SECOND EDITION

TEXTBOOK OF ANAESTHESIA

EDITED BY

A. R. Aitkenhead
G. Smith

Churchill Livingstone

Textbook of Anaesthesia

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CHURCHILL LIVINGSTONE
EDINBURGH LONDON MELBOURNE AND NEW YORK 1990

World Publishing Corporation,Beijing,China

CHURCHILL LIVINGSTONE
Medical Division of Longman Group UK Limited

Distributed in the United States of America by
Churchill Livingstone Inc., 1560 Broadway, New York,
N.Y. 10036, and by associated companies, branches
and representatives throughout the world.

First edition 1985
Reprinted 1985
Reprinted 1988
Second edition 1990

ISBN 0 443 039577 **ISBN 7-5062-2248-5**

British Library Cataloguing in Publication Data
Textbook of anaesthesia. — 2nd ed
1. Medicine. Anaesthesia
I. Aitkenhead, A. R. (Alan R.) II. Smith, G.
(Graham), *1941–* IV. Smith, G. (Graham), *1941–*
Textbook of anaesthesia
617'.96

Library of Congress Cataloging in Publication Data
Textbook of anaesthesia edited by A. R. Aitkenhead,
G. Smith. — 2nd ed.
p. cm.
Includes bibliographies and index.
ISBN 0-443-03957-7
1. Anesthesiology. I. Aitkenhead, A. R. (Alan R.)
II. Smith, G. (Graham)
[DNLM: 1. Anesthesia. WO 200 T355]
RD81.T44 1990
617.9'6 — dc20
DNLM/DLC
for Library of Congress 89-7217
CIP

This edition of Textbook of Anaesthesia
is published by World Publishing Corporation, Beijing, 1991
by arrangement with Churchill Livingstone, London
Licensed for sale in The People's Republic of China only
只限在中华人民共和国发行

Printed in Great Britain at The Bath Press, Avon

Preface

The first edition of this book was intended to satisfy the needs of the new recruit into anaesthesia during the first 1–2 years in the specialty. In addition, it was hoped that it might provide suitable reading for anaesthetists studying for the (then) new Part 1 FFARCS examination (now Part 1 FCAnaes) and the European Diploma of Anaesthesiology. The response to the first edition was very encouraging and it clearly proved useful not only to the intended audience but also to a wider readership including medical practitioners giving occasional anaesthetics in rural areas or underdeveloped countries and non-medical staff involved full-time in anaesthesia. The success of the first edition has therefore stimulated us to produce a second.

The aims of this new edition are broadly similar to those of the first. However, as a result of our own awareness of some deficiencies in the first edition, and after receiving many helpful comments from reviewers and readers of the book, we have introduced several new chapters, undertaken major revision of chapters on pharmacology and practical aspects of anaesthesia, and updated the content of the remainder.

We have rewritten those chapters describing the pharmacology of intravenous and inhalation anaesthetics, and of drugs used to supplement anaesthesia. A new chapter outlining basic knowledge of physics, an important area for the trainee anaesthetist, has been incorporated to supplement the physics contained in the contributions on anaesthetic apparatus and monitoring; these chapters also have been revised very substantially, and this reflects the vital importance of a full understanding of all types of equipment employed in anaesthetic practice. The chapter describing the operating theatre environment has been expanded considerably to incorporate essential details of theatre design and to discuss briefly the medicolegal aspects of anaesthetic practice, which is assuming increasing importance worldwide.

Chapters on postoperative care, postoperative pain, local anaesthetic techniques and obstetric anaesthesia and analgesia have also been rewritten. In order to discuss in more detail the management of patients encountered frequently by the trainee anaesthetist, we have introduced new chapters describing anaesthesia for gynaecology, genitourinary and orthopaedic surgery, radiological investigation and radiotherapy. There is also a new chapter on the management of fluid, electrolyte and acid-base balance. We have retained chapters that discuss more complex forms of surgery because trainees may be required to undertake some of these procedures from time to time, albeit under supervision. The appendices have been expanded and revised to provide ready access to detailed information which may be useful during preoperative assessment and management of patients undergoing anaesthesia and surgery.

We are again grateful to our contributors, who have allowed us to undertake widespread revision of manuscripts in an attempt to obtain uniformity of style. We are indebted again to the publishers, Churchill Livingstone, who have arranged for redrawing of the substantial number of new figures. Our gratitude must be recorded to Mrs Rosaleen O'Brien, Principal Secretary in the University Department of Anaesthesia at Leicester, for substantial secretarial work.

We hope that this text will prove as popular as

the first edition, and will be used by trainees as a practical guide in the operating theatre and as the foundation of their theoretical learning. It may be valuable also as an 'aide memoire' for teachers in anaesthesia, and may be appropriate reading for undergraduates who undertake an elective period of training in anaesthesia, and for recovery room nurses.

Nottingham and Leicester, 1990 AA
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Acknowledgements

Many of the figures and diagrams incorporated in the text have been redrawn or modified from original diagrams appearing elsewhere. We therefore gratefully acknowledge permission from authors, publishers and editors in respect of the following:

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Fig. 1.15 *from* Lord Brock 1982 Lung abscess, 2nd edn. Blackwell Scientific Publications, Oxford. Fig. 1.21 *from* Lee, J A, Atkinson R C 1978 Lumbar puncture and spinal anaesthesia. Churchill Livingstone, Edinburgh. Figs 1.3, 1.4, 1.5, 1.10, 1.11, 1.12, 1.13, 1.14, 1.16, 1.17, 1.18, 1.19 and 1.20 *from* Ellis H, Feldman S 1977 Anatomy for anaesthetists, 3rd edn. Blackwell Scientific Publications, Oxford.

Chapter 3
Fig. 3.14 *from* Smith J J, Kampine J P 1980 Circulatory physiology — the essentials. Williams and Wilkins, Baltimore. Fig. 3.15 *from* Guyton A C 1967 New England Journal of Medicine 277: 805. Fig. 3.19 *from* Ledingham I McA, Hanning C D In (eds) Gray, T C, Nunn J E, Utting J F 1980 General anaesthesia, 4th edn. Butterworths, London. Fig. 3.20 *from* Prys-Roberts C 1980 The circulation in anaesthesia. Blackwell Scientific Publications, Oxford.

Chapter 5
Fig. 5.1 *from* Chapnick P 1973 Skin of ourselves. Science, April: 20. Figs 5.14, 5.16, 5.17, 5.28, 5.29 and 5.41 *from* Bell G H, Emslie-Smith D M, Paterson C R 1980 Textbook of physiology, 10th edn. Churchill Livingstone, Edinburgh. Figs 5.2, 5.3, 5.4, 5.5, 5.6 and 5.13 *from* Hendry B 1981 Membrane physiology and cell excitation. Helm Croom. Figs 5.7, 5.8 and 5.9 *from* Maze M 1981 Clinical implications of membrane receptor function in anaesthesia. Anesthesiology 55: 160. Fig. 5.10 *from* Braesrup C 1982 Neurotransmitters and CNS disease anxiety. Lancet 2: 1030. Fig. 5.12 *from* Spero L 1982 Neurotransmitters and CNS disease: epilepsy. Lancet 2: 1319. Figs 5.18, 5.19, 5.21, 5.22, 5.24, 5.25, 5.26 and 5.27 *from* Mitchell G A Essentials of neuroanatomy, 3rd edn. Churchill Livingstone, London. Fig. 5.20 *from* Green J H 1976 An introduction to human physiology, 4th edn. Oxford University Press, Oxford. Fig. 5.36 *from* Ganong W F 1979 Review of medical physiology, 9th edn. Lange Medical Publications, California. Fig. 5.23 *from* Patten J P 1977 Neurological differential diagnosis. Starke, London. Fig. 5.30 *from* Jessel T M 1982 Neurotransmitters and CNS disease: pain. Lancet 2: 1084. Fig. 5.31 *from* Lipton S 1979 The control of chronic pain. Fig. 5.32 *from* Gray T C, Nunn J F, Utting, J E (eds) 1980 General anaesthesia, 4th edn. Butterworth, London. Fig. 5.35 *from* Maynard D B, Jenkinson J L 1984 The cerebral function analysing monitor: initial experience, application and further development. Anaesthesia 39: 678–690. Fig. 5.37 *from* Branthwaite M 1980 Anaesthesia for cardiac surgery and allied procedures. Blackwell Scientific Publications, Oxford.

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Figs 9.1–9.9 *from* Eger E I 1982 Isoflurane (AErrane). Airco Inc.

Chapter 12
Fig. 12.3 *from* Churchill-Davidson H C 1965 Anesthesiology 26: 224.

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Figs 16.3 and 16.18 *from* Parbrook G D, Davies P D, Parbrook E O 1982 Basic physics and measurement in anaesthesia. Heinemann, London. Figs 16.5, 16.13 and 16.21 *from* Mushin W, Jones P L 1987 Macintosh, Mushin and Epstein's Physics for the anaesthetist, 4th edn. Blackwell Scientific Publications, Oxford. Fig. 16.6 *from* Ward C S 1985 Anaesthetic equipment: physical principles and maintenance, 2nd Edn. Baillière Tindall, Eastbourne.

Chapter 17
Figs. 17.5, 17.6, 17.9 and 17.27 *from* Ward C S 1985 Anaesthetic equipment: physical principles and maintenance, 2nd Edn. Baillière Tindall, Eastbourne. Fig. 17.17. Courtesy of Penlon Limited. Figs 17.20 *from* Mapleson W W 1960 The concentration of anaesthetics in closed circuits with special reference to halothane. 1: Theoretical study. British Journal of Anaesthesia, 32: 298. Fig. 17.36 by courtesy of Colgate Medical Ltd.

Chapter 20
Fig. 20.2 *from* Atkinson R S, Rushman G B, Lee J A 1982 A synopsis of anaesthesia, 9th edn. John Wright, Bristol. Fig. 20.3 *from* Lichtiger M, Moya F (eds) 1978 Introduction to the practice of anaesthesia, 2nd edn. Harper and Row, Hagerstown, Maryland.

Chapter 21
Figs 21.6 and 21.7 *from* Kidd J F 1988 Pulse oximeters: basic theory and operation. Care of the Critically Ill 4: 10. Fig. 21.9 *from* Ward C S 1975 Anaesthetic equipment: Physical principles and maintenance. Baillière Tindall, Eastbourne. Fig. 21.20B *from* Hinds C J 1987 Intensive care: a concise textbook. Baillière Tindall, Eastbourne. Fig. 21.22 *from* Huch R, Huch A 1976 Transcutaneous non-invasive monitoring of PO_2. Hospital Practice 2: 43. Fig. 21.26 *from* Simpson J C 1981 Monitoring during Anesthesia for Cardiac Surgery. In: Gerson G R (ed) Monitoring during Anesthesia. International Anesthesiology Clinics 19 (1): 137. Tables 21.6 and 21.7 *from* Sykes M K 1987 Essential monitoring. British Journal of Anaesthesia 59: 901.

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Figs 24.2 and 24.5 *from* West J B 1977 Pulmonary Pathophysiology — The Essentials. Blackwell Scientific Publications, Oxford.

Chapter 25
Fig. 25.1 *from* Hannington-Kiff J G 1981 Pain, 2nd edn. Update Publications Limited, London. Fig. 25.2 *from* Austin K L, Stapleton J V, Mather L E 1980 Multiple intramuscular injections: A major source of variability in analgesic response to meperidine. Pain 8: 47.

Chapter 26
Fig. 26.4 *from* Lichtiger M, Moya F (eds) 1978 Introduction to the practice of anesthesia, 2nd edn. Harper and Row, Hagerstown, Maryland. Figs 26.11 and 26.13 *from* Wildsmith J A W, Armitage E N (eds) 1987. Principles and practice of regional anaesthesia. Churchill Livingstone, Edinburgh. Fig. 26.12 *from* Ellis H, Feldman S 1977 Anatomy for anaesthetists, 3rd edn. Blackwell Scientific Publications, Oxford. Fig. 26.15 *from* Moore D C 1979 Regional block, 4th edn. Charles C. Thomas, Springfield, Illinois.

Chapter 30
Fig. 30.1 Courtesy of Siemens Limited.

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Fig. 33.1 *from* Moir D D 1976 Obstetric anaesthesia and analgesia. Ballière Tindall, London.

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Fig. 37.2 *from* Cole P In: Langton Hewer C, Atkinson R S 1979. Recent advances in anaesthesia and analgesia, Vol. 13. Churchill Livingstone, London.

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Fig. 38.3 *from* Kitahata L M, Galicich J H, Sato I 1971 Journal of Neurosurgery 34: 185.

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Fig. 44.1 *from* Feldman S, Ellis H 1975 Principles of resuscitation, 2nd edn. Blackwell Scientific Publications, Oxford. Figs 44.2 and 44.3 *from* Gilston A, Resnekov L 1971 Cardiorespiratory resuscitation. William Heinemann, London.

Appendix XI(b) *from* Cotes J E 1979 Lung function, 4th edn. Blackwell Scientific Publications, Oxford.

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Contents

1. Anatomy

A knowledge of anatomy is important to the anaesthetist. In the conduct of anaesthesia it is required to enable him to cannulate veins and arteries, to undertake laryngoscopy for tracheal intubation or to undertake bronchoscopy for removal of aspirated material. It is also essential to know the anatomy relating to local anaesthetic nerve blocks. In addition, a sound knowledge of anatomy is necessary in cardiopulmonary medicine and to understand the surgeon's techniques and requirements.

Clearly, this short chapter cannot cover all the anatomical knowledge required of the anaesthetist. Its purpose is to describe in detail only those aspects relevant to the conduct of general anaesthesia and spinal anaesthesia and to,indicate areas for further study in the standard textbooks of anatomy.

VENEPUNCTURE

Upper limb

The valved superficial veins form varying patterns, but the common arrangements are shown in Figures 1.1 and 1.2.

The arrangement of the arteries is less varied than that of the veins. However, developmental anomalies do occur and it is wise to inspect and palpate for arterial pulsation before undertaking venepuncture. An 'ulnar' artery may leave the brachial artery in the arm and, passing superficial to the common attachment of the superficial flexor muscles of the forearm, lie immediately deep to the median basilic vein — without the intervention of the bicipital aponeurosis. Similarly a 'radial' artery may arise proximally and be situated superficially in the forearm.

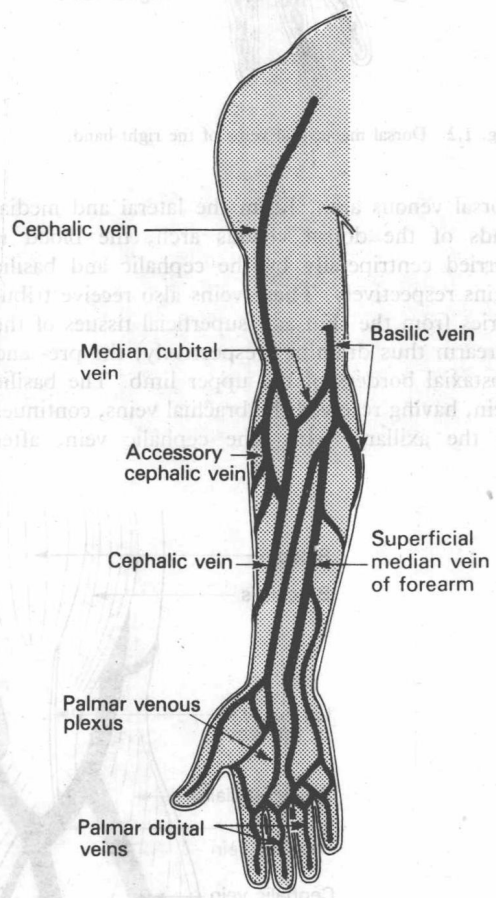

Fig. 1.1 Superficial veins of the right upper limb.

Metacarpal veins, lying superficially on the back of the hand, drain blood from the digits and hand (Fig. 1.2). These veins join together to form the

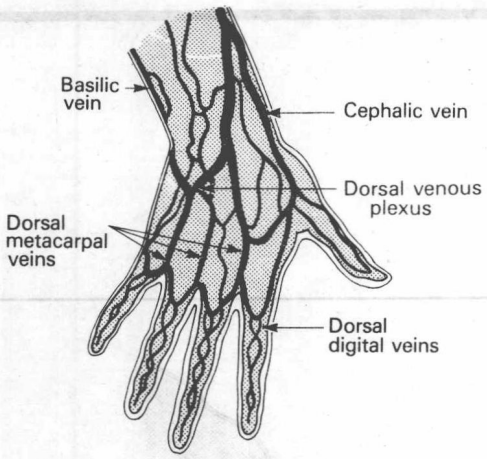

Fig. 1.2 Dorsal metacarpal veins of the right hand.

dorsal venous arch. From the lateral and medial ends of the dorsal venous arch, the blood is carried centripetally by the cephalic and basilic veins respectively. These veins also receive tributaries from the skin and superficial tissues of the forearm thus draining, respectively, the pre- and postaxial borders of the upper limb. The basilic vein, having received the brachial veins, continues as the axillary vein. The cephalic vein, after passing through the deltopectoral groove, drains into the axillary vein

Venepuncture may be performed at the following sites:

1. On the back of the hand and lateral aspect of the wrist in one of the dorsal metacarpal veins (Fig. 1.2).
2. On the anterior aspect of the forearm in the cephalic or median veins (Fig. 1.1), or one of their tributaries. Usually there are useful veins also on the posterior aspect.

It is preferable to cannulate veins on the back of the hand and on the forearm rather than those at the elbow because the cannula may be secured more easily in situ.

When a venepuncture is to be made at or below the elbow greater venous distension can be obtained in an obstructed vein if the front of the forearm is massaged by firm pressure from the wrist upwards. This delivers blood from the superficial veins and from the deep (communicating) vein (Fig. 1.3) which drains the deeper structures of the forearm. A conscious patient should be asked to flex and extend the digits forcibly several times and then to clench the fist firmly. Subsequently the forearm should be massaged from the wrist upwards.

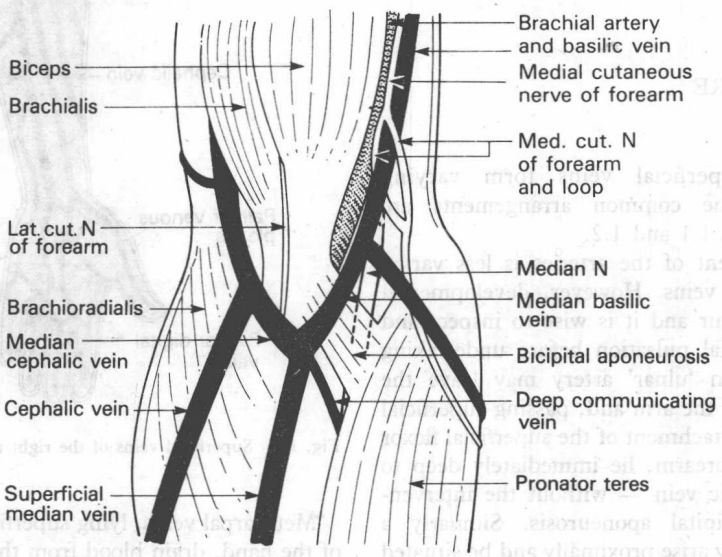

Fig. 1.3 Veins at the right elbow.

3. At the elbow in either the median cephalic or median basilic vein (Fig. 1.3). Usually the median basilic vein is the larger and more mobile of the two, but, if used inexpertly, there may be complications. If the needle is inserted too deeply, it may pass through the bicipital aponeurosis and penetrate the brachial artery. The pulsation of this artery can be felt immediately medial to the tendon of the biceps. Medial to the brachial artery lies the median nerve. An anomalous ulnar artery may lie just deep to the median cubital vein and be at risk if the vein is penetrated too deeply. Withdrawal of arterial blood in a pulsatile stream indicates that this has happened.

The medial cutaneous nerve of the forearm divides into its anterior and posterior branches at the elbow (Fig. 1.3) and sometimes these loop around the median basilic vein. Thus perivenous piercing with the needle, extravasation of fluid, or the occurrence of a haematoma at this site may damage nerve fibres and in the conscious patient cause acute pain along the inner border of the forearm.

4. Below the clavicle in the subclavian vein (Fig. 1.4). Use of the right subclavian rather than the left provides easier access to the superior vena cava and right atrium. The subclavian vein — the continuation of the axillary — runs from a point just below and medial to the midclavicular point. From here it arches upwards, then, passing downwards and forwards (Fig. 1.5) it joins the internal

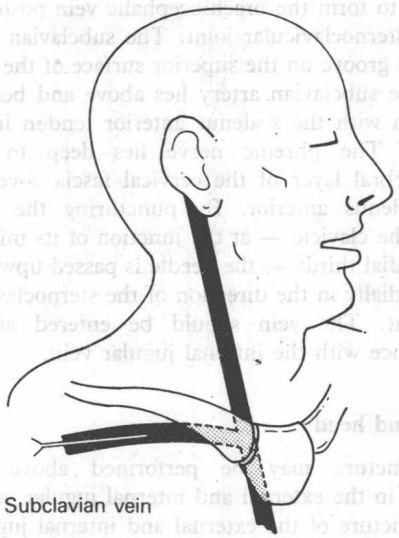

Fig. 1.4 Right subclavian and jugular veins.

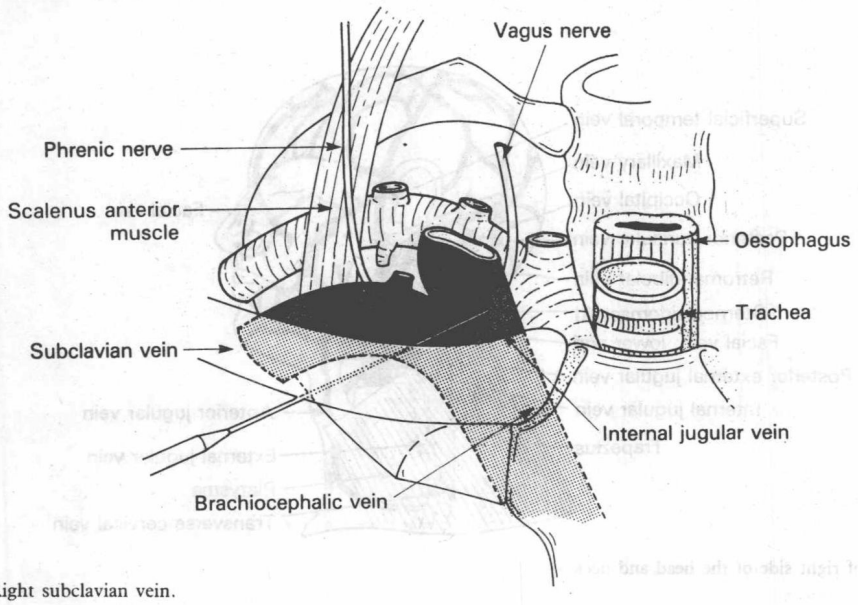

Fig. 1.5 Right subclavian vein.

jugular to form the brachiocephalic vein posterior to the sternoclavicular joint. The subclavian vein lies in a groove on the superior surface of the first rib. The subclavian artery lies above and behind the vein with the scalenus anterior tendon intervening. The phrenic nerve lies deep to the prevertebral layer of the cervical fascia covering the scalenus anterior. By puncturing the skin below the clavicle — at the junction of its middle and medial thirds — the needle is passed upwards and medially in the direction of the sternoclavicular joint. The vein should be entered at its confluence with the internal jugular vein.

Neck and head

Venepuncture may be performed above the clavicle in the external and internal jugular veins. For puncture of the external and internal jugular veins the patient should be lying in a slight Trendelenburg position with the head turned away from the side of puncture. This position provides easy access to and distension of the veins and minimises the risk of air embolism. Finger pressure just above the middle of the clavicle also produces distension of the external jugular vein.

The external jugular vein, receiving blood from the scalp and face, is formed by the union of the posterior auricular vein and the posterior division of the retromandibular vein (Fig. 1.6). It runs vertically downwards from just behind the angle of the mandible to pass posterior to the clavicle lateral to the sternocleidomastoid muscle, where it terminates in the subclavian vein. In its course it lies deep to the skin and the platysma muscle, and superficial to the investing layer of the deep cervical fascia and sternocleidomastoid muscle. Puncture of the vein should be made one finger's breadth above the clavicle.

The internal jugular vein (Figs 1.6 and 1.7) is the continuation of the sigmoid sinus. It runs from its superior bulb (dilation) just below the base of the skull to terminate posterior to the sternoclavicular joint, where its inferior bulb is joined by the subclavian vein to form the brachiocephalic vein. The internal jugular lies deep to the sternocleidomastoid muscle on the lateral side of the internal and common carotid arteries (Fig. 1.8).

It is safest to puncture the internal jugular vein using a 'high approach'. A common technique is to approach the vein at the apex of the triangle formed by the sternal and clavicular heads of sternocleidomastoid muscle (Fig. 1.8). This is found usually at the level of the cricoid cartilage. At this point a needle is directed downwards at an angle of 30° to the skin in the direction of the ipsilateral nipple. If the internal jugular vein is not encountered, the needle is redirected medially.

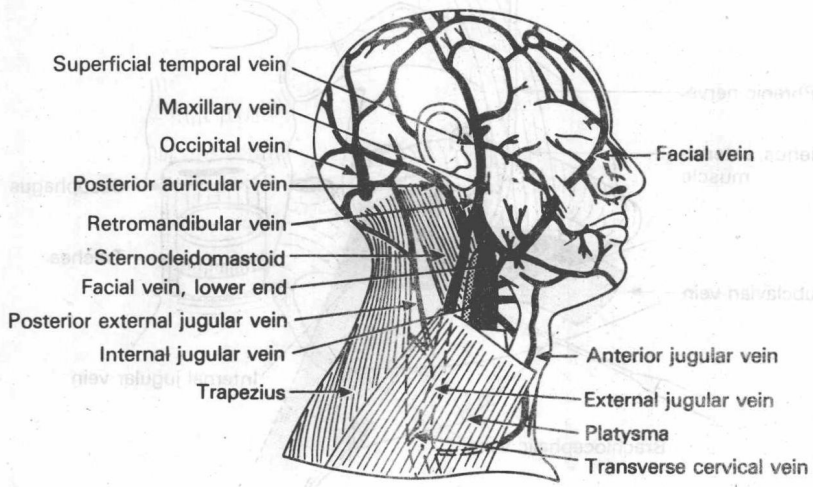

Fig. 1.6 Veins of right side of the head and neck.

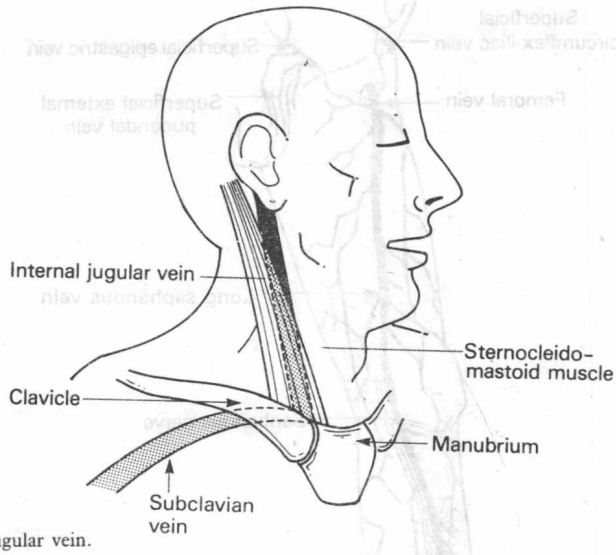

Fig. 1.7 Right internal jugular vein.

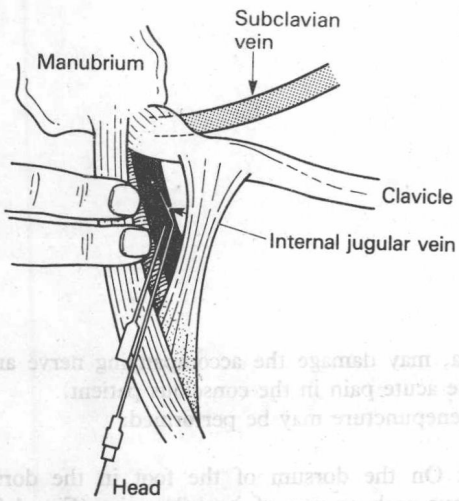

Fig. 1.8 Approach to the right internal jugular vein. Catheter inserted through cannula.

Complications include puncture of the common carotid artery, branches of the costocervical trunk, or the thoracic duct (on the left side) and damage to the sympathetic trunk. The 'high approach' reduces the chance of injury to the pleura and lung.

On the right side, cannulation of the right atrium is easy because the right internal jugular vein, brachiocephalic vein, superior vena cava and right atrium lie almost in a straight line.

Lower limb

There are several different patterns of the superficial saphenous system. Various direct and indirect communications exist between the long (great) and short (small) saphenous veins (Fig. 1.9). Throughout their courses these veins both receive tributaries from the skin and subcutaneous tissues and also give off perforating branches which join the deep veins. The perforating veins normally convey blood from the superficial to the deep system. All the veins of the lower limb have bicuspid valves which are arranged so that blood is directed towards the heart. The flow of blood may be reversed when varicosity of the veins is present.

Dorsal metatarsal veins, which receive blood from the toes, run together to form a dorsal venous arch which lies across the foot over the heads of the metatarsal bones. This dorsal network of veins also receives blood from the sole and sides of the foot. The medial end of the dorsal venous arch is continued as the long saphenous vein; the lateral end continues as the short saphenous. These veins respectively mark the pre- and postaxial borders of the lower limb.

The long saphenous vein lies with the

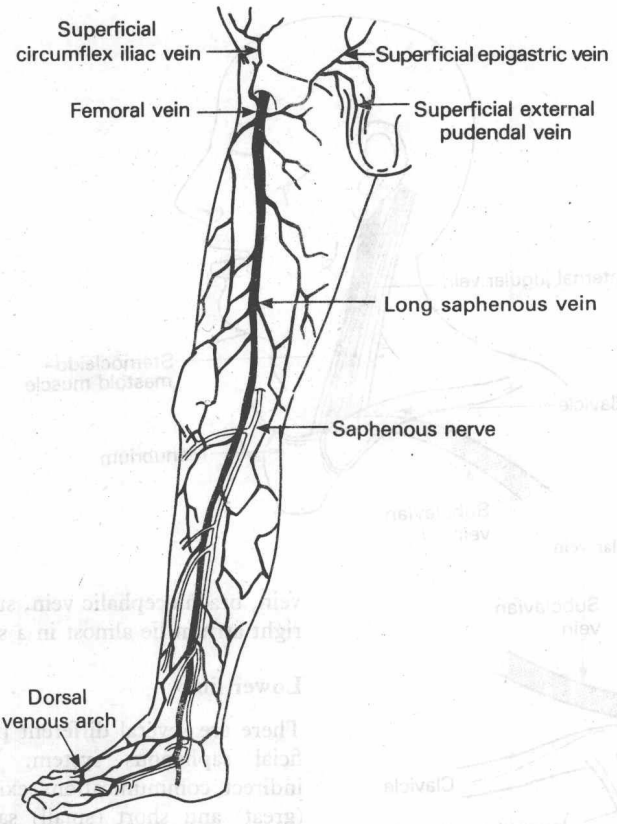

Fig. 1.9 Superficial veins of the right lower limb.

saphenous nerve immediately anterior to the medial malleolus at the ankle (Fig. 1.9). As the vein ascends (still accompanied by the saphenous nerve) along the medial side of the leg, it passes obliquely across the lower part of the tibia to become posteromedial at the medial condyles of the tibia and femur. From here, often accompanied by branches of the medial femoral cutaneous nerve, the vein passes upwards and obliquely forwards to pass through the saphenous opening of the deep fascia (which lies two finger breadths below and lateral to the pubic tubercle) to enter the femoral vein, which lies medial to the femoral artery. When puncturing the long saphenous vein, any perivenous probing with the needle or spread of injection fluid, or the occurrence of a haematoma, may damage the accompanying nerve and cause acute pain in the conscious patient.

Venepuncture may be performed:

1. On the dorsum of the foot in the dorsal venous arch or one of its tributaries (Fig. 1.9). This provides the best site in the lower limb for i.v. infusions in the operating theatre.
2. On the anteromedial aspect of the leg using either the long saphenous vein or one of its tributaries (Fig. 1.9). The saphenous vein has a thick wall and therefore a sharp needle is required. The lowest part of the vein, in its own fascial sheath, lies in direct contact with the periosteum over the tibia and care should be taken to avoid injuring these structures.