

VOLUME TWO **CAMPBELL'S**
OPERATIVE ORTHOPAEDICS

Editor

A. H. CRENSHAW, M.D.

Memphis, Tennessee

With 3472 illustrations and 2 color plates

FIFTH EDITION



SAINT LOUIS

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Fifth edition

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PREFACE TO FIFTH EDITION

In this edition of *Campbell's Operative Orthopaedics*, which commemorates the golden anniversary of the founding of the Campbell Clinic, the revisions have been much more extensive than were anticipated by the editor and reflect the many advancements in orthopaedic surgery made during the past several years. New operations have been described for some affections, and changes in the role of surgery have been emphasized for others. Of the illustrations in this edition, approximately one fourth are new.

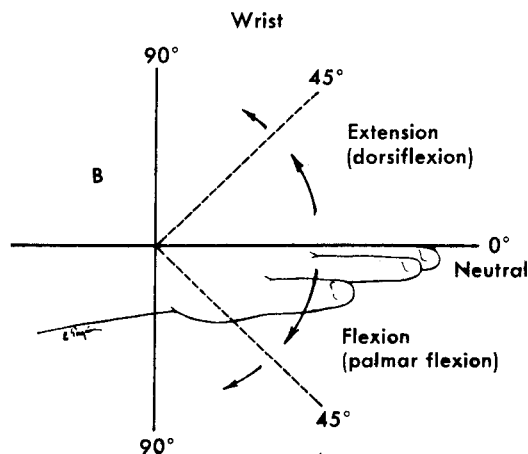
All chapters have been either revised or rewritten. The chapter on hand surgery has been enlarged to include new sections on amputations and other subjects. The chapter on amputations (excluding those of the hand) has been completely rewritten to include the newer techniques, such as immediate postsurgical prosthetic fitting. The section on Vitallium mold arthroplasty of the hip in Chapter 16 has also been rewritten to bring it up to date. To Chapter 22

has been added a section on spina bifida cystica.

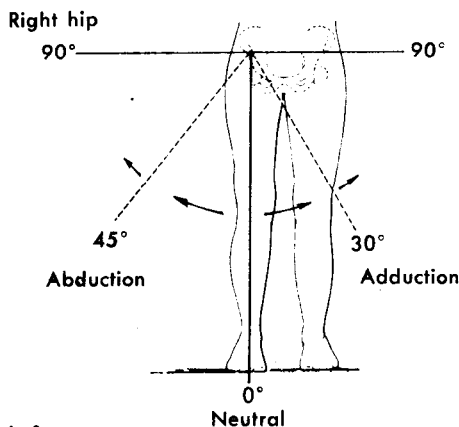
We have continued to use almost entirely the method of measuring joint motion that has been advocated by the American Academy of Orthopaedic Surgeons. The neutral position is 0° instead of 180° as in the first three editions (see accompanying sketches 1 through 4*). For the shoulder, however, the method of the Academy seems too complicated for adoption here. Although the neutral position is 0° as for other joints, the direction of movement in adduction, abduction, flexion, and extension is the same as that used in previous editions (see sketches 5 and 6).

The editor and other members of the staff of the Campbell Clinic are especially indebted to those authors who are not members of the staff: Dr. Otto E. Aufranc, Dr. James E. Bateman, Dr. J. A. Pitcock, and Dr. James C. H. Simmons. We extend our thanks to Dr. Lenox

*Reproduced by courtesy of the American Academy of Orthopaedic Surgeons.



Sketch 1

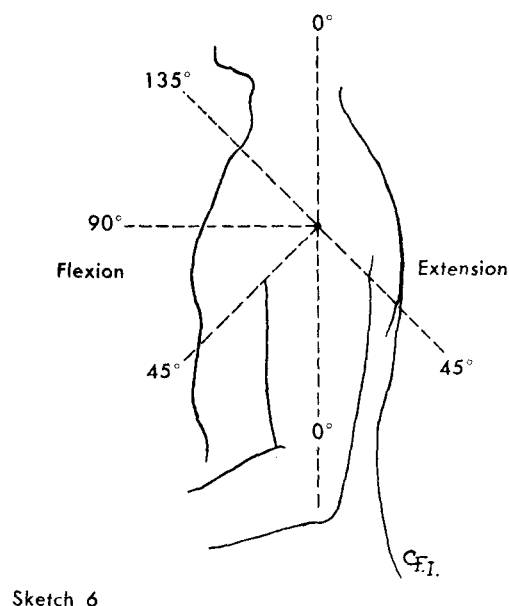
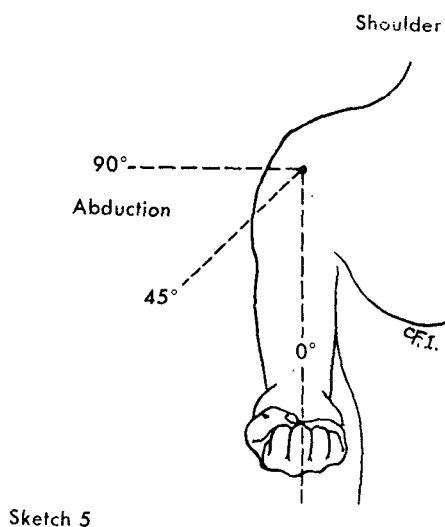
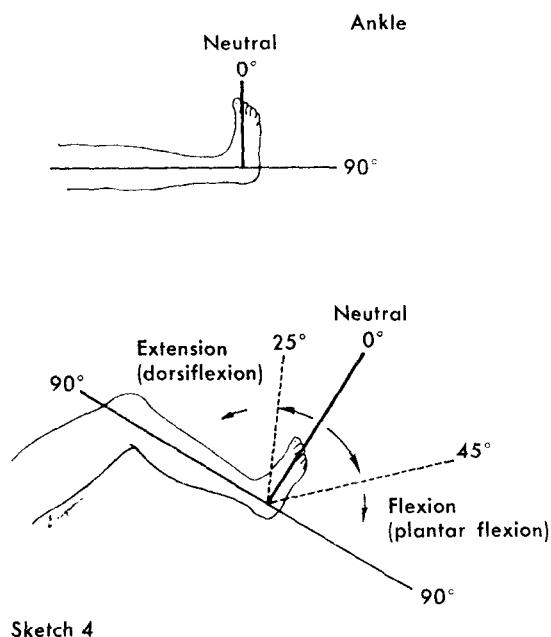
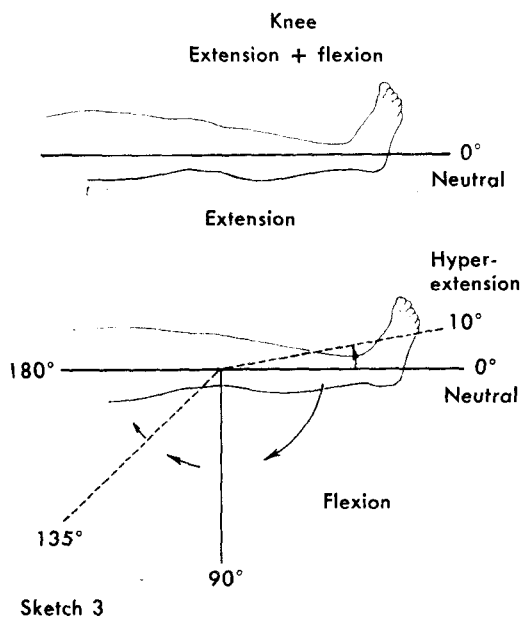


Sketch 2

D. Baker, Dr. Walter P. Blount, Dr. David M. Bosworth, Dr. William F. Enneking, Dr. Herbert Knodt, and Professor A. R. Hodgson, who have offered special suggestions and comments or have proofread material for this edition or the fourth edition. We also extend our thanks to the many surgeons who so kindly permitted us to reproduce their illustrative material.

I wish especially to express my appreciation to Mrs. I. C. Harper for her skillful assistance with the manuscript and references, and to Miss Jan Hawkings, our librarian and medical editor, for her help. I wish also to thank Mr. C. F. Ingram, our medical artist, and Miss M. Irene Jones, the librarian of the University of Tennessee College of Medicine.

A. H. Crenshaw, M.D.



PREFACE TO FIRST EDITION

The title of this book, *Operative Orthopedics*, is not intended to convey the impression that the chief or most important method of treatment of orthopedic affections is open surgery. Although many orthopedic affections are best treated by operative measures alone, the majority are successfully treated by more conservative means. Further, such measures are often essential adjuncts either before or after operation.

This volume has been written to meet the current need for a comprehensive work on operative orthopedics, not only for the specialist, but also for many industrial and general surgeons who are doing excellent work in some branches of orthopedic surgery, and are making valuable contributions to this field.

The evolution of orthopedic surgery has been exceedingly slow as compared to that of surgery in general. Not until aseptic technic had been materially refined was surgery of the bones and joints feasible. The statement is often made that the World War afforded the experience which made possible the rapid development of orthopedic surgery during the past two decades. The surgery of the war, however, was chiefly the surgery of sepsis; there was little of the refined asepsis which is required in reconstruction surgery. Undoubtedly, the demonstration during the war of the necessity and importance of this field led many able men to specialize in orthopedics, and to them considerable credit is due for its subsequent progress.

No classification of orthopedic affections is entirely satisfactory; consequently, any arrangement of operative procedures is subject to similar criticism. With the exception of the chapters on Arthroplasty and Arthrodesis, operations described in this text are grouped together according to their applicability to a given affection. This involves less repetition as to

generalities of etiology, pathology, and treatment than would be necessary in a classification according to anatomic location. Operative procedures appropriate to two or more affections are described in the discussion of the one wherein they are most commonly employed.

To overcome the too widespread conception of orthopedic surgery as a purely mechanical equation, an effort is made in the first chapter of this book to correlate the mechanical, surgical, and physiologic principles of orthopedic practice, and throughout the book to emphasize the practical application of these physiologic principles. A special chapter has been written on surgical technic, for the purpose of stressing certain details in preparation and aftertreatment which vary to some extent from those described in works on general surgery. A thorough knowledge of these phases of treatment is a requisite to success. To avoid constant repetition, chapters have been included on apparatus and on surgical approaches; repeated reference is made to these chapters. The aftertreatment is given in detail for practically all operative technics. This is a most essential, yet too often neglected, factor in the success of any surgical treatment.

In giving the position or range of motion of a joint, only one system has been followed: With the exception of the ankle and wrist, the joint is in neutral position when parallel with the long axis of the body in the anteroposterior and lateral planes. As the joint proceeds from the neutral position in any direction, the number of degrees in which such movement is recorded decreases progressively from 180 to 170, 160, and so on, to the anatomic limit of motion in that particular direction. To illustrate, complete extension of the knee is 180 degrees; when the joint is flexed 30 degrees, the position is recorded as the angle formed between the com-

ponent parts of the joint, i.e., the leg and thigh, or 150 degrees. Flexion to a right angle is 90 degrees, and full flexion 30 degrees. In the wrist, the joint is at 180 degrees, or in the neutral position, when midway between supination and pronation, and flexion and extension. In the ankle joint, motion is recorded as follows: the extreme of dorsiflexion, 75 degrees; right angle, 90 degrees; and the extreme of plantar flexion, 140 degrees.

In some instances, the exact end results have been given, to the best of our knowledge. So many factors are involved in any one condition, that a survey of end results can be of only questionable value unless the minute details of each case are considered. Following arthroplasty of the knee, for example, one must consider the etiology, pathology, position of the ankylosed joint, the structure of the bones comprising the joint, the distribution of the ankylosis, and the age of the patient, in estimating the end result in each case. Further, a true survey should include the results of *all* patients treated over a period of *many* years, and should be made by the surgeon himself, rather than by a group of assistants, or by correspondence.

In our private clinic and the hospitals with which we are associated, a sufficient amount of material on every phase of orthopedic surgery has been accumulated during the past twenty years or more to justify an evaluation of the various procedures. From this personal experience, we also feel that definite conclusions may be drawn in regard to the indications, contraindications, complications, and other considerations entering into orthopedic treatment. In all surgical cases, mature judgment is required for the selection of the most appropriate procedure. With this in mind, the technics which have proved most efficient in the author's experience have been given preference in the text. In addition, after a comprehensive search

of the literature, operative measures have been selected which in the judgment of the author are most practicable.

Although no attempt has been made to produce an atlas of orthopedic surgery, an effort has been made to describe those procedures which conform to mechanical and physiologic principles and will meet all individual requirements. In any work of this nature, there are sins of omission; also, many surgeons in the same field may arrive independently at the same conclusions and devise identical procedures. We have endeavored, however, to give credit where credit was due. If there are errors, correction will gladly be made. In some of the chapters we have drawn heavily from authoritative articles on special subjects; the author gratefully acknowledges his indebtedness for this material. He also wishes to thank those authors who have so graciously granted permission for the reproduction of original drawings.

In conclusion, I cannot too deeply express my sincere appreciation and gratitude to my associate, Dr. Hugh Smith, who has untiringly and most efficiently devoted practically all of his time during the past two years to collaboration with me in the compilation and preparation of material, which alone has made this work possible. I also desire to express appreciation to Dr. J. S. Speed for his collaboration on the sections on Spastic Cerebral Paralysis and Peripheral Nerve Injuries; to Dr. Harold Boyd for anatomic dissections verifying all surgical approaches described, and for his assistance in preparing the chapter on this subject; to Dr. Don Slocum for his aid in the preparation of the chapter on Physiology and Pathology; to Mrs. Allene Jefferson for her efficient editorial services, and to Mr. Ivan Summers and Mr. Charles Ingram for their excellent illustrations.

Willis C. Campbell
1939

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other operations for traumatic lesions of the joint seemed to cause synovitis similar to that which followed gonorrhea; it was presumed to be of traumatic origin. Occasionally slight local fever and other evidence of inflammatory changes within the joint suggested the possibility of a postoperative infection that failed to become purulent because of the action of sulfa drugs or penicillin.

Specific synovial lesions such as those of neoplastic or traumatic origin or those associated with rheumatoid arthritis or osteoarthritis are discussed elsewhere.

Synovectomy

A persistent swelling of the joint, with fluctuation but without edema of the surrounding soft parts, is characteristic of chronic synovitis and may be both seen and felt. The indications for synovectomy are a thickening of the capsule and synovium and an increase in synovial fluid that do not subside during conservative treatment. The possibility that the synovitis is tuberculous must be ruled out before surgery.

If synovectomy is to be successful, rules as given by Swett, J. S. Speed, Inge, and others for selecting joints suitable for the operation must be followed:

1. The disease should be limited to the synovial membrane, or almost so, with little or no involvement of cartilage or bone.
2. The joint should contain much fluid, presumably as a result of advanced chronic changes in the synovium.
3. The disease should have already had efficient conservative treatment including the use of adrenocortical hormones to which it did not respond.
4. The disease should be limited to one or at most two joints.
5. The acute inflammation, if any, should have subsided.

When these rules are followed, synovectomy offers a better prospect than any other treatment for eliminating the lesion.

The discussion of synovectomy will be limited to the knee because this joint is involved more frequently than others. After synovectomy motion of the joint is usually permanently impaired to some extent; in some instances it may approach normal but will not be increased by the operation. After synovectomy the joint should be sufficiently free of pain to allow the normal amount of walking without discomfort and should flex to at least 70°.

Technique. Completely expose the anterior

compartment of the knee through a long anteromedial incision (p. 68); this exposure does not divide important structures, and early motion later can be permitted. Define the line of cleavage between the synovium and capsule at the proximal end of the suprapatellar pouch. Beginning proximally and proceeding distally, excise the entire synovial membrane by block dissection from the medial, lateral, and anterior aspects of the joint; excise the prepatellar fat pad. Remove the menisci if they are no longer serviceable (Fig. 12-1). With a gauze sponge or curet, gently remove all pannus and other pathologic tissue from the medial and lateral aspects of the femoral condyles and with a scalpel excise any fibrillated cartilage and defects of the articular surfaces.

Usually the synovial membrane of the posterior compartment of the joint need not be excised. But when it is severely affected, excise it by either of two methods: (1) through medial and lateral Henderson incisions (p. 71) or (2) through a midline posterior incision (p. 79.) Exposing the medial and lateral aspects of the posterior compartment through the midline incision is difficult and incomplete, and care must be taken to avoid injuring the popliteal vessels. But any popliteal cyst as well as the synovial membrane of the posterior compartment could be excised through a modified midline incision.

Release the tourniquet, obtain complete hemostasis, and close the wound. Use constant suction on the joint for 48 hours after surgery.

Aftersurgery. A Thomas splint with a hinge at the knee is applied, and the extremity is suspended from an overhead frame; with this apparatus, active and passive motion may be carried out later with the aid of pulleys. If constant suction has not been used and hemarthrosis becomes marked, the knee is aspirated. Motion should be started with pulleys at 10 to 14 days or earlier if feasible. Baking and massage are also begun at about this time to hasten absorption of blood and promote early restoration of function. When sufficient control of the knee has returned, usually at 3 to 4 weeks, walking is allowed, with the extremity supported in a brace with a drop ring or dial-controlled knee joint; at first the knee is held rigid, but motion is begun and is gradually increased according to the reaction of the joint to weight bearing. If the range of motion is not more than 30° at 3 to 4 weeks after surgery, manipulating the knee under general anesthesia is justified. Manipulation must be gentle; the knee must

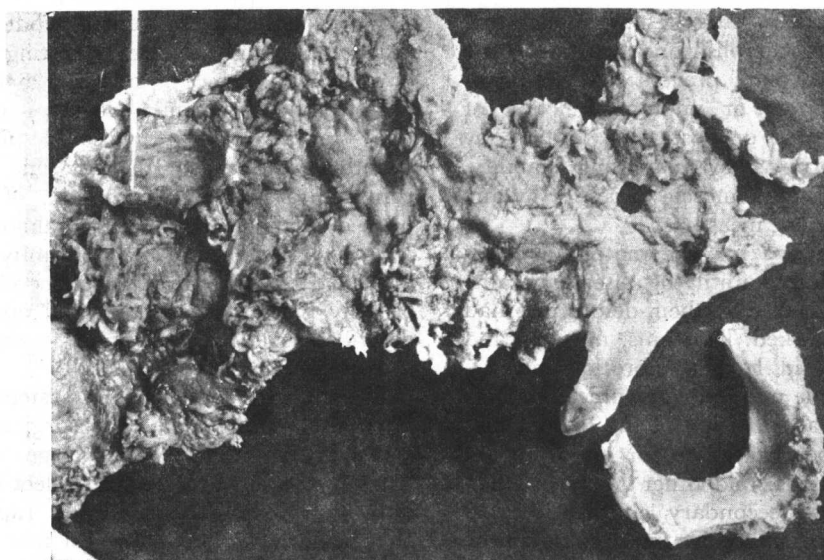


Fig. 12-1. Specimen consisting of hypertrophied synovium and of menisci removed at synovectomy.

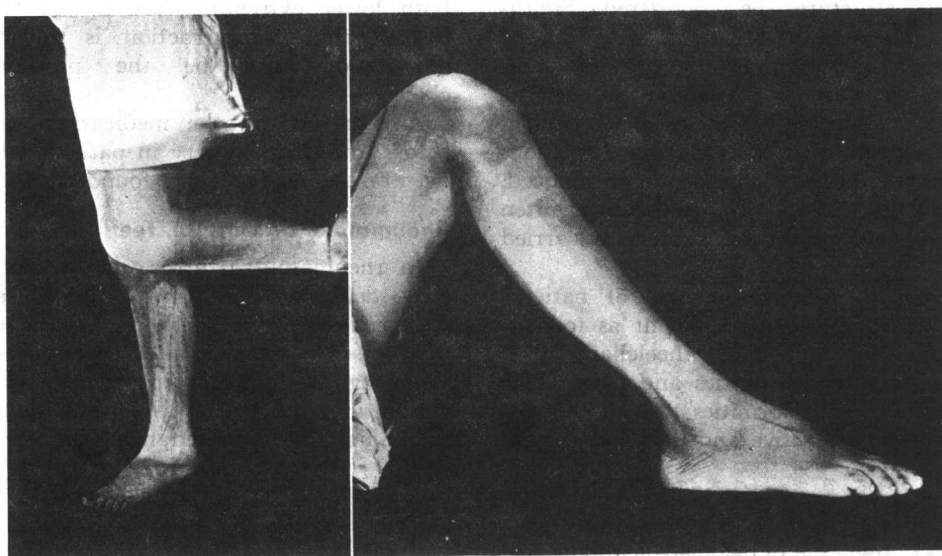


Fig. 12-2. A, Doubly exposed photograph of patient after synovectomy to show range of flexion and extension of knee. B, Range of flexion of knee after synovectomy in another patient who was affected by rheumatoid arthritis that was almost quiescent in all joints.

not be carried through a full range of motion if doing so requires force. The injection of hydrocortisone into the joint reduces the reaction after manipulation and allows exercises to be resumed earlier.

RHEUMATOID (ATROPHIC) ARTHRITIS

The exact etiology of rheumatoid arthritis remains obscure. During recent years, however,

knowledge of the nature and pathogenesis of the disease has increased and management of the disease both medically and surgically has improved. This improvement in management is most evident in those centers using the team approach and employing fully the services of rheumatologists, orthopaedic surgeons, and physical therapists in deciding the time appropriate for the various procedures and in rendering care before, during, and after surgery.

According to Sones, surgery for rheumatoid arthritis should accomplish one or more of the following: relieve pain, prevent destruction of cartilage or tendon, or improve function of joints by increasing or decreasing motion, by correcting deformity, by increasing stability, by improving effective muscle forces, or by any combination of these measures.

Formerly, surgery for rheumatoid arthritis was usually deferred until the disease became quiescent (Fig. 12-2). By then, deformities had often become marked, ligaments, muscles, and joint capsules had become fibrotic, and the bones had become markedly atrophic. Furthermore, the general condition of the patient had made him a poor candidate for major reconstructive operations, and other joints by then had often shown secondary changes due to excessive strains imposed by the dysfunction or absence of function of the joints primarily involved. Unfortunately, rheumatoid arthritis is rarely monarticular, and therefore management requires that many joints and associated soft tissue structures be considered. Smith-Petersen, Aufranc, and Larson were among the first to point out that surgery in rheumatoid arthritis may be preventive as well as corrective; accordingly, they recommended surgery in some situations during remissions of the disease, either spontaneous or induced. Currently, the activity of the disease is often disregarded and preventive surgery is carried out early.

According to Mercer the fate of patients with rheumatoid arthritis is about as follows: (1) confinement to bed or wheelchair, 10%, (2) persistence of deformities and pain, 28%, (3) persistence of deformities though the disease has become inactive and pain has ceased,

12%, (4) satisfactory function but occasional pain, 22%, and (5) no persisting subjective or objective evidence of arthritis, 26%.

Deformity frequently develops during active stages of the disease despite careful splinting; the most frequent one is flexion contracture in which extension, of course, is limited, but flexion remains almost normal. In some instances the deformity may be corrected by apparatus alone; in others it can be only partially corrected, and operations as described in Chapter 15 are necessary if it is to be completely corrected.

Rheumatoid arthritis is a systemic disease; often the patient is a poor surgical risk and cannot withstand several large operations. Thus it is often necessary to select one procedure that may be carried out rapidly without shock even though several more extensive ones might better restore function. A hopelessly deformed finger or toe that interferes with function of the other digits or of the part should be amputated. Sometimes when both lower extremities are so stiff and deformed that reconstruction is not feasible, amputation may be the procedure of choice.

A discussion of the medications necessary before and after surgery in patients who have been on steroid therapy is found on p. 17.

Rheumatoid arthritis of feet

In rheumatoid arthritis, the feet often become deformed and painful and as such are major causes of disability; this is also true, but to a lesser extent, in other types of arthritis. Relieving the feet of pain often decreases the disability of the patient as a whole much more than might be expected from the size of the

Table 12-1. Treatment of deformity in arthritic feet

<i>Deformity</i>	<i>Treatment</i>
Hallux valgus	Keller bunionectomy
Hallux rigidus	Excision of proximal two thirds of proximal phalanx and exostectomy of metatarsal head
Hammertoe	Excision of proximal interphalangeal joint; dorsal metatarsophalangeal capsulotomy if necessary
Hammertoe with fixed flexion deformity of distal interphalangeal joint; terminal corn	Generous excision of proximal interphalangeal joint (preferable) or amputation of distal one half of toe
Claw toe	
Mild and moderate	Excision of proximal phalanx
Severe, multiple	Excision of metatarsal heads (Hoffman)
Rigid, severe, with marked metatarsalgia	Amputation through metatarsal necks
Bunionette (tailor's bunion)	Excision of lateral one third of fifth metatarsal head; excision of entire metatarsal head if forefoot splaying severe
Hypertrophied or thickened toenail (onychogryposis)	Great toe: excision of nail and amputation of tuft (Lapidus, and Thompson and Terwilliger); other toes: amputation of distal phalanx
Rheumatoid subcutaneous nodules about tarsus and bases of metatarsals	Excision

operations necessary. The operations that are useful in treating the various deformities are given in Table 12-1. All are described in detail in Chapter 21 and Chapter 24, except those for severe clawing of the toes, which are discussed here. No two rheumatoid feet are alike, and consequently uniform recommendations for surgery are impossible to make. Often multiple procedures are indicated, sometimes even as many as ten separate but minor or relatively minor ones on the two feet. Using a separate surgical team for each foot shortens the period of anesthesia and often eliminates the need for operating on two separate occasions.

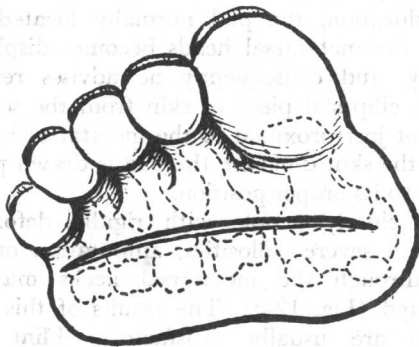


Fig. 12-3. Hoffman transverse plantar incision for resection of metatarsal heads.

After surgery the toes are held in the corrected position by small dressings, and a snug bandage is applied to the forefoot. The dressings are changed on the second day, and the patient is allowed to sit in a chair or to walk a little as desired, but the feet must be elevated enough to control swelling during the day as well as during the night. At 2 weeks all dressings are discarded, except for a snug bandage about the forefoot and toes. Usually within a month after surgery the patient can walk quite well and is fairly comfortable; he may be expected to show continued improvement for several more weeks. If desired, either a light forefoot plaster slipper or a walking boot cast may be worn during the first 2 weeks after surgery.

Clawing of toes

Clawing of the toes may occur in any of several conditions; usually it is most severe in rheumatoid arthritis. The deformity is characterized by hyperextension of the metatarsophalangeal joints, flexion of the proximal interphalangeal joints, and flexion or extension of the distal interphalangeal joints. Dorsal contracture of the toes may be so extreme that the phalanges become dislocated dorsally upon the metatarsals: the metatarsal heads then become prominent on the soles of the feet. The deformity of the great toe may be

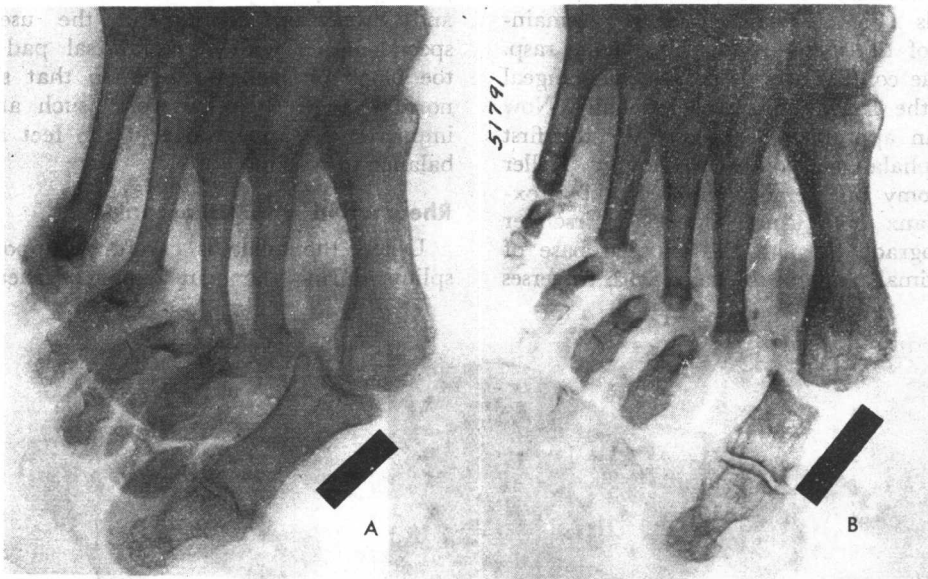


Fig. 12-4. A, Anteroposterior view of forefoot showing severe rheumatoid arthritis with joint destruction, absorption, and dislocation of lateral four metatarsophalangeal joints. B, Marked improvement 3 months after operation. Bases of proximal phalanges as well as metatarsal heads were resected. Keller bunionectomy was performed. Three years later function was still markedly improved.

similar, or it may be one of hallux rigidus with valgus and rotation.

The deformity is rarely corrected completely unless the bones are shortened enough to relax the contracted soft tissues. For mild or moderate clawing of the toes the operations described in Chapters 21 and 24 are suitable; for extreme fixed clawing in which correction is impossible by operations limited to the soft tissues, we usually perform a modification of an operation devised by Hoffman in 1911. In this operation the heads of the metatarsals are resected to shorten the bones and relax the contracted soft tissues. Theoretically, the operation removes important weight-bearing structures of the feet, but practically the results have been satisfactory in rheumatoid arthritis; it is not recommended for clawing of the toes in most other conditions. The operation as described by Hoffman resects all five metatarsal heads through a plantar incision (Fig. 12-3). We prefer to resect the four lateral ones through dorsal incisions and to correct the deformity of the great toe by a Keller bunionectomy (p. 1815).

Technique (Hoffman, modified). Make dorsal longitudinal incisions between the second and third and between the fourth and fifth metatarsal heads. Free the four lateral heads of all soft tissue attachments; resect the heads and enough of the necks to release the contracted soft tissues and allow free motion between the bases of the phalanges and the metatarsals (Fig. 12-4). Smooth the remaining ends of the metatarsals with a bone rasp. Correct the contractures of the interphalangeal joints of the lateral four toes manually. Now through an appropriate incision over the first metatarsophalangeal joint carry out a Keller bunionectomy but remove more of the proximal phalanx than usual. Insert a Kirschner wire retrograde through the exposed base of each proximal phalanx so that a wire traverses

each toe and emerges through its tip. Under direct vision align each toe properly in relation to its metatarsal and drill the wire proximally into the medullary canal of the metatarsal. Cut off the end of each wire so that about $\frac{1}{2}$ inch protrudes beyond the tip of the toe and place a sterile cork on the protruding part. Close the incisions and apply a bulky pressure dressing.

Aftertreatment. The sutures are removed at 2 weeks and the Kirschner wires at 3 weeks. Walking is then allowed in soft shoes. After swelling has subsided, leather cork arch supports with metatarsal pads are fitted.

Fowler has recommended a similar procedure through a single transverse dorsal incision just proximal to the webs of the toes. According to him, in clawing of the toes of long duration, the pad normally located beneath the metatarsal heads becomes displaced distally, and consequently he advises removing an elliptical piece of skin from the sole of the foot just proximal to the metatarsal heads; when the skin is closed, the pad is drawn proximally to its proper position.

For elderly people with rigidly deformed toes and severe callosities, amputation of the toes through the metatarsal necks may be indicated (Fig. 12-5). The results of this procedure are usually satisfactory. Flint and Sweetnam reported the results of amputating all toes through the metatarsophalangeal joints in 47 operations upon 28 patients. All patients were pleased with the result. Flint and Sweetnam recommend the use of a special insole with a metatarsal pad and a toe block of sponge rubber so that shoes of normal length may be worn; such an insole improves the appearance of the feet and the balance in walking.

Rheumatoid arthritis of ankle

Unless the ankle is carefully supported by splints during the acute stage of rheumatoid

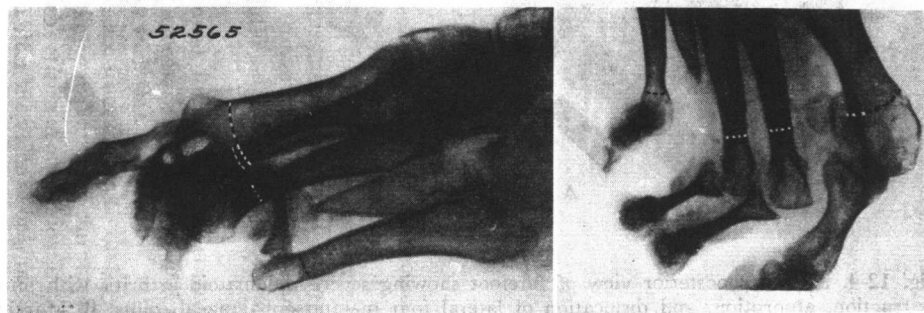


Fig. 12-5. Anteroposterior and lateral views of foot with severe rheumatoid arthritis. Dotted lines, level of metatarsal amputation.

arthritis of the joint, an equinus deformity develops that rapidly becomes fixed. An equinus of long duration is corrected by lengthening the tendo calcaneus and dividing the posterior capsule (p. 1210). If the joint is ankylosed, an osteotomy is made to realign the foot (p. 1213), the tendo calcaneus is lengthened if necessary, and the ankle is then fused, preferably by the compression method of Charnley (p. 1128).

Rheumatoid arthritis of knee

In rheumatoid arthritis flexion contractures of both knees are frequent; when they exceed 30° , the patient is usually confined to a chair. In addition to operations designed primarily to correct deformity (Chapter 15), the following are also useful: (1) synovectomy, (2) arthroplasty or reconstruction, (3) proximal tibial osteotomy, and (4) arthrodesis.

Synovectomy

Synovectomy not only aids in restoring function of the knee, but according to some physicians may also improve the general condition of the patient because pathologic tissue that may act as a focus is removed. The technique of synovectomy is described on p. 988.

The basic indication for synovectomy in rheumatoid arthritis is failure of the disease to respond to efficient medical treatment after 4 to 6 months. If the operation is to be successful, the disease should be limited almost entirely to the synovial membrane with little if any involvement of cartilage or bone and

consequently with little if any roentgenographic evidence of narrowing of the joint space. The involvement of two or more joints and the presence of acute inflammation are no longer considered contraindications for synovectomy. When the indications for it are appropriate, this operation offers a better prospect than any other treatment for improving function. After synovectomy the range of motion of the joint is usually equal to or slightly better than before surgery, but a marked increase in motion should not be expected; furthermore, the joint should be sufficiently free of pain to allow a normal amount of walking with little if any discomfort.

When pain beneath the patella is a prominent symptom and the articular surface of the patella is extremely rough, patellectomy (p. 1010) may be combined with the synovectomy (p. 988).

Arthroplasty or reconstruction

In any operation to relieve ankylosis and increase the range of motion in rheumatoid arthritis, a more extensive resection of the joint surfaces is required than when ankylosis has been caused by acute infectious arthritis. In some patients, arthroplasty (p. 1238) or reconstruction (p. 1005) may result in improvement, but whether satisfactory function will be permanently restored by either method is always uncertain.

Metal plates and other devices have been designed for placement between the apposing articular surfaces of the knee, and prostheses for

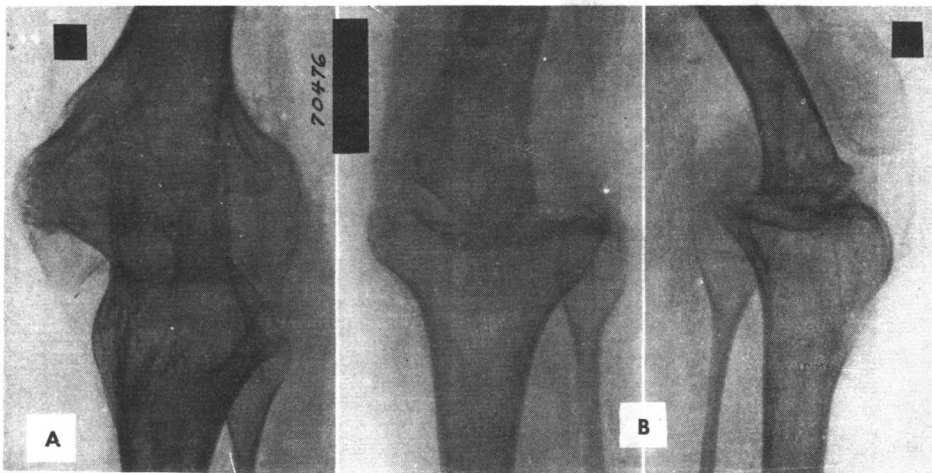


Fig. 12-6. Severe polyarticular rheumatoid arthritis with bilateral ankylosis of knees. **A**, Right knee was left ankylosed so that one limb would be stable. **B**, Left knee was treated by fascial arthroplasty, which restored a satisfactory range of motion; lateral instability, however, made use of long leg brace necessary (same patient as shown in Fig. 12-14).

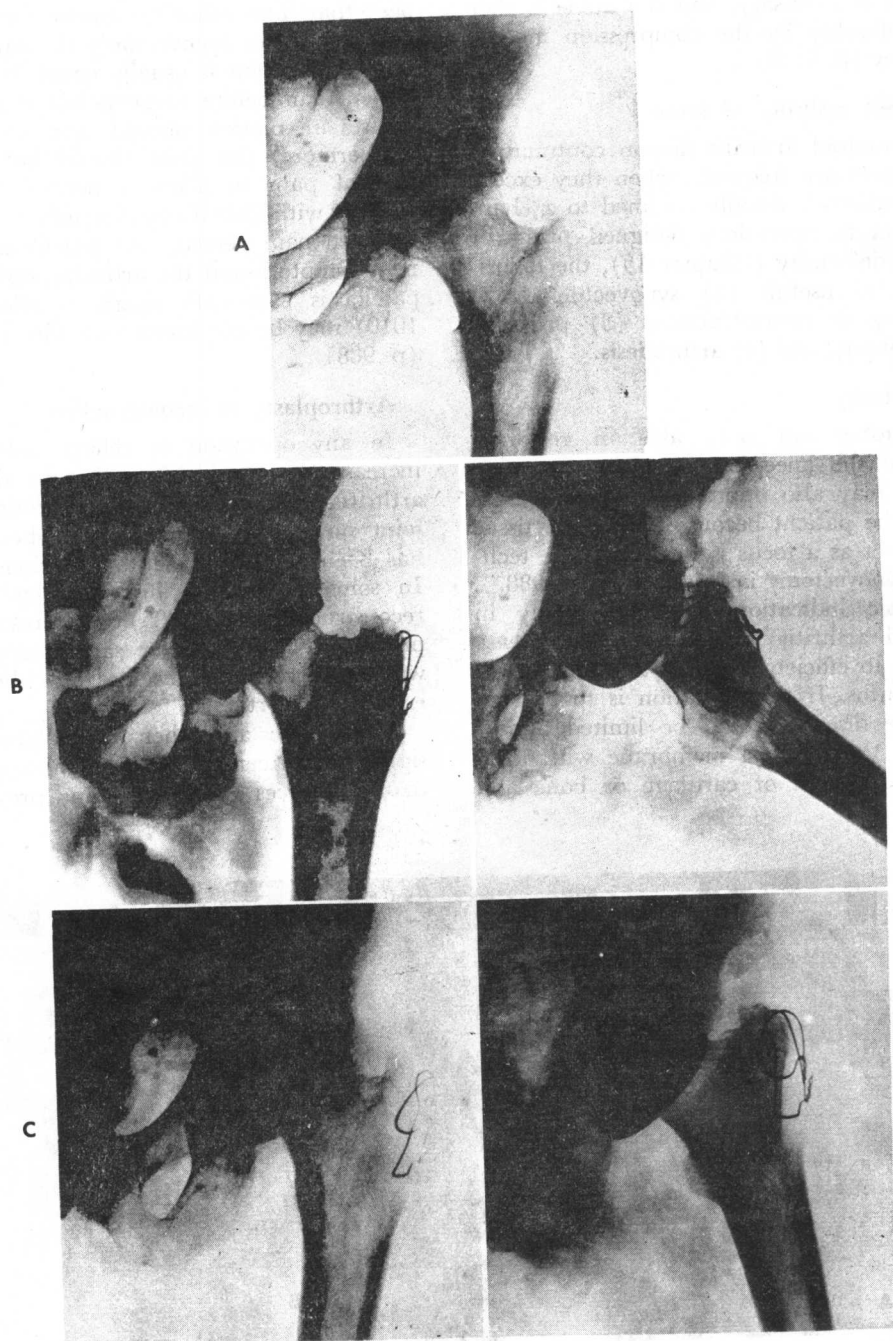


Fig. 12-7. Painful hip in man 45 years of age with rheumatoid arthritis treated by cup arthroplasty. **A,** Before surgery. **B,** One year after cup arthroplasty in which capsule was completely excised; modified Gibson approach was used. **C,** Three years after surgery. Hip is painless and motion and gait are normal. Complete capsulectomy is especially important in rheumatoid arthritis.