Microvascular Reconstructive Surgery

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Preface

One of the most challenging developments in reconstructive surgery, in the last 25 years, has been microsurgery of small vessels and nerves. The initial experimental and clinical successes in microvascular surgery, in the sixties, have been followed by rapid progress in the seventies. Broad applications have evolved with increasing success but further evaluation and refinement of case selection is required. Each year new clinical fields have appeared and now, in addition to replantation surgery, the microvascular free transfer of flaps, omentum, toes, bones and muscles has been established. Microlymphatic surgery has been introduced and is the subject of much interest in the treatment of obstructive lymphoedema.

Other realms of microsurgical endeavour will be discovered, not only in reconstructive surgery, but in all disciplines of surgery. No branch of surgery can escape the use of magnification, even if for the purpose of dissection only. As the value of the microscope becomes more widely appreciated, surgical techniques will be refined further or replaced. Some conventional procedures, such as 'tube pedicles', are being re-examined in the light of these new techniques.

Many aspects of patient care, including organization, equipment and personnel, need revision. Economic problems related to long hospitalization are well known and reduction of this problem, by the use of microvascular surgery, merits close attention.

Some established surgeons may feel an understandable lack of enthusiasm for participation in microvascular surgery but their encouragement, especially of younger surgeons, is invaluable. Reconstructive surgery must be open to change now that microvascular surgery has arrived. It has already assumed an important role in the training of young reconstructive surgeons and their microsurgical training must be comprehensive. The integration of fulltime and long-term clinical and experimental work, in the author's opinion, is the best method of training in this specialized field. There is a pressing need for the establishment of centres, throughout the world, which possess a broad clinical work load and which provide the necessary experimental and clinical opportunities for all kinds of microvascular surgery. Microsurgical courses, which include one to two day laboratory tuition, are interesting measures only. It is impossible to achieve expertise in such a short period and many participants do not continue with the work. Lectures and films are illuminating but experimental courses, conducted under artificial and inadequate conditions, have little value.

Microvascular surgery has introduced a new field of team surgery — that is it is not the work for a single individual as it seeks to provide a community service of a wide nature. Surgical units may need extensive re-organization to encompass this and hospitals must adjust accordingly.

The lack of a microsurgery textbook has been felt and this attempt to fill that need reflects the author's personal experience in the operating theatre, wards and laboratory over a 10-year period at St Vincent's Hospital, Melbourne. It was the publisher's request that the work be of single authorship at this stage. The book has been written, and the proofs corrected, in one year and, it is hoped, gives an up-to-date viewpoint of microvascular surgery. Two chapters on microneural surgery have been added as, not infrequently, this is associated with microvascular surgical problems. A chapter on the microsurgery of miscellaneous tubes and structures (partly microvascular) completes the text.

Melbourne,
May, 1976

B. O'Brien

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The author is greatly indebted to St Vincent's Hospital for its support and the creation of the Microsurgery Unit of which the author is the Director. The hospital has provided laboratory facilities and staff at all stages of the project and, in 1972, new laboratories were established. In the clinical field the operating theatre staff have given maximum support, often at irregular hours, and the ward nursing staff have maintained a vigilant, and often protracted, postoperative management. The enthusiasm and co-operation of the Sister Superior and her staff at St Vincent's Private Hospital, where much clinical microvascular surgery has been performed, is gratefully recognized.

The unfailing support of my Plastic Surgery Colleagues, Mr R. K. Newing, Mr A. M. MacLeod and Mr W. A. Morrison, is warmly acknowledged. Mr Newing has not only given steady encouragement, but has referred many patients. Some of the cases illustrated in the book have been operated upon by Mr MacLeod and Mr Morrison and the excellent results obtained are a testimony to their surgical skill and judgement. The trust of the many other Medical Practitioners, who have referred patients for new procedures, has been a source of great encouragement.

The laboratory staff of the Microsurgery Research Unit, led most capably by Madeleine McEniry, S.R.N., have not only worked diligently over many years, but have been unstinting in their enthusiasm. They have assisted the surgical staff in every possible way.

Approximately 40 long-term Surgical Research Fellows from nearly twenty countries have made a notable contribution, both in the laboratory and in the clinical field. Dr Jay Hayhurst of Oklahoma City, U.S.A. (formerly of Norfolk, Virginia) has provided valuable assistance with sections of the book and the author is indebted especially to him. Dr E. F. O'Sullivan has given valuable advice in Chapter 6 regarding blood coagulation and related problems and has assisted in the management of anti-coagulant therapy in clinical replantation surgery. Dr V. Stanisich and Dr H. Butel, have not only been most helpful in the writing of Chapter 8 (on anaesthesia), but have steered many of the patients safely through their long microvascular operative procedures, without mortality.

The author owes a special debt to Professor Gerard Crock of the Melbourne University Department of Ophthalmology. He has been associated with the project since 1967. His department was the first to become so linked, initially, in the development of micro instrumentation (J. M. Parel and L. J. Pericic) and then in the provision of the earliest workers in basic microvascular surgery. Miss Nan Carroll, from the same Department, has given invaluable assistance in the field of scanning electron microscopy. An active programme on micro-ophthalmology has since been conducted in the Microsurgery Research Unit.

Dr Thelma Baxter, from the Melbourne University Department of Surgery at

St Vincent's Hospital, has carried out an exhaustive study of the histopathology of basic microvascular surgery and many of the histopathological illustrations in the book have stemmed from her skilled work. Professor R. C. Bennett, Professor of Surgery at St Vincent's Hospital, gave support to the early research work and the author acknowledges his assistance in this area.

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The illustrative work in this book comes mainly from the skilled hand of Mr William Owen. He has displayed great dedication, and has been meticulous in the provision of photographs, drawings and tables, often at very short notice, and the author is most appreciative of his contribution. Mr M. Cotela, Clinical Photographer at St Vincent's Hospital, supplied many photographs of clinical cases, Mr A. Wigley some of the drawings and the author wishes to record their assistance. Some of the photographic work, in addition to the production of many films, has been ably supplied by Mr Vernon Wagstaff, Director of Cine Service Pty Ltd, Melbourne.

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The bibliography in this text required much attention and Medical Librarians, Miss A. Bush, St Vincent's Hospital, Mrs B. McNeice, Royal Australasian College of Surgeons, Mrs J. Marshall, Monash University Medical Library and Miss A. Harrison, Brownless Medical Library, University of Melbourne, have all carried out work of great assistance to the author.

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To the Publishers, Churchill Livingstone, the author expresses his appreciation. Due to the efficiency of the publisher, the 12·000 mile gap, between editor and author, was bridged with minimal difficulty.

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Contents

1. The Operating Microscope

Microsurgery means surgery using a microscope. The modern operating miscrope, with its refined optics and improved magnification, enables a surgeon to achieve goals not possible with conventional techniques. The skills of the surgeon are augmented by fine instrumentation and microsutures which, not only minimize trauma to small structures but, enable these to be repaired with a precision not previously possible. Any surgical operation, requiring a precise recognition of small tissues or structures, will be improved by the use of the surgical operating microscope. The operating microscope is desirable for surgery on structures 3 mm or less in diameter and absolutely essential for successful surgery in the region of 1 mm or less in diameter.

The advent of atraumatic surgery was the surgery of millimetres replacing that of centimetres. Microsurgery has heralded a new era: the surgery of micrometres.

History

The compound microscope was invented in 1590 by Zacharia Janssen. It was subsequently used for many centuries in microbiology, histology and pathology but it was not until 1921 that the operating microscope was first used experimentally by Nylen in Sweden (Fig. 1.1), who operated on labyrinthine fistulae and carried out fenestrations in rabbits with a magnification of 10 to 15 times. A monocular microscope (Fig. 1.2) was designed with an enlargement up to 235 times (Nylen, 1954, 1972). He used a primitive binocular microscope in the autumn of 1921 on a case of chronic otitis and a few cases with pseudofistula symptoms. In 1922 his chief, Holmgren, introduced a Zeiss binocular microscope to otology. Microsurgery in otolaryngology then progressed slowly over the next three decades but in the early fifties rapid progress led to the highly sophisticated levels of today. In 1946 Perritt (1950), in the United States, began to use the microscope for routine ophthalmic surgery. Then followed the successful experiments of Jacobson and Saurez (1960) in microvascular surgery; the application of the microscope to plastic and reconstructive surgery (Buncke and Schulz, 1965); to peripheral nerve surgery (Smith, 1964; Kurze, 1964; Michon and Masse, 1964); to neurosurgery (Donaghy and Yasargil, 1967) and to experimental organ transplantation (Fisher, 1965).

THE MICROSCOPE

The value of magnification can be illustrated by comparison of the naked eye view of an artery, diameter 0·8 mm repaired with a 19 μm metallized nylon microsuture (Fig. 1.3), with the same vessel seen at six times and twenty times through the operating microscope with a simple household pin just above the vessel.

The operating microscope does have certain disadvantages because of its bulk, immobility, small operative area and depth of focus. These features become less important when the work requires higher magnification. A serviceable microscope should have strong cold lighting with magnification ranging from six to forty times. A foot or hand operated control panel changes magnification and focus. It has the capacity also to move the microscope about 3 cm horizontally in several directions (XY plotter). The head of the microscope should tilt in all

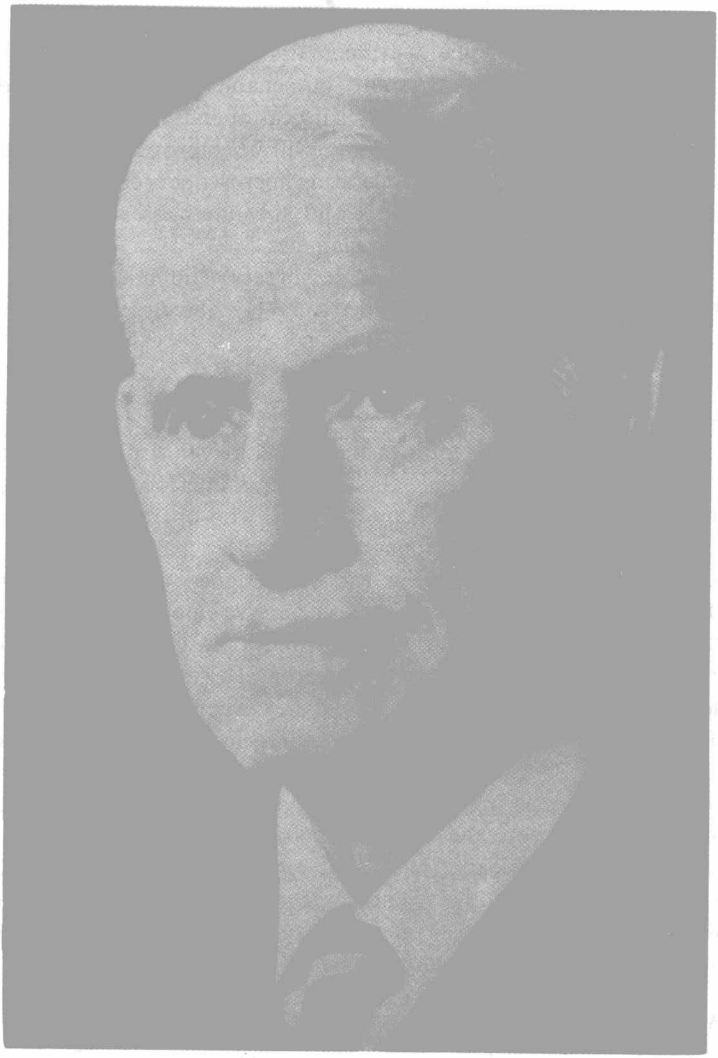

Fig. 1.1 Professor Carl-Olof Nylen, founder of the clinical operating microscope in 1921. (Reproduced with kind permission of the *Annals of the Royal College of Surgeons*.)

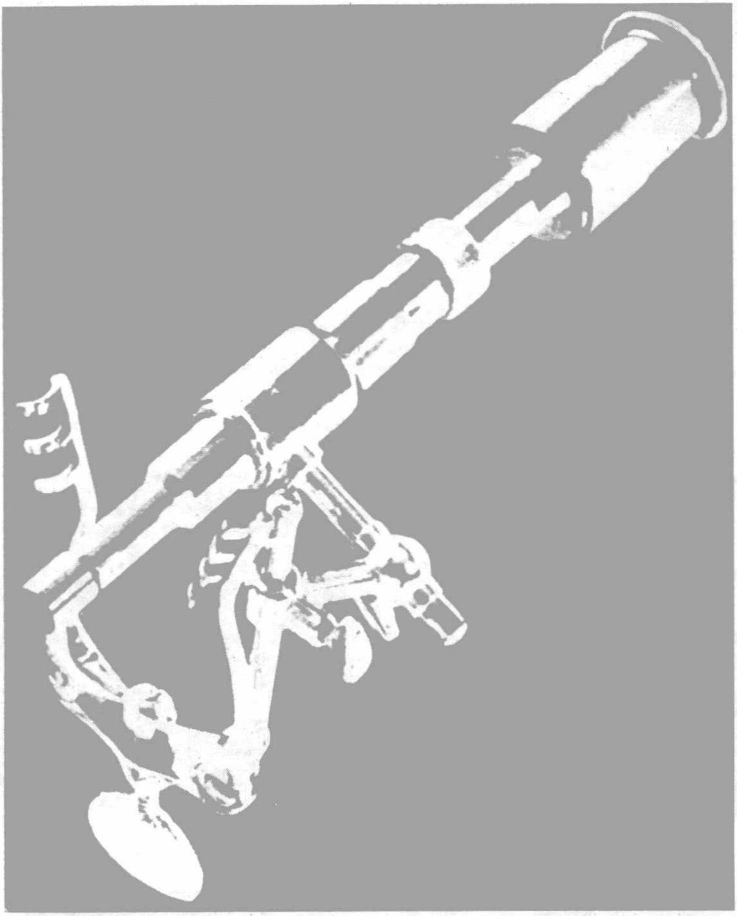

Fig. 1.2 Monocular microscope of C-O. Nylen, H. Persson and M. Storm from 1933. (Published with permission of the Editor of *Acta Otolaryngologica*.)

planes to provide access for all clinical situations. The assistant's binocular system views the same operating field as the surgeon and the assistant needs to be able to sit at any point from 90° to 180° from the surgeon. For teaching and recording purposes the microscope should be capable of carrying an observation tube and still, movie or television camera. Microscope stands need to be as light as possible and ceiling suspensions have many merits in eliminating cumbersome stands and avoiding storage problems. Installation of the Carl Zeiss ceiling mounting requires a ceiling greater than 295 cm in height, but not exceeding 430 cm. For the range 350 to 430 cm an intermediate segment is inserted. The vertical range of movement of the microscope is 53 cm. The microscope must be free of vibration as this is increased with magnification. The head and eye should be fixed in position to achieve satisfactory precision and, likewise, the operating field should possess little or no movement.

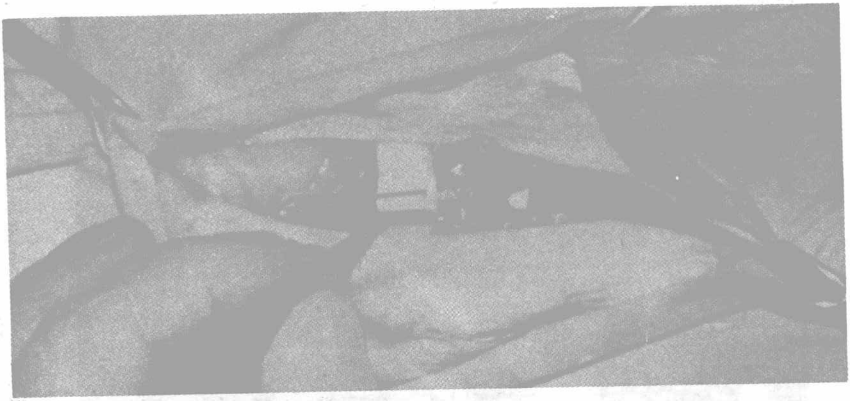

Fig. 1.3A Naked eye view of repaired artery 0·8 mm diameter with a household pin beside it.

Fig. 1.3B 6 × view of the same pin and artery.

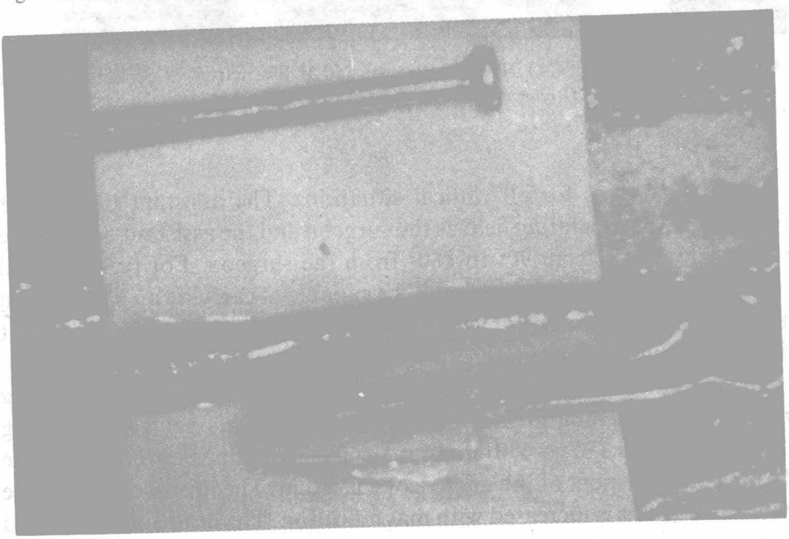

Fig. 1.3C 20 × view of the same pin and artery.

Magnifying loupes

Sometimes magnifying loupes are more practical than a microscope particularly for microdissectional surgery. Preliminary dissection is often carried out with magnifying loupes until the stage is reached where the operating microscope only can provide the necessary resolution. The Keeler magnifying loupe times 4 is found to be the most useful and the swivelling of the telescopic lenses enables them to be moved out of the field (Fig. 1.4). Loupes with higher magnification have too small a field of vision with a very restricted depth of focus and it is impossible for the surgeon to keep his head still for any long period. Prototypal lightweight models, designed by Clodius (1974), which incorporate a head lighting system, appear to overcome some of these problems.

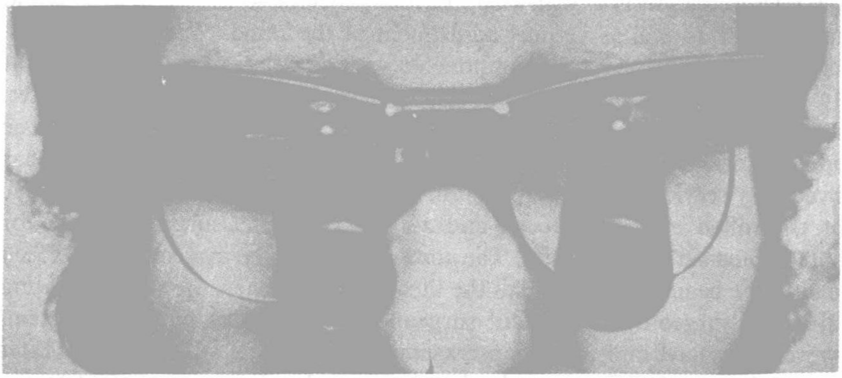

Fig. 1.4A Keeler magnifying loupes 4 × magnification.

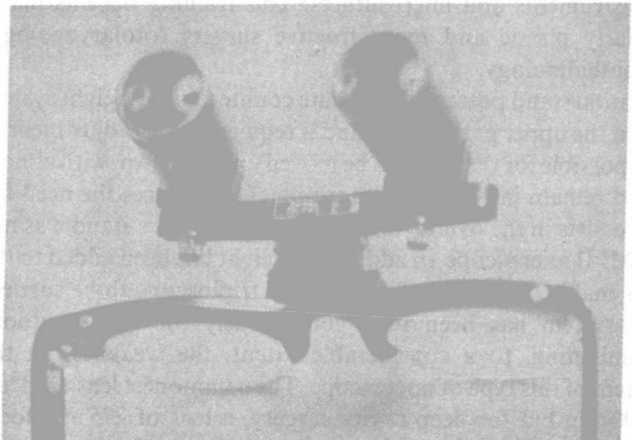

Fig. 1.4B Telescopic lens swivelled upwards.

Zeiss operating microscopes

The author is more familiar with the Zeiss operating microscopes. The earliest OPMI I model was developed in 1952 by the Carl Zeiss Company, followed in 1961 by the introduction of the Diploscope, by H. Litmann, which linked two OPMI I microscopes by a central prism and thus allowed two surgeons to operate together for the first time. Each of them could choose his own magnification manually and each had full stereopsis. This rather bulky and cumbersome arrangement prevented its general acceptance in microsurgery.

OPMI II microscopes and modifications

The diploscope was followed by the introduction of electrically controlled zoom microscopes in 1967 with a double foot panel for control of fine focus and magnification as well as vertical adjustment of the stand. With the OPMI II microscope came new optical components such as a beam splitter to take not only a camera, but additional viewing systems and a stereo beam splitter, permitting two surgeons to work opposite each other with full stereopsis. The modified Zeiss triploscope (O'Brien, 1973) based on the OPMI II model has proved very serviceable at both experimental and clinical levels with its single foot controlled motorized focus and zoom to free the surgeons hands for uninterrupted surgery (Fig. 1.5). The additional binocular system that has been added to the beam splitter enables the theatre nurse to view the same operating field as the surgeon and assistant surgeon (Fig. 1.6). This binocular system, however, does have limited stereopsis as it uses only one half of the beam splitter system. It has proved of value to the theatre nurse who plays an important part in microneurovascular operations, assisting with suction, traction and with the passage of microsutures into the surgical field. She maintains a general awareness of the microsurgical operation. This type of surgery demands a 'micro-orientated' nurse with a knowledge of the microscope and training in the handling of small instruments and microsutures. This training benefits many specialities, particularly plastic and reconstructive surgery, otolaryngology, neurosurgery and ophthalmology.

The Zeiss combination stand possesses a delicate counterpoised weight system in which no locking of the upper part of the stand is required. With adjustment of variable weights it is possible for the stand to be moved up and down, with almost fingertip control, and remain in the correct position. This reduces the need for coarse focusing and assists in the overall manoeuvrability. As the stand was not designed for the OPMI II microscope an additional weight has been added to the balancing system to enable the increased bulk of the triploscope to be carried. The overload light system has been used continuously for hours without untoward effect eliminating, to a considerable extent, the weakness in the internal lighting system of this type of microscope. The commonest lens used has a focal length of 200 mm but for deep cavity surgery, a lens of 275 mm focal length is better. Straight or angled binocular tubes are used, preferably straight for the surgeon and assistant surgeon, but angled for the theatre nurse.

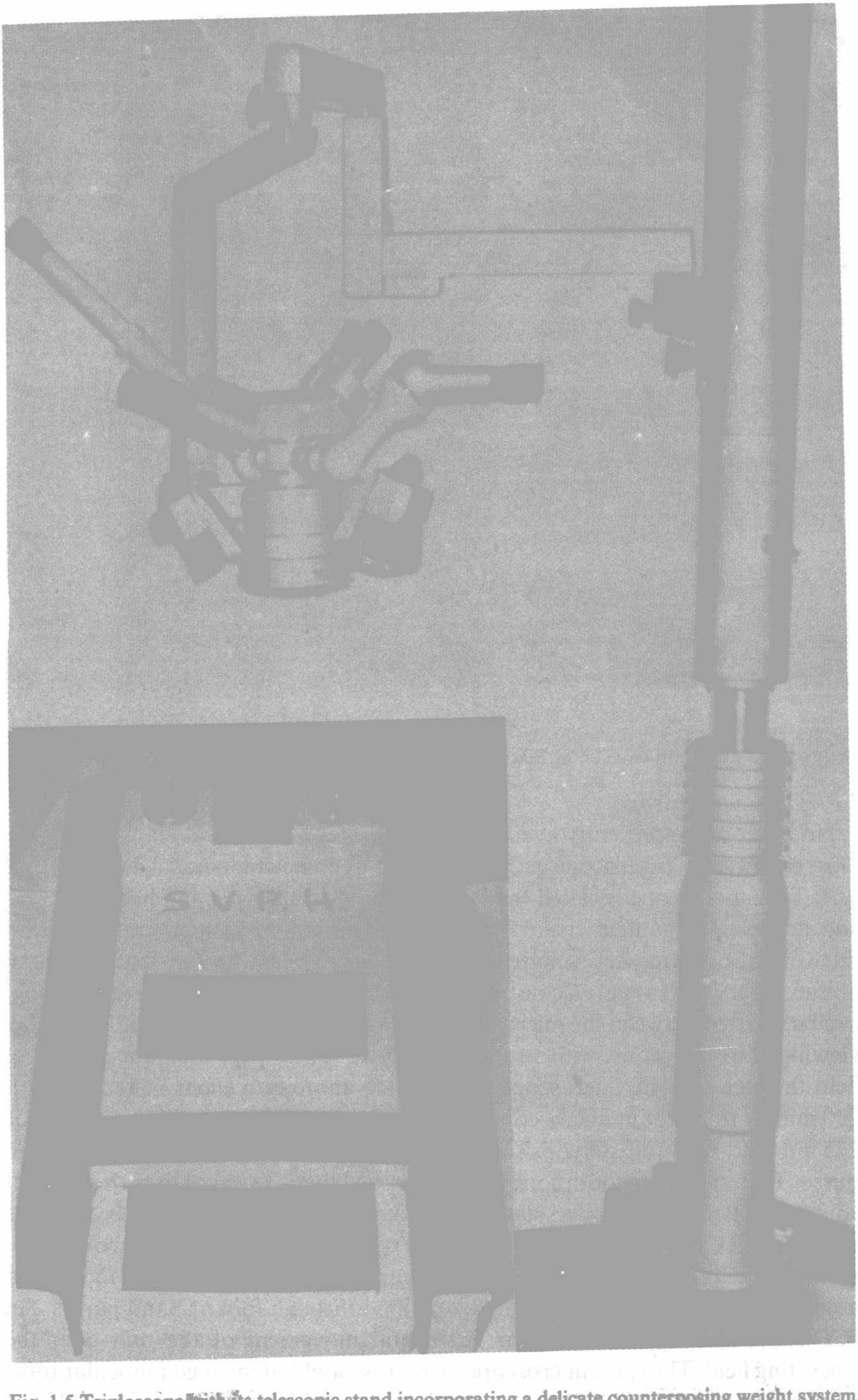

Fig. 1.5 Triploscope with its telescopic stand incorporating a delicate counterposing weight system. (Reproduced with permission of the Editor of the *British Journal of Plastic Surgery*.) *Inset* Single foot panel controlling focus and magnification for the triploscope.

Fig. 1.6 The triploscope in use for hand surgery with a theatre nurse using the third binocular system. (Reproduced with permission of the Editor of the *British Journal of Plastic Surgery*.)

7 P/H Zeiss triploscope

No microscope presently available incorporates all the ideal features but the most recent Zeiss triploscope with fiber optic lighting includes most of these (Fig 1.7). This microscope is called the 7 P/H, suitable for plastic and hand surgery, and possesses large field coaxial cool light illumination with several times the intensity of previous Zeiss models. A special small beam splitter that can carry one accessory such as a still, cine or television camera, or stereo observation tube, can be inserted between the microscope body and the adaptor for dual binocular viewing. Two surgeons, with straight binocular tubes, view the same operating field through the one microscope system with an objective lens of focul length 200 mm. A third zoom microscope, angled at about 7°, with an objective lens of 225 mm and with full stereopsis, can be fitted for a second assistant or theatre nurse. Preferably this additional microscope should be capable of horizontal rotation through 180°. The stand is of extremely slim design, as is also the microscope complex, allowing free view of the operating field around the microscope. It is manoeuvrable with a tilt angle up to ±30° and the motorized control of zoom and focusing can be operated through foot or hand panels. An XY coupling may be added for horizontal movement of the unit over the operating field. The third microscope, with its straight or inclined binocular tube, has its own electric zoom changer with foot or hand pedal. Improvement of this microscope by the production of a special coupling is planned.