshly-formed thrombus from coronary arteries and grafts ('hydrocatheter'). A high pressure injection is made down the catheter and extraction occurs through a separate port. Preliminary results in selected patients have been impressive with this technique particularly if thrombosis is recent.

Support Devices

With expanding indications for coronary angioplasty including multivessel coronary disease and patients with impaired left ventricular function, mechanical support of the patient is often required as an adjunct to reduce the procedural risk and improve patient tolerance. Broadly speaking, this can be achieved by increasing coronary artery perfusion directly, or by providing left ventricular assistance without directly cannulating the coronary vessels.

The 'direct' coronary perfusion techniques include antegrade transcatheter coronary perfusion whereby the distal coronary artery is perfused passively via proximal and distal side holes in the catheter. This technique is useful where prolonged balloon inflation is required but the patient cannot tolerate a prolonged occlusion by an inflated balloon. It is also useful for haemodynamic stability in a patient where an artery tends to reocclude allowing safe transfer to the operating theatre.

Coronary sinus retroperfusion is an alternative method of direct myocardial perfusion. Retroperfused blood is delivered in a pulsatile manner through a balloon catheter inserted in the coronary sinus, the catheter being introduced either from the left subclavian or internal jugular vein. Oxygenated blood is obtained from the femoral artery and infused via a balloon-tipped catheter during ventricular diastole. The balloon is located one centimetre from the tip of the catheter and inflates and deflates with pressurised carbon dioxide during each cardiac cycle, preventing egress of retroperfused oxygenated blood into the right atrium. Flow rates of up to 250 mls/minute have been obtained [25].

'Non-coronary' percutaneous perfusion techniques include intra-aortic balloon counterpulsation, cardiopulmonary bypass, the Hemopump, left ventricular assistance and partial left heart bypass. The intra-aortic balloon pump reduces myocardial oxygen consumption by 10 to 20% and is best inserted prior to high-risk angioplasty being undertaken. Vascular complicatons occur in 10 to 20% of patients and ileo-femoral disease may result in failure of the balloon insertion in up to 10% of patients. There are conflicting reports as to whether coronary blood flow is actually improved or whether its main benefit is in reducing afterload.

Percutaneous cardiopulmonary bypass also requires the introduction of a large bore catheter (18F to 20F) via the femoral artery and vein. A

long venous cannula is advanced to the right atrium, venous blood withdrawn via means of a vortex-centrifugal Biomedicus pump in series with a membrane oxygenator and returned to the circulation via a femoral artery cannula. With this method systemic vascular resistance is reduced and fluid administration is required. Flow rates of one to six litres per minute can be achieved. The presence of a skilled perfusionist is required and high dose heparinisation may result in increased bleeding risk. The Hemopump is a left ventricular assist device whereby blood is drawn directly from the left ventricle via a miniature Archimedes spiral vane screw pump in the base of the cannula which rotates at 27 000rpm, producing non- pulsatile flow rates of up to 3.5 litres per minute into the descending aorta. A cut down is required of the femoral artery to allow access of the 21F cannula. The advantage of this technique is that it is independent of left ventricular function or cardiac rhythm. By decompression of the left ventricle the device increases collateral coronary artery perfusion as well as maintaining assistance to the systemic circulation[26].

Recently a percutaneous partial left heart bypass system has been used during high risk angioplasty to provide circulatory support. A 14F to 20F catheter is placed in the left atrium via a transeptal puncture and oxygenated blood is withdrawn and returned to systemic circulation via a similar sized cannula in the femoral artery. The advantage of this technique over percutaneous cardiopulmonary bypass is that no oxygenator is required. The drawback is that transeptal placement of large bore catheters is technically more complicated than right atrial access and may be attendant with a higher incidence of systemic emboli[27].

DISCUSSION

Over the past decade cardiac catheterisation has evolved from a simple diagnostic procedure to a technique that now involves complicated interventions as part of treatment. It is clear from the National Heart Foundation of Australia Registry that the number of coronary angioplasties is continuing to increase from an initial 45 procedures in 1981 to 5 726 in 1991. This has mainly been in patients with single vessel disease although there has been a steady increase in the number of patients with multivessel disease. An increasing proportion of cases involve patients who have had previous angioplasty - approaching 18%. However, it is important to note that in approximately half of these angioplasty was performed more than 12 months previously and in the majority of these cases involved a totally different artery to the one which was previously dilated.

Increasingly we are seeing patients return with symptomatic coronary artery disease one to 10 years later with additional disease in native arteries graft stenosis or graft occlusion. These patients may well be served by coronary or graft angioplasty or related interventional procedures. Whilst angioplasty is not a 'definitive' therapy it may afford the patient freedom of symptoms for many years until multivessel disease supervenes, requiring coronary artery bypass surgery.

Much of the interest in coronary angioplasty revolves around its relative safety. The failure rate at St Vincent's requiring bypass surgery in the last 12 months was 2.2% in line with registry figures, and compares with a failure rate requiring operation of 11.1% in 1981. Mortality rate according to last published registry figures was a very safe 0.3%.

The main drawback of coronary angioplasty may be summarised by its acute complications and later restenosis. There are a number of techniques and devices which are used to address the former including for example intracoronary stenting. There will doubtless be further improvements both to existing devices and with newer devices. However, restenosis remains the biggest drawback of the technique. It may occur in up to 30% of patients and many of these will require some further form of intervention such as repeat angioplasty, intracoronary stenting, debulking or bypass surgery. The newer devices such as rotational ablation ('Rotablator') are more useful for a specific type of stenosis rather than preventing restenosis itself. There have been conflicting reports as to the results of stenting in preventing restenosis.

In the United States in 1986 there were 110,000 angioplasty procedures performed and approximately 240,000 coronary bypass operations. In 1990 there were 300,000 angioplasty procedures and 350,000 coronary artery bypass operations. Today the frequency of coronary angioplasty per annum is approximately that of bypass surgery but is rising at a more rapid rate. Angioplasty can be performed at approximately one-third of the in-hospital cost of bypass surgery with a shorter hospital stay and convalescent period and shorter absence from work. However most cost studies do not factor in the expense of bypass surgery as a back-up procedure, the treatment of restenosis and complications. Further the cost savings depend heavily upon operator experience and the procedure is best confined to large institutions with a high work load and large operator experience.

With increasing skill more complicated cases of angioplasty are being undertaken. Haemodynamic support is available to allow a greater margin of safety for high risk lesions and patients with severe left

ventricular dysfunction or multivessel disease. They should only be used in a setting where there is a large experience in angioplasty and an experienced perfusionist and good surgical back up are available. At present there is a device available for closure of patent ductus arteriosus as was demonstrated recently in three patients at St Vincent's Workshop. One would anticipate in future devices to close atrial and ventricular septal defects.

REFERENCES

1. Dotter CT, Judkins MP. Transluminal Treatment of Arteriosclerotic Obstruction: Description of a New Technique and a Preliminary Report of its Application. Circulation 1964: 30: 654.
2. Greuntzig A, Kumpe DA. Technique of Percutaneous Transluminal Angioplasty with the Greuntzig Balloon Catheter. Amer. J. Radiol. 1979; 132:547.
3. Simpson JB, Baim DS, Robert EW, Harrison DC. A New Catheter System for Coronary Angioplasty. Amer. J. Cardiol. 1982; 49:1216
4. Finci L, Meier B, Roy P, Steffenino G, Rutishauser W. Clinical Experience with the Monorail Balloon Catheter for Coronary Angioplasty. Cathet.Cardiovasc. Diagn. 1988;14:206-212
5. Feldman RL, MacDonald RG, Hill JA, Conti R, Pepine CJ, Carmichael MG, et al. Coronary Angioplasty at the Time of Initial Cardiac Catheterisation. Cathet. Cardiovasc. Diagn. 1986; 12:219
6. Topol EJ, Califf RM, George BS, et al. A Randomized Trial of Immediate versus Delayed Elective Angioplasty after Intravenous Tissue Plasminogen Activator in Acute Myocardial Infarction. New Engl. J. Med.1987; 317:581-588.
7. Simoons ML, Arnold AE, Betriu A, et al: For the European Co-Operative Study Group. Thrombolysis with Tissue Plasminogen Activator in Acute Myocardial Infarction: No Additional Benefit from Immediate Percutaneous Coronary Angioplasty. Lancet 1988; 1:197-203.
8. The TIMI Research Group. Immediate versus Delayed Catheterisation and Angioplasty Following Thrombolytic Therapy for Acute Myocardial Infarction. JAMA 1988; 260:2849-2858.
9. The TIMI Study Group. Comparison of Invasive and Conservative Strategies Following Intravenous Tissue Plasminogen Activator in Acute Myocardial Infarction. Results of the Thrombolysis in Myocardial Infarction (TIMI) II trial. New Engl. J. Med. 1989; 320:618-628.
10. Hibbard MD, Holmes DR, Bailey KR, Reeder GS, Bresnahan JF, Gersh BJ.0: Percutaneous Transluminal Coronary Angioplasty in Patients with Cardiogenic Shock. JACC. 1992; 19:639-646.
11. Abbott-Smith CW, Topol EJ, George BS, et al. Fate of Patients with Acute Myocardial Infarction with Patency of the Infarct-Related Vessel Achieved with Successful Thrombolysis versus Rescue Angioplasty. JACC: 1990; 16: 770-778.
12. Ellis SG, Van de Werf F, Ribeiro-da Silva E and Topol EJ. Present Status of Rescue Coronary Angioplasty: Current Polarization of Opinion and Randomized Trials. JACC 1992; 19: 681- 686.
13. Wohlgelernter D, Cleman M, Highman HA, Zaret BL. Percutaneous Transluminal Coronary Angioplasty of the Culprit Lesion for the Management of Unstable Angina Pectoris in Patients with Multi-Vessel Coronary Artery Disease. Amer. J. Cardiol. 1986; 58:460.
14. Dorros G, Johnson WD, Tector AJ, Schmahl TM, Kalush SL, Janke L: Percutaneous Transluminal Coronary Angioplasty in Patients with Prior Coronary Artery Bypass Grafting. J. Thor. Cardiovasc. Surgery. 1984;87:17-26.
15. Hollman J, Gruentzig AR, Douglas JS, King SB, Ischinger T, Meier B. Acute Occlusion After Percutaneous Transluminal Angioplasty - New Approach. Circulation 1983; 68:725.
16. Bredlau CE, Roubin GS, Leimgruber PP, Douglas JS, King SB, Gruentzig AR. In-Hospital Morbidity and Mortality in Elective Coronary Angioplasty. Circulation 1985; 72:1044.
17. Weintraub WS, Kosinski AJ, Brown CL, King SB: Can Restenosis After Coronary Angioplasty Be Predicted From Clinical Variables? JACC 21: 1993; 6-14.
18. Hirshfeld JW, Schwartz JS, Jugo R, MacDonald RG, Goldberg S, Savage MP, et al. Restenosis After Coronary Angioplasty: A Multivariate Statistical Model to Relate Lesion and Procedure Variables to Restenosis. JACC 1991; 18:647-656
19. Dimas AP, Grigera F, Arora RR, Simpfendorfer CC, Hollman JL, Frierson JH, et al. Repeat Coronary Angioplasty As Treatment for Restenosis. JACC 1992; 19: 1310-1314.
20. Schwartz RS, Edwards WD, Huber KC, Antoniades LC, Bailey KR, Camrud AR. Coronary Restenosis: Prospects for Solution and New Perspectives from a Porcine Model. .Mayo Clin. Proc. 1993; 68:54-62.
21. Hlatky M, Schwab S, Pieper K, Davidson C, Morris K, Bashore T. A Randomized Trial of Ionic and Non-ionic Contrast for Cardiac Angiography: Effect on Renal Function (Abstract.. Circulation 1988; 78 (suppl.II.: II-378.
22. Galbreath C, Salgado ED, Furlan AJ, Hollman J. Central Nervous System Complications of Percutaneous Transluminal Coronary Angioplasty. Stroke 1986; 17: 616-618.
23. Reis GJ, Pomerantz RM, Jenkins RD, Kuntz RE, Baim DS, Diver DJ. Laser Balloon Angioplasty: Clinical Angiographic and Histological Results. JACC 1991; 18:193-202.
24. Holmes DR, Forrester JS, Litvack F, Reeder GS, Leon MB, Rothbaum DA, et al.: Chronic Total Obstruction and Short-Term Outcome: The Excimer Laser Coronary Angioplasty Registry Experience. Mayo Clin. Proc. 1993; 68:5-10.
25. Hajduczki I, Kar S, Areeda J, et al. Reversal of Chronic Regional Myocardial Dysfunction (Hibernating Myocardium. by Synchronized Diastolic Coronary Venous Retroperfusion During Coronary Angioplasty. JACC 1990; 15:238-242.
26. Merhige ME, Smalling RW, Cassidy D, et al. Effect of the Hemopump Left Ventricular Assist Device on Regional Myocardial Perfusion and Function: Reduction of Ischemia During Coronary Occlusion. Circulation: 1989; 80 (suppl. III.: 158-166.
27. Lincoff AM, Popma JJ, Ellis SG, Vogel RA, Topol EJ. Percutaneous Support Devices for High Risk or Complicated Coronary Angioplasty. JACC 1991; 17:770-780.

The Sisters of Charity of Australia Crest

The Crest bears the motto of the Congregation of the Sisters of Charity - "Caritas Christi Urget Nos" which means "The Love of Christ urges us on" and is a saying of St Paul (2 Cor. 5:14).

The main feature of the design is a shield on which are entwined the letters M and A, the initial letters of the words Maria Angelorum. It was under this title that Mary Queen of Angels was chosen as patroness by the founding members of the Sisters of Charity. A row of stars above the monogram and the moon below represent the figure of the Blessed Virgin as she appears in the prophetic book of Revelations - a crown of stars on her head and the moon beneath her feet. (Rev: 12:1).

Above the Crest, a cross based in a crown reminds the Sisters that it is by their imitation of Christ's obedience to His Cross that they can hope to win the Crown of Eternal Life.

Mary Aikenhead, the founder of the Order of Sisters of Charity, wanted the direct title of Mother of God represented everywhere, so the Crest which signifies the Queenship of Mary is displayed in all our facilities.

St Vincent's Clinic Emblem

An Emblem is a distinctive symbol, depicting the aims of a specific facility or organisation. It is easily recognisable, and may be reproduced in a variety of media.

The Clinic Emblem presents the aims of the St Vincent's Clinic in a clear and symbolic form.

These aims are: patient care, medical teaching and clinical research. Each of these three aims is depicted within the Emblem by three single triangular shapes of equal size.

Since these three aims are interdependent, they form a link with each other, and this is represented in the Emblem.

There are several ways in which these three links can be put together, but there is only one way where each is binding with the other two, to form a secure bond, that unites the Clinic aims together.

This Emblem offers a clear symbolic representation of the Clinic's aims, interwoven in a unique design.

The Medical staff of St Vincent's Clinic acknowledge with gratitude the creation of the Emblem by Dr Bruce Taylor.