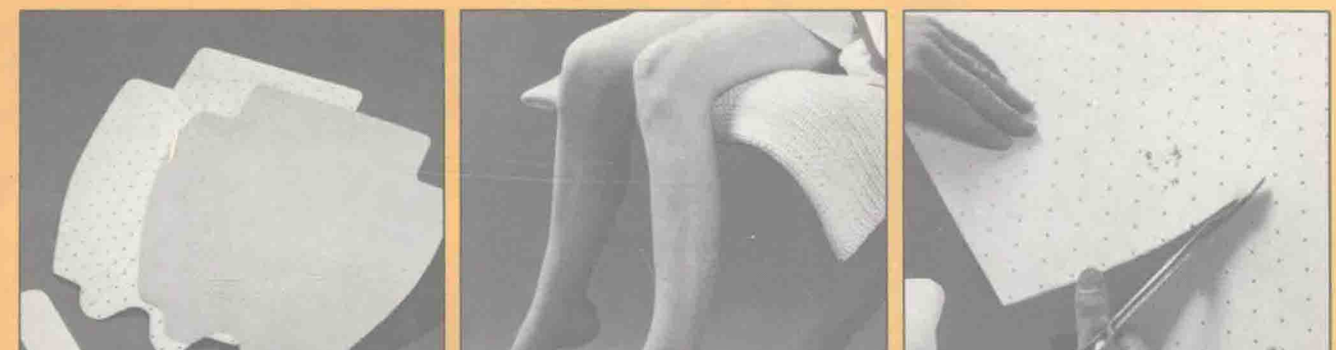
MANUAL OF FRACTURE BRACING



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with illustrations by R.S. Barnett

Churchill Livingstone

Manual of Fracture Bracing

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Churchill Livingstone
EDINBURGH LONDON MELBOURNE AND NEW YORK 1985

CHURCHILL LIVINGSTONE
Medical Division of Longman Group 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 published 1985

ISBN 0 443 02691 2

British Library Cataloguing in Publication Data

Hall, A.J.
Manual of fracture bracing.
1. Fracture fixation 2. Orthopedic braces
I. Title II. Stenner, R.W.
617'.15 RD101

Library of Congress Cataloging in Publication Data

Hall, A.J. (Anthony John)
Manual of fracture bracing.

Bibliography: p.
Includes index.
1. Extremities (Anatomy)—Fractures—Treatment.
2. Orthopedic braces. I. Stenner, R.W. II. Title.
[DNLM: 1. Fracture fixation—Methods—Handbooks.
2. Braces—Handbooks. WE 39 H174m]
RD551.H35 1984 617'.158 84-4980

Printed in Hong Kong by
Sheck Wah Tong Printing Press Ltd

Preface

This book is intended to provide a practical guide to the application of functional fracture braces. It is hoped that it will prove to be of interest to the many people involved in fracture treatment including doctors, nurses, plaster technicians and orthotists. The burgeoning interest in bracing techniques has arisen from the combined effects of the pressure on orthopaedic beds and the need to reduce the length of stay in hospital following fractures on the one hand, and on the other, the growing expectancy of the general public for rapid return to functional activity. There is ample evidence in the literature of the efficacy of bracing techniques, but information on the practical aspects of fracture bracing application is sparse. We have provided a list of suggested further reading, but the majority of the book is devoted to the method of applying the braces. The applications described and illustrated in the text have been in use in our unit over the past 10 years and have been found satisfactory. However, as our interest in the subject has grown, we have had the opportunity of observing other experts in the field who use different methods. Nevertheless, we believe that the principles described are sound, and that armed with these, the reader will be able to develop and adapt the techniques to the best advantage of his or her own unit.

The constant endeavour of the manufacturers to improve on their products is almost certain to result in omissions and inaccuracies in the chapter on materials, but we hope that all the generic types of material have been included and that the inaccuracies will be confined largely to the handling characteristics of the materials. The reader is encouraged to refer to the appendix of manufacturers to obtain the latest information.

No book can be produced without the co-operation and assistance of others and this book has been particularly demanding in this respect. We would like to thank all these people, especially our patients, who have participated in our endeavours and have encouraged us in this enterprise. Some of them are illustrated in the following pages, many are not, but participated just the same by allowing us to photograph the various stages of their fracture treatment.

Our secretarial assistance has been ably provided by Mrs Joyce Sasson and Mrs Amanda Slade who have devoted themselves to the task of typing and retyping the text with cheerful dedication. We are pleased also to acknowledge the help and assistance of the student nurses at Charing Cross Hospital who acted as models for some of the illustrations. Finally we should like to make special mention of Mr R.S. Barnett who has devoted many hours of his spare time to produce the illustrations for this book. His professional expertise and attention to detail has been outstanding.

A.J.H.
R.W.S.

Contents

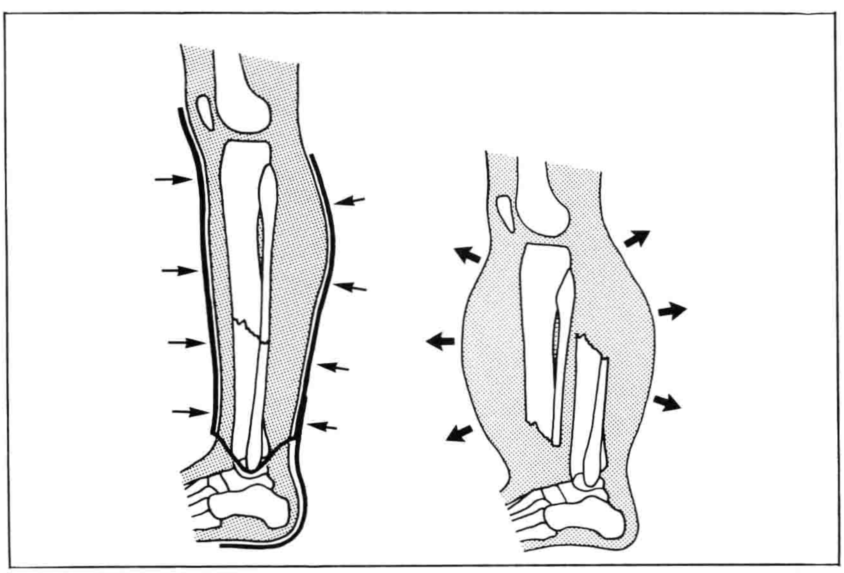
1 Principles

The fracture brace is an external splint which can be applied to a fractured limb in such a way as to provide adequate support for the fracture whilst permitting maximum function of that limb until union is complete. The main applications are in the upper and lower limb though it might be argued that spinal braces could be considered a form of fracture bracing when used for the treatment of vertebral fractures.

In most instances, the fracture brace should be regarded as the second stage of management of a fracture. In the later chapters of this book, the application of fracture bracing in specific fractures will be described, but the guiding principle must be that the primary treatment of the fracture should be adequate. The brace will not correct malalignment nor will it compensate for any inadequacies in the initial treatment; for example, in the treatment of fractures involving joint surfaces. Providing the initial reduction of the fracture is satisfactory, there will be no significant increase in angulation nor will there be any significant shortening in the brace. In over 500 tibial fractures, Sarmiento found that 92% had less than 5° of angular deformity and the average shortening was 6.7 mm.

It seems likely that the brace works by supporting the soft tissues of the limb. The leg cannot shorten without an increase of circumference which is prevented by the closely applied and rigid walls of the brace (Fig. 1.1). If the primary treatment of fractures is not affected by the subsequent use of the fracture brace, why should one consider using the brace at all? Bracing does not reduce the time a fracture takes to unite, though it does appear to reduce the incidence of delayed union, and non-union seems to be much less common after fracture bracing. This effect may merely reflect the selection of more favourable cases for fracture bracing, though the successful treatment of patients referred to the authors for treatment of delayed and established non-union by fracture bracing would tend to discount this.

Fig. 1.1
To show how the brace prevents shortening by supporting the soft tissue.



The most tangible benefits of this method of treatment are the reduction in disability caused by prolonged immobilization in traction or in a full-length plaster cast and a dramatic reduction in the length of rehabilitation following a fracture. Thus a patient with a fractured femur can be mobilized at 6 weeks, discharged from hospital at 8 weeks in a femoral brace, with a fairly confident prediction that the fracture can be expected to be fully united at 12 weeks with a good if not full range of hip, knee and ankle movements.

For the uncomplicated tibial fracture the benefits are even more impressive. Such a patient could have a closed reduction and be discharged from hospital in the usual way after 2–3 days in a full-leg plaster cast. At 2 weeks, on the patient's return visit to the fracture clinic, this plaster cast can be removed and a tibial brace applied without anaesthetic, partial weight-bearing can be started immediately and the patient can be expected to be fully weight-bearing by 6 weeks when, if he is a sedentary worker, he can return to work (Fig. 1.2). On removing the brace at 12 weeks, knee and ankle movements will be almost full and little or no physiotherapy is required to remobilize the patient. Although muscle wasting occurs with any fracture, it is far less

Fig. 1.2a & b Patient with segmental fracture of the tibia wearing a tibial brace which is undetectable under his clothes and permits reasonably full activity whilst the fracture unites.

marked when the patient has been able to use his limb almost normally throughout the period of treatment.

The use of the external functional brace is not confined to simple fractures treated by closed reduction. There are many circumstances in which internal fixation may be inadequate to permit full weight-bearing without some form of external support. In these cases the fracture brace provides the ideal form of protection since it permits the full use of the adjacent joints without undue stress on the metallic implant. In the severely compound fracture, the improved external fixators currently available have dramatically improved the prospects for wound healing when there has been gross tissue damage, but their excessive bulk does not lend itself to full functional activity, and furthermore, prolonged application tends to delay fracture union, providing another situation in which the functional brace is the ideal second stage of management once wound-healing is complete.

HISTORICAL BACKGROUND

Examples of external splinting of fractures have been discovered from the time of the 5th Egyptian Dynasty some five thousand years ago. Hypocrates also taught the principles of external splinting over two thousand years ago (Fig. 1.3).

Traction suspension methods of reducing and treating fractures of the femur seem to have been introduced in the fourteenth century, and by the seventeenth century, a large variety of external appliances were being manufactured from steel and leather for various orthopaedic deformities.

Scientists in the nineteenth century produced some of the most profound changes in the management of fractures. John Hilton (1804–

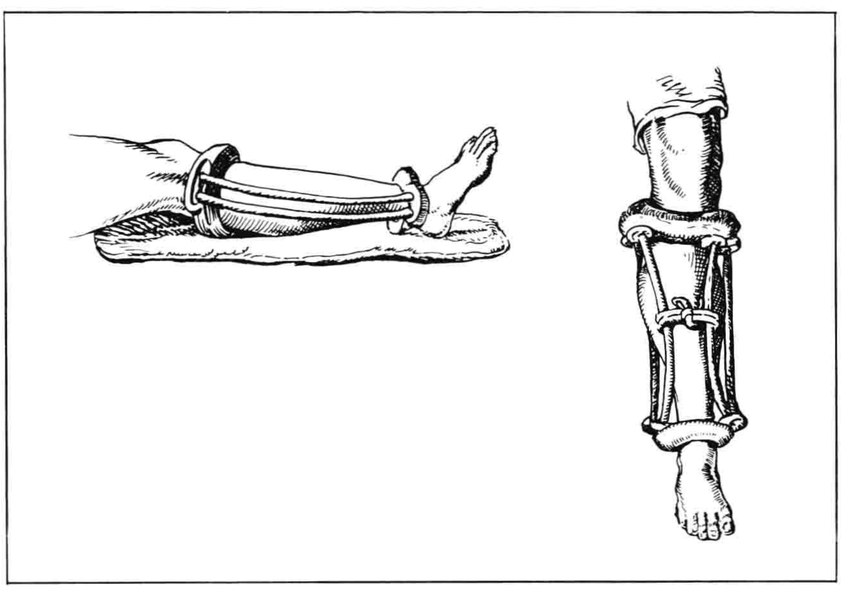


Fig. 1.3
Tibial brace from Hypocratic era.

1878) advocated the principle of absolute rest in the care of surgical cases. Hugh Owen Thomas (1834–1891) extended Hilton's principle to the management of fractures. In the same century X-rays were discovered by Roentgen and used to show fractures, and a method of impregnating bandages with plaster of Paris was introduced by Mathijsen.

The recent history of fracture bracing

Early weight-bearing for fractured tibiae was advocated early in the twentieth century by Championniere, but it was not until Sarmiento's paper in July 1967 that the concept gained general acceptance. From his experience with patellar tendon bearing prostheses for below knee amputees, Sarmiento developed a close-fitting patellar tendon bearing plaster cast for the treatment of tibial fractures. He advocated conventional primary treatment of the fractures until the swelling had subsided, after which a tight-fitting plaster was applied with careful moulding about the patellar tendon to permit full weight-bearing at an early stage and full movement of the knee. Sarmiento has extended his bracing techniques and has described a functional brace for fractures of the ulna and a brace for fractures of the humerus.

In December 1970, Mooney, Nichols, Harvey and Snelson described a close-fitting plaster of Paris brace with metal knee hinges for use in femoral fractures after approximately 6 weeks in traction. This brace permitted the patient to walk approximately 6 weeks earlier than he would have normally expected to do so. It reduced the time taken for union of the fracture and in the series of 150 cases presented, it abolished non-union. Time spent in hospital was reduced and the use of the hip spica was avoided.

Much of the material in this book is based on the authors' experience of Sarmiento's techniques and the techniques described by the team from Rancho Los Amigos Hospital, California, whose pioneering work we wish to gratefully acknowledge.

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2 Indications

As this book is intended as a practical guide, the indications for fracture bracing will be discussed in this chapter in order to maintain clarity in the chapters devoted to the treatment of specific fractures.

LOWER LIMB BRACING

Although there are useful applications of fracture bracing in the upper limb, the improvement of splinting of lower limb fractures by the use of a brace is far more beneficial to the patient and his surgeon, mainly because it allows earlier weight-bearing.

Ankle fractures

Fracture bracing has no important part to play in ankle fractures because those fractures which do not require internal fixation usually unite rapidly and are safely managed in below-knee walking plasters. In the more severe fractures, importance of accurately re-aligning the joint by internal fixation is well recognised and if splintage is required post-operatively, the below-knee walking plaster usually suffices. Recent trends towards early mobilization of joints after operative treatment may encourage efforts to produce a satisfactory ankle brace, but as yet none has been described.

Tibial fractures

The ideal tibial fracture for bracing is a closed spiral fracture of the middle third of the tibia with an associated fibular fracture which has been adequately reduced and immobilized in a long leg non weight-bearing plaster for 2 weeks. At this stage the plaster cast can be removed in the fracture clinic without an anaesthetic and a tibial brace substituted. Since the efficacy of the tibial brace depends upon its close application to the limb, it is not possible to apply the brace to an acute fracture, since padding would allow movement to take place when the swelling subsided and a close fitting brace on an acute fracture would result in undesirable vascular complications. At 2 weeks most patients can tolerate the small amount of movement which takes place at the fracture site when the long leg plaster is removed and the tibial brace substituted. As soon as the brace is applied, the patient is encouraged to start partial weight-bearing and patients who are reluctant to weight-bear are instructed to attend the physiotherapy department until they have overcome their reluctance.

Although the ideal fracture has been described, most fractures of the tibia, not involving the upper or lower joint surfaces, can be treated in this way, providing the initial fracture is closed.

Fractures of the proximal 3 inches of the tibia may be difficult to control in a tibial brace, particularly in a fat patient, in which case a femoral brace with knee hinges should be applied.

In compound fractures of the tibia the emphasis must be on wound-healing, which should be complete before the brace is applied. Minor lacerations caused by fragments of bone penetrating from within can usually be managed by primary suture and the application of a long leg cast, but when there is a major compound injury a thorough wound excision should be carried out. The choice of primary immobilisation is largely a matter of individual preference, which may range from the application of a long leg plaster with a removable window for inspection of the wound, to calcaneal traction with the limb suspended on a Braun frame or an external fixator. Alternatively, the surgeon may decide upon internal fixation either by plating or an intramedullary Kuntscher nail. If internal fixation is employed, it may sometimes be possible to do without external support for the limb whilst the patient is mobilised, but usually some form of external support is required and the tibial brace provides the ideal form of splintage. The external fixator has greatly facilitated the management of severe compound tibial fractures, but it is an unwieldy apparatus in which to mobilise the patient, and since union in these injuries is likely to be delayed, the substitution of the external fixator by a tibial brace once wound-healing is complete provides an ideal solution.

Fractures of the tibia with an intact fibula have a deservedly bad reputation because of their tendency to unite in varus and internal rotation. In addition, union may be delayed in these fractures due to the distraction effect of the fibula. Nevertheless, the authors have found that application of a tibial brace at 2 weeks in these fractures has not adversely affected the prognosis and there is a clinical impression that union progresses more rapidly if the patient is treated by early ambulation in a fracture brace.

It cannot be over-emphasised that the primary treatment of the fracture must be adequate. If the initial reduction is unsatisfactory and there is unacceptable angulation at the fracture site at the time of application of the tibial brace, the patient will not be comfortable and will be reluctant to walk in the apparatus, and the angulation will increase within the brace. Thus at 2 weeks, if X-rays show that the fracture is not correctly aligned in the long leg plaster cast, the alignment should be corrected by a further reduction or by wedging of the plaster or alternatively by internal fixation. The tibial brace can then be applied after a further 2 weeks of conventional immobilisation.

Fractures involving the knee joint

The guiding principle for fractures involving the articular surface of the knee should be to restore the joint surfaces as accurately as possible by open reduction and internal fixation with the appropriate device. Where sub-articular cancellous bone has been compressed, bone grafting may be required to support the repositioned articular surface. After the operative treatment of these fractures, the surgeon frequently faces a dilemma, because in all but the simplest fractures, the internal fixation cannot be relied upon to permit early weight-bearing without detriment to the joint surfaces. This is particularly true in the elderly. A simple plaster cylinder affords satisfactory protection but has the undesirable effect of immobilising the knee joint. Alternatively the patient may be allowed to mobilise gently in bed which takes up valuable hospital resources. On the other hand a femoral brace with knee hinges makes it possible to mobilise the patient at an early stage and prevent damage to the joint surfaces whilst the patient bears weight on the affected limb.

It should be stressed that the brace cannot be used as an alternative to operative restoration of the joint surface with adequate internal fixation, since although alignment of the joint can be restored by the use of the brace, deformity will recur as soon as it is removed due to the loss of anatomical integrity of the joint surfaces.

Fractures of the femur

Fractures of the middle and distal thirds of the femur are amenable to treatment in a femoral brace. The main advantages of femoral bracing are a reduction of the period of hospital in-patient care and a more rapid rehabilitation following the fracture. Once again the primary treatment of the fracture must be adequate and if the primary treatment is to be traction, good alignment of the fracture is important. The femoral brace should be applied at 6 weeks by which time the fracture will be sufficiently 'sticky' to remove the skeletal traction and apply the fracture brace without an anaesthetic. If the primary treatment of the femoral fracture has been internal fixation, it may well be possible to mobilise the patient without external fixation. However, when internal fixation is less than ideal, a femoral brace can provide protection of the fracture until union is complete.

Fractures of the proximal third of the femur

In general most fractures of the proximal femur are best treated by internal fixation, either by pin and plate or by intramedullary devices such as the signal arm. But when internal fixation is less than adequate, or when the primary treatment has been traction, bracing can be provided by means of a femoral brace with the addition of a pelvic band made from a modified lumbar corset.

UPPER LIMB BRACING

Fractures of the humerus

Fractures of the humeral neck can be treated by simple collar and cuff slings, and early pendulum exercises give very satisfactory results.

Fractures of the humeral shaft with or without radial nerve involvement are not so easy to manage by conventional means. Use of a simple sling does not prevent painful fracture movements and frequently results in malunion or even non-union. The sugar tongs plaster can be extremely useful, but it is difficult to apply in fat patients, it is cumbersome to the patient and does not permit movement at the elbow. The authors have found that the humeral brace is the most useful upper limb splint. Whereas in the lower limb braces can be made from plaster of Paris or thermoplastic sheeting materials, plaster of Paris bandaging is not appropriate for humeral braces, for the following reasons: humeral shaft fractures are one of the few indications for an immediate application of a brace in order to provide the patient with immediate release of pain from the fracture. The thermoplastic sheeting is applied in such a way as to allow for adjustment when swelling occurs. A plaster brace would have to be padded to accommodate such swelling and would therefore not provide adequate support. The light weight of the thermoplastic material makes it easy to suspend from the shoulder by contouring it over the deltoid. The lightness of the brace combined with its lack of bulk and firm support of the fracture enables the patient to move the limb from the outset, which is a distinct advantage over other forms of humeral splinting. 'Reduction' of the fracture is achieved by allowing the arm to hang by the patient's side with the elbow extended whilst the brace is applied and, for the first few days at least, a sling is also used to provide additional support, although exercising the arm out of the sling is encouraged from day 1.

Supracondylar fractures

These fractures are best treated in conventional ways. In children, closed reduction with meticulous attention to the potential dangers of vascular complications, or open reduction when an unacceptable degree of valgus or varus deformity persists, is followed by a period of 3 weeks of splinting in a flexed position, usually with a backslab. In adults these fractures frequently involve the joint surfaces, when there is usually an indication for internal fixation, unless there is gross comminution in which case early mobilisation on the 'bag of bones' principle may be employed. Hinged elbow braces have been made on special occasions where there has been difficulty in maintaining the alignment of the elbow joint, but indications for these specialised braces have been few and our experience with them is limited.

Forearm fractures

There are no indications for fracture bracing in radial head and neck fractures. Fracture dislocations such as the Monteggia fracture or the Galeazzi fracture are best treated by internal fixation of the fractured bone and reduction of the dislocated joint. When both forearm bones are fractured a satisfactory reduction should be obtained by conventional methods, with the emphasis on accurate reduction. In adults internal fixation may be necessary, whereas in children, apposition of the fractured bone ends with reasonable alignment is usually acceptable. After 2 weeks immobilisation in an above elbow plaster, a forearm brace can be applied. This brace is designed so as to restrict movement at the elbow and to prevent pronation or supination of the forearm. This is a useful brace as it provides protection of the fracture whilst permitting a considerable amount of functional activity on the part of the patient.

Colles' fracture

Although a Colles' brace has been described, the authors find little use for this brace in clinical practice and indeed if the criteria for the application of braces in other fractures were applied to the Colles' fracture, many would fail to qualify for bracing, on the grounds that the initial reduction is less than satisfactory. When the initial reduction has been good and the subsequent immobilisation has been held in a properly applied Colles' plaster for 5 weeks, very little disability results. We do not feel that a brace could be designed which would cater for the two most common errors in Colles' fracture management, namely, failure of the initial reduction and failure to maintain that reduction when the swelling subsides.