MODERN TRENDS

IN

ORTHOPAEDICS

3

FRACTURE TREATMENT

Edited by

JOHN M. P. CLARK, M.B.E., M.B., F.R.C.S.

Orthopaedic Surgeon, General Infirmary, Leeds; Consultant Orthopaedic Surgeon, Pinderfields Hospital, Wakefield, Senior Clinical Lecturer in Orthopaedics, University of Leeds

LONDON

BUTTERWORTHS

1962

Printed in Great Britain by
The Whitefriars Press Ltd.
London and Tonbridge

PREFACE

What hempen home-spuns have we swagg'ring here,
So near the cradle of the Fairy Queen?

It is not the intention here to produce yet another textbook on the subject of fractures, because this field has already been admirably covered. Such books, by definition, aim at assisting undergraduates and men reading for higher degrees and diplomas, and they must necessarily be didactic to the point of over-simplification in order to make a clearing in the forest of tangled information and thought. But there can be no absolute rules governing the practice of a craft. Equally good results may be obtained by different craftsmen pursuing paradoxical techniques always provided that fundamental principles be not offended.

The reader to whom it is hoped that this collection of essays will make a particular appeal is the man who is beginning to take responsibility for the treatment of injuries only to realize that the problems presented to him have the knack of avoiding the neat solutions purveyed in the dramatically clear recipes of the dogmatist. A precise understanding of the basic truths of the matter is essential and must always be the sheet anchor to which the mind will revert in any difficulty. The attractiveness of a new fashion, or of the apparent expediency of a much advertised method, may well obscure the real issue until the incidence of complications shall reveal how the unwary tyro succumbed to the blandishments of Vanity Fair. The very plausibility of airy empiricism, or of the triumph of technique over reason, ought to sound a note of warning loud enough to make even the most injudicious take stock and recall how dearly has the experience of his seniors been bought.

At any meeting of a professional society or association it is common to observe what a contrast there is between the conduct of the meeting in the hall and the vigorous exchange of views during the intervals. The docility of the floor of the house in the face of the outrageousness of some of the theses often propounded from the platform is only to be matched by the vivacity of the statements expressed in the adjoining rooms once the audience is let off the leash. Observation and practice are bandied by men of all shades of opinion and at all stages of professional growth. The most junior will shrilly assert his success with one remarkable instance in the face of a man growing mellow in the knowledge of his chequered career

in the management of a hundred such. Ripe craftsmen may well be softly exchanging their careful assessments rather than contend with the more vocal, and thus the benefit of their mastership will be lost to an audience which naturally tends to prefer the ease of the practised orator to the less suave utterance of the occasional speaker.

It is not the consideration of the abstruse which constitutes the burthen of the argument among these randomly selected groups of men but the perennial wrangle about the management of the commoner fractures and injuries which form the daily work of the orthopaedic surgeon. Each interlocutor is ready to asseverate the efficacy of his personal method (even to the exclusion of all others) and to imply that each nostrum is worthy of universal adoption. It is this atmosphere of uninhibited exchange of urgent belief and scientific thought that it is hoped has been captured in this volume.

After an introductory note on the evolution of fracture treatment each contributor has been asked to argue his case forensically in order to give due weight to all aspects of his selected problem. Mistakes in the management of injured persons must always occur, opportunities be missed, false gods be served, retrograde steps be retraced, limbs be salvaged and disasters, even when courted, be resolutely held at bay. It is to help in the achievement of these ends that the seasoned craftsmen, whose essays form the matter of this volume, have lent their hands and given of their wisdom.

JOHN M. P. CLARK

Leeds,
August, 1962

CONTENTS

CHAPTER 1

INTRODUCTION

JOHN M. P. CLARK

The evolution of fracture treatment is similar to that of any other human endeavour. A few fundamental truths are enunciated at earliest recorded time. Then the pattern of development is one of fresh application, lapses of memory, blurring of first principles, rediscovery of forgotten knowledge and the re-establishment of the real guides which ought to have remained steadfast throughout.

It is customary to relate the phases of improvement to the waging of wars. This proposition is not entirely true, but at least the sudden influx of many casualties does bring the problems of their treatment freshly to mind. Nevertheless, it is lamentable to reflect that through the long period of history from the Sumerian civilization to the turn of the nineteenth century, there was virtually no change of approach to the management of the wounded although there was no shortage of military engagements.

The principle of immobilization of a fracture dates back to earliest medical history, and the use of splints for this purpose was practised and recorded by Hippocrates (460-335 B.C.). The Ancient Egyptians anticipated the use of the modern plaster of Paris cast by impregnating bandages with resin. The Arabian surgeons, in the time of Avicenna one thousand years ago, reduced fractures and dislocations by manipulation and traction, and even claimed some success with the use of bone from a freshly killed dog or sheep for grafting. Yet through all these centuries the morbidity and mortality of open fractures remained regrettably high. Wound repair was only very slowly encompassed by granulation under cover of laudable pus, and 'green wounds' were a hopeful sign of healing. Radical treatment by immediate amputation was frequently the method of choice and often the only practical means of securing survival.

The operative dexterity of Ambroïse Paré (1510–90), together with his Hunterian powers of observation and inductive reasoning, extraordinary in themselves, are even more so when viewed against the background of the Renaissance. Paré has often been cited as the father of modern surgery, but the true rebirth of surgery had to

wait until the dawn of the nineteenth century. The first true organization for the treatment of battle casualties was instituted by D. J. Larrey (1766-1842) who based his administration on two principles: the minimum of post-operative treatment (because of the danger of wound infection in hospitals) and the great value of immobilization of the injured part. Larrey's practice of early evacuation of casualties and their distribution down lines of communication held good during World Wars I and II of our own century and was only surpassed in recent times in the speed of movement and the rapidity of wound healing.

Larrey's precepts were inevitably allowed to lapse in spite of the work of H. O. Thomas (1834-91) which was of signal importance, not only in the mechanical application of his ideas of treating injury and disease, but in the fundamental nature of his concepts. Thomas's rather haunted and obsessive personality might have kept his teachings confined to his time and locality had it not been for the proselytizing ability of his great disciple Sir Robert Jones (1858–1933). The work carried out by Jones during the building of the Manchester Ship Canal (1887–93) was the rehearsal for the organization which he was to inaugurate during World War I. The introduction of the Thomas splint for the treatment of field casualties was alone sufficient to reduce the mortality of open fractures of the femur from 80 to 20 per cent. Even so, the open fracture remained a formidable injury, often leaving a long trail of ill health, discharging sinuses, deep puckered fibrous scars, tissue paper skin covering (and therefore subject to repeated rupture and abrasion), delayed union and non-union of the fracture.

The next landmark in the modern approach to the treatment of fractures was the publication of the work of Böhler who taught that all the body, except the actual fractured bone, must be mobilized as soon as possible after the injury. For this purpose Böhler designed apparatus for the immobilization of the minimum of the injured limb compatible with fixation of the fracture and started rehabilitation almost immediately. The saving in loss of time from work was so apparent that the committed insurance companies were happy to subsidize an appropriate accident hospital service in Vienna. In Great Britain the teachings of Thomas, Jones and Böhler were crystallized with admirable clarity of exposition in the publication of the work of Watson-Jones (1940) which has remained the accepted effective summing up of the current situation.

At the time when Böhler was perfecting his methods of treating

fractures Orr (1928) published his work on the treatment of open fractures with occlusive dressings of Vaseline gauze and plaster of Paris, so that there could be no interference with the natural antibacterial action of the bodily tissues and fluids; the wounds granulated surprisingly quickly and produced a mobile scar. Orr's method gained little credence (except in the treatment of acute haematogenous osteomyelitis) until the first European example of total war in Spain (1936–39). The full scale experience gained in the method was published by Trueta (1939) and it formed part of the basis of fracture treatment in World War II. The method came to be modified by the introduction of sulphonamides, and by the use of delayed primary suture which made it possible for the majority of wounds to be closed within a week of infliction. The advent of penicillin in 1943 carried the efficacy of this policy still further and produced a high degree of wound healing and so consequently a more rapid union of fractures. The preservation of life by the improved treatment of surgical shock, the constant availability of blood for transfusion and the control of wound infection formed the major differences in the prognosis for casualties in the two World Wars.

Since the close of World War II the increase in the incidence of home, road and industrial accidents and the prevailing use of high-speed traffic have ensured that the treatment of multiple severe injuries shall be a daily problem. The principles of resuscitation, exploration of the wound, decompression of soft tissues, removal of foreign matter and devitalized tissue, closure of the skin, immobilization of the fracture and early rehabilitation remain the guide for the management of the injured. The best means of achieving these ends is frequently the cause of debate (and even of controversy), but it is intended that some measure of agreement shall be reached in the establishment of a country-wide accident organization greater and more highly developed than any military emergency has ever brought into play. Nothing less can be adequate for the present and yet more may be needed to meet the challenge of the future.

BIBLIOGRAPHY AND REFERENCES

Böhler, L. (1935). *The Treatment of Fractures*, 4th ed. Bristol; Wright

Cope, Z. (1958). ' The Treatment of Wounds Through the Ages.' *Med. Hist.* **2,** 43

Dible, J. H. (1959). ' D. J. Larrey, A Surgeon of the Revolution, Consulate and Empire.' *Med. Hist.* **3,** 100

Guthrie, D. (1945). *A History of Medicine.* Edinburgh; Nelson

Keynes, G. (1951). *The Apologie and Treatise of Ambroise Paré.* London; Falcon

Le Vay, D. (1956). *The Life of Hugh Owen Thomas.* Edinburgh; Livingstone

Levy, R. (1957). ' Avicenna—His Life and Times.' *Med. Hist.* **1,** 249

Orr, H. W. (1928). ' The Treatment of Infected Wounds without Sutures, Drainage Tubes or Antiseptic Dressings.' *J. Bone Jt Surg.* **10,** 605

Penicillin Issue (1944). ' Penicillin in Warfare.' *Brit. J. Surg.* **32**

Seddon, H. J. (1961). ' The Manchester Ship Canal and the Colonial Frontier.' *J. Bone Jt Surg.* **43B,** 425

Trueta, J. (1939). *Treatment of War Wounds and Fractures.* London; Hamish Hamilton

Watson-Jones, R. (1940). *Fractures and other Bone and Joint Injuries.* Edinburgh; Livingstone

CHAPTER 2

INTRACAPSULAR FRACTURES OF THE NECK OF THE FEMUR

ROLAND BARNES

Intracapsular fractures of the neck of the femur remain one of the most serious problems in the field of surgical endeavour. They are a common cause of invalidity in the elderly, and make heavy demands on our hospital resources. The number of these fractures increases year by year as the age of the population rises; often they are caused by a trivial injury, indicating that the neck of the femur is abnormally fragile. Since osteoporosis is common in elderly females and more than four-fifths of all femoral neck fractures occur in women, it seemed likely that osteoporosis was an important aetiological factor. Stevens and his colleagues (1961) investigated this problem and found that almost half the patients with fractures of the neck of the femur had radiographic or histological evidence of osteoporosis, significantly higher than in a control series. The cause of senile osteoporosis is at present obscure, and to discuss the various theories that have been proposed is outside the scope of this chapter. It is, however, likely that the defect in bone metabolism has been present for many years before it produces sufficient weakening of the bone to predispose a patient to a fracture of the femoral neck. It is possible that these fractures in elderly females are often the first symptoms of a preventable metabolic bone disease (Bauer, 1961).

THE BLOOD SUPPLY OF THE HEAD AND NECK OF FEMUR

The blood vessels of the capital fragment sustain some damage in most intracapsular fractures of the neck of the femur. The extent of the vascular injury determines the viability of the femoral head, and in many instances the success or failure of union of the fracture. In recent years there has been a number of important contributions on the vascular anatomy of the head and neck of the femur, including Tucker (1949), Trueta and Harrison (1953), Judet and his colleagues (1955), and Trueta (1957).

The medial femoral circumflex artery is the most important

vessel supplying the upper end of the femur. Its branches pierce the capsule of the hip joint at its femoral attachment and are disposed in two main groups on the superior and inferior aspects of the neck of the femur. The postero-superior group of arteries are the chief source of supply to the head and neck of the femur. Two or three branches from this group supply the greater part of the neck (superior metaphyseal arteries) (*Figure 1*). The terminal branches of the postero-superior group of arteries—the lateral epiphyseal arteries of Trueta—supply that portion of the femoral head which developed from the epiphysis, and they are damaged in many displaced intracapsular fractures.

The postero-inferior group of arteries also arises from the medial circumflex artery. They supply chiefly that part of the femoral head

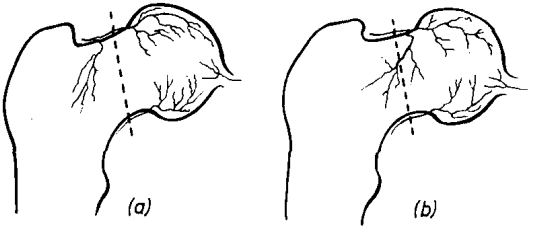

Figure 1. Diagram of blood supply of head and neck of femur. Three arteries supply the head of the femur, the lateral epiphyseal, the inferior metaphyseal and the artery of the ligamentum teres. The latter is small or absent in some subjects. The superior metaphyseal artery is the main vessel of the neck of the femur. It is not damaged by an intracapsular fracture if its disposition is as in (a), but it will be divided if its origin is close to the articular margin of the head, as in (b)

not developed from the capital epiphysis, and the adjacent part of the neck. These arteries are also damaged in many displaced intracapsular fractures, but they are not so vulnerable to injury as the lateral epiphyseal arteries, nor do they make so important a contribution to the blood supply of the head of the femur.

The arteries of the ligamentum teres—the medial epiphyseal arteries of Trueta—have been the subject of many investigations, and until recent years there has been doubt regarding their importance to the nutrition of the head of the femur. It is now generally agreed that one or more arteries are present in most adults, but in 20–30 per cent of subjects these vessels are small or absent; in these circumstances the viability of the femoral head will be in jeopardy if the lateral epiphyseal and inferior metaphyseal arteries are also damaged.

In an adult there is said to be a free anastomosis between these

various groups of arteries, but in children over the age of 4 years the epiphyseal and metaphyseal circulations are quite distinct, and until about the age of 9 years there is seldom any significant contribution from the arteries of the ligamentum teres (Trueta, 1957). This explains the high incidence of avascular necrosis in femoral neck fractures in children (McDougall, 1961).

The lateral epiphyseal arteries are the main vessels of the head of the femur. They have some mobility until they approach the articular cartilage of the femoral head. It is at this point that they are most vulnerable, which explains the higher incidence of avascular necrosis in subcapital fractures. When the main superior metaphyseal artery which supplies the greater part of the neck also arises close to the head of the femur (Judet and his colleagues, 1955), the blood supply to the neck may also be impaired which may prevent revascularization of the femoral head (*Figure 1*).

METHODS SUGGESTED FOR DETERMINING THE VIABILITY OF THE FEMORAL HEAD

The argument usually advanced in favour of an immediate prosthetic replacement of the femoral head is the high incidence of avascular necrosis in subcapital fractures, but if it were possible to demonstrate that the head of the femur is viable shortly after injury there would be no objection to an osteosynthesis. Radioactive tracers such as ^{32}P have been used by Tucker (1950), Arden and Veall (1953) and Boyd, Zilversmit and Calandruccio (1955). These authors used a somewhat similar technique which involved calculating the uptake of ^{32}P from the circulation by the femoral head and the trochanter; if the uptake of ^{32}P by the capital fragment was found to be negligible when compared with the trochanter it was assumed that the capital fragment was ischaemic. The criticism of this method is that the uptake of ^{32}P does not depend on the viability of bone. Stevens (1960) has shown that a rat tibia which has been killed by alternate freezing and thawing will take up about 80 per cent as much ^{32}P as living bone by a simple process of ionic exchange. It is therefore essential before using any method involving the uptake of tracers by bone to be sure that it can only occur by a process of metabolic incorporation.

The present author attempted to determine if the femoral head has an intact blood supply by giving patients human serum albumin labelled with ^{131}I in a dose of approximately 100 μc. It was assumed that a molecule of this size would remain within

the capillaries, and a count of a sample of bone removed from the head of the femur at the time of ' nailing ' would give an indication of its vascularity. It has not proved any more reliable.

Laing and Ferguson (1959) studied the clearance rates of ^{24}Na after it had been injected into the femoral heads of dogs. They found that the rate of clearance was much lower from a femoral head which had been rendered ischaemic by division of the ligamentum teres and the stripping of all the vessels from the neck, than it was from the opposite normal hip. So far as is known these authors have not published the results of this method in the determination of the viability of the capital fragment in man. It is, however, doubtful if any method using radioactive tracers could be wholly reliable, for it is generally assumed that the part of the femoral head from which the readings are taken is a representative sample. This assumption is not tenable, for a segment of the head in the neighbourhood of the fovea may well be supplied from the arteries of the ligamentum teres, whilst the rest is ischaemic. Furthermore, there is at present no method of knowing to what extent in any individual patient the blood supply of the head of the femur may be restored in the first few days by dilatation of the vascular anastomoses. Similar objections apply to the method of venography advocated by Hulth (1958). The prospects of discovering a reliable method of determining the viability of the femoral head shortly after injury are, therefore, not encouraging. At present one cannot do better than make an intelligent guess. Grossly displaced subcapital fractures, in which the fracture line is within 0·5 cm of the superior articular margin of the femoral head, have a high incidence of avascular necrosis (Claffey, 1960).

RADIOGRAPHIC AND PATHOLOGICAL CHANGES IN AVASCULAR NECROSIS

An understanding of the radiographic and pathological changes that accompany avascular necrosis is essential for the management of femoral neck fractures. Increased density of the capital fragment is usually regarded as evidence of avascular necrosis, but this is seldom observed before 6 months after injury. It is not often appreciated, although it was pointed out by Phemister (1920), that the increase in density of the femoral head may be relative or absolute. Relative increase in density occurs when the amount and composition of bone in the capital fragment is unchanged, while the surrounding bone undergoes disuse atrophy. About 60 per cent of

the calcium, however, must be extracted from bone before it is noticeably less dense in radiographs taken through soft tissues (Fusi, 1953). If a patient walks after a successful ' nailing ', and the fragments are held securely in position it is unlikely that this degree of oestoporosis of the distal fragment will occur. Radiographs are therefore of no value in the diagnosis of ischaemia of the femoral head, until inactivity causes a severe degree of osteoporosis of the distal fragment.

Absolute increase in density of the femoral head may be due to

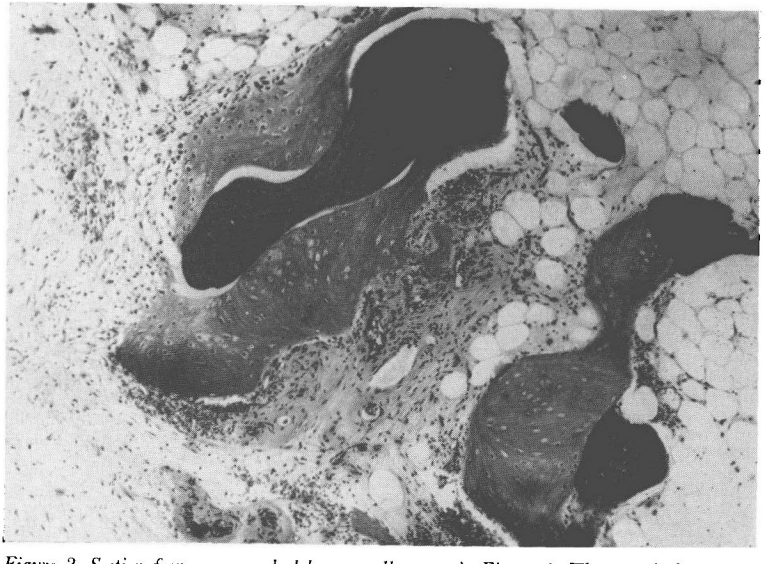

Figure 2. Section from area marked by a small arrow in Figure 4. The very dark staining areas are dead trabeculae. New bone is being laid down on the dead trabeculae and in the marrow spaces (× 84; reduced to two-thirds in reproduction)

the uptake of mineral by the avascular bone through a process of ionic exchange which is not dependent on an intact blood supply (Ray and his colleagues, 1955); or more probably it may be due to a simple increase in bone bulk during the process of re-ossification in which new bone is laid down on the dead trabeculae (Bobechko and Harris, 1960) (*Figures 2 and 3*). This is the usual cause of the increased, and often patchy, density of the femoral head observed in a patient who is walking 2–3 years after a successful 'nailing'.

In recent years many displaced subcapital fractures of the femur

have been treated by the insertion of a suitable prosthesis. This has provided an opportunity of studying the pathology of the excised femoral head at intervals from a few days to many months after injury. Coleman and Compere (1957) examined histologically 60 femoral heads removed at intervals of from 24 hours to 11 years after injury; they stated that some degree of necrosis of the capital fragment was discernible in every case. Revascularization of the

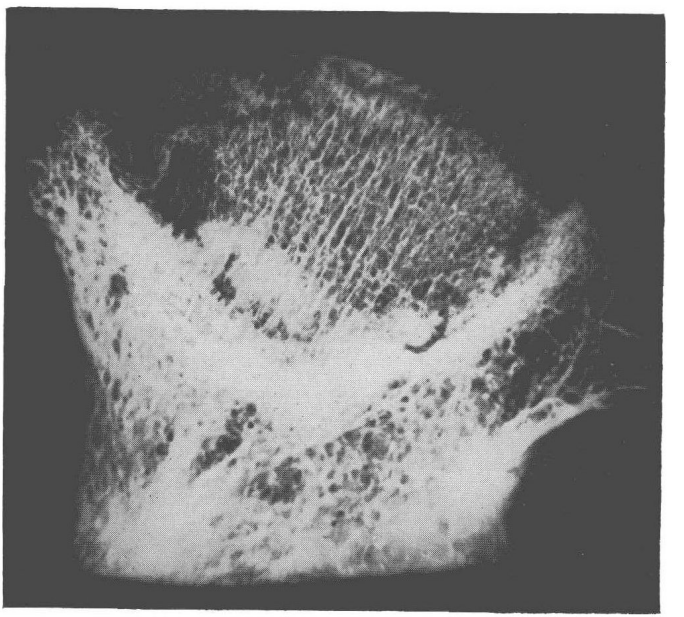

Figure 3. Radiograph of a femoral head excised 4 years after fracture, showing an area of segmental necrosis. The fracture has united and the capital fragment is partly re-ossified. The goblet-shaped area of sclerosis is the margin of the re-ossified area. The bone between it and the articular cartilage is necrotic

femoral head commonly occurs from the intact vessels in the ligamentum teres. New blood vessels can be seen invading the necrotic marrow, and this is followed by osteoclasis of dead bone and the laying down of new bone on dead trabeculae and in the marrow spaces, which may cause a true increase in bone density not always apparent in radiographs. If the arteries of the ligamentum teres are of reasonable size the whole head may be revascularized in this manner in a few weeks (*Figures 2 and 4*). If, on the other hand, the arteries of the ligamentum teres are small or absent, revasculariza-

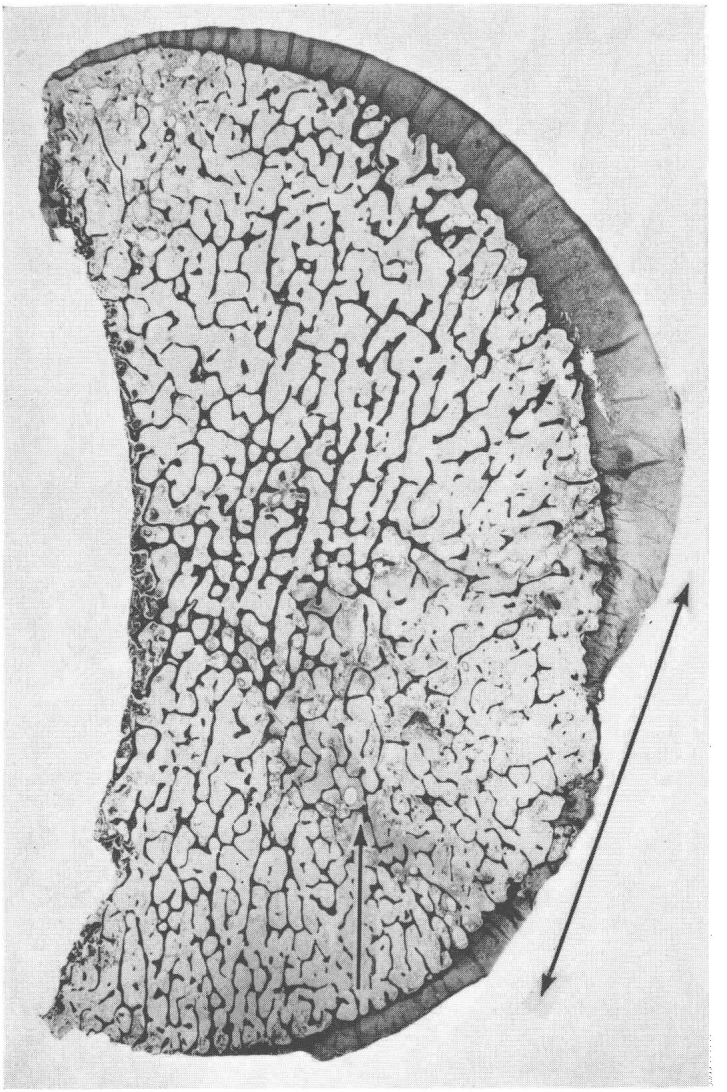

Figure 4. Section of a femoral head which was totally ischaemic. It has been partly revascularized from the ligamentum teres. The margins of this area are indicated by the larger arrow. The wedge-shaped zone with the darker boundary is the edge of the area of re-ossification ($\times 2\frac{1}{4}$)