

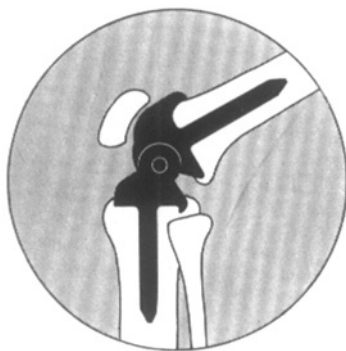
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ARTHROPLASTY OF THE KNEE USING AN ENDOPROSTHESIS

By

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Preface

I wish to express my profound gratitude to my Chief, Professor Sten Friberg, for giving me the possibility of starting and continuing this work at his Clinic. The fact that he allowed me to take the responsibility, and showed his confidence in the practicability of the method, was an encouragement that greatly facilitated its performance. He has never failed, in every situation, to give me his unstinted support and guidance.

My sincere thanks are due to my colleagues at the Clinic, for sound and stimulating criticism.

I also take this opportunity of expressing my appreciation to the following:

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Stockholm, March 1957

Börje Walldius

Introduction

The results of arthroplasty of the knee with the techniques hitherto used have been fairly uncertain. The operation has therefore been used to a limited extent. Watson-Jones (1949) has stated that, even if operation is performed by an experienced surgeon in carefully selected cases, good results can be anticipated in only about 50 per cent. He also expressed the view that the method is still in the experimental stage. Consequently, there have been sound reasons for trying to elaborate a better technique than those in current use.

I was encouraged to make such an attempt when, in 1950, I saw at our clinic the promising primary results of arthroplasty of the hip with an acrylic prosthesis, applying a method introduced by the brothers Jean and Robert Judet (1950, 1954). It therefore seemed plausible to try to construct an acrylic prosthesis for arthroplasty of the knee. This work was started in the spring of 1951.

The first operation with the prosthesis in question was performed on October 12, 1951. During the subsequent five years, 26 patients have been operated on and treatment completed. The operation has been undertaken 32 times, since arthroplasty of both knees was performed in six patients. Consequently, it seems justified to present a report of the experience hitherto gained.

CHAPTER I

Historical Survey

The term arthroplasty, introduced by Gluck (1902), is derived from the Greek *ἄρθρον* = joint and *πλάσσειν* = to form. It is an operation designed to create a movable and functioning joint. The term can be used in a wider denotation to include every operation aimed at increasing the mobility of a joint. Nowadays it is, however, used in a more restricted sense, and then denotes an operation on a joint with replacement of one or more of its essential parts.

Methods of Operation

On broad lines, the historical development of arthroplasty of the knee has taken the following course with respect to the types of operation: resection, arthrolysis, interposition, and replacement.

Resection

Fergusson (1861) was the first to obtain a movable and functioning knee joint with this method. As a rule, resection did not lead to the desired results. If too much bone was resected, a flail joint developed, and if too little was removed, ankylosis or rigidity appeared. A satisfactory result was, in fact, a matter of pure chance.

Arthrolysis

Wolff (1897) introduced the term arthrolysis, by which he meant removal of any mobility-limiting tissues present in the joint. Operation was intended to be followed by energetic training of movement. Schuh (1853) attempted to restore mobility of the knee joint by open freeing of the patella, but was unsuccessful. Similar operations were carried out by Ollier (1885) with variable results. Kocher (1907) performed arthrolysis and placed the knee in a position of dislocation for two weeks, after which it was reduced. The results were poor.

The results of arthrolysis were generally poor, since the bleeding in the joint associated with operation became organized into fibrous tissue, which once more caused the joint ends to become adherent to each other. The method is, however, still used in certain cases of post-traumatic rigidity,

often in combination with X-shaped elongation of the quadriceps tendon and partial or total excision of the patella.

Interposition Operation

Vernetil (1860) was the first to suggest interposition of tissue between the resected surfaces of a joint to prevent them from becoming adherent. Many attempts have been made, both clinically and in animal experiments, to find a substance that is both strong enough and that does not elicit foreign-body reactions in the tissues. Both organic and inorganic materials have been tested.

Cramer (1901) succeeded in making the patella movable by inserting a flap of vastus medialis below it, but did not achieve any marked increase in mobility of the knee as a whole. It is to Murphy (1905) that the greatest credit is due for further elaboration of the interposition technique in the knee joint. After resecting the joint surfaces, he inserted a pedicled flap of fascia lata — and later a free flap — between them. This method, using a free fascial graft, has subsequently been that most extensively used. Reports of its application have been published by a number of authors, as can be seen from Table 1.

Baer (1909, 1918) made use of chromicized pig's bladder as interposition material, and Allison & Brooks (1918) employed silver-impregnated fascia. Lexer (1917) and Hass (1944) used a free flap of fat.

The surgical technique with the use of the aforementioned tissues has varied. Putti (1920, 1921) made a lateral, longitudinal incision. The femoral and tibial condyles were reshaped to conform as far as possible to the normal anatomy, and each was covered by a fascial graft. Campbell (1921, 1924, 1925, 1928) used a straight, longitudinal incision in the midline, and cut through the medial aspect of the joint capsule. He reshaped the distal end of the femur to form a single large condyle, and chiselled out a concavity to fit it in the tibia. Both joint ends were covered by a large, continuous fascial graft. A flap of fat was used to cover the patella. MacAusland (1933) used the same incision as Campbell. He cut through the joint capsule on both sides of the patella, so that it could be reflected distally in a flap. The condyles were reshaped with Putti's technique, and covered by a very large fascial graft, lining almost the whole joint cavity.

Albee (1928, 1933) chiselled out the femoral and tibial condyles in a V-shape, with the object of reducing the risk of instability. Hass (1944) based his operation more on a physiologic than on an anatomic principle. In order to decrease the contact between the ends of the joint, he reshaped the femoral condyles so that they resembled a wedge, with the tip resting on the joint surface of the tibia. Training of mobility was facilitated by this means.

A number of other organic tissues have been tried out, but they have not been of any practical importance as far as the knee is concerned. Thus, Foederl (1895) made use of membranes from ovarian cysts and pig's bladder, Weglowski (1907) of cartilage, Hofman (1908) of periosteum, Schmerz (1911) of amnion, Kaloczek (1912) of peritoneum, and von Hacker (1919) of hernial sac. The use of skin as interposition material was introduced by Gluck (1902). This idea has been revived by Kallio (1956).

Various metals, usually in the form of foil, have also been tried as interposition material. Aluminium was tested by Doisy (1894), nickel by Pitarka (1894), and tin, zinc, silver and magnesium by Chlumsky (1900). Hübscher (1901) inserted 5 mm thick magnesium foil below the patella, but with poor results. Jones (1908) used gold, and Rehn (1934) steel. Venable & Stuck (1937) and Smith-Petersen (1939) introduced vitallium, an alloy consisting of 30 per cent chromium, 5 per cent molybdenum and 65 per cent cobalt.

Many organic artificial products have been used. Chlumsky (1900) made experiments with celluloid, rubber and collodium. Delbet (1919) and Robineau (1926) used ebonite. Smith-Petersen tested glass in 1923, viscalloid in 1925, pyrex in 1933 and bakelite in 1937. Cellophane was tried out by McKeever (1943). The tissue tolerance of acrylic material was demonstrated by Clark & Wentsler (1938) in experiments on monkeys. It started to be used in orthopaedic surgery by the Judet brothers (1950) in particular. Good results with nylon membranes in arthroplasty of the knee were achieved by Kuhns & Potter (1950). Scales (1953) has, however, pointed out the unsuitability of nylon, since it does not withstand wear and tear, and worn-off particles give rise to fibrosis. According to Newman & Scales (1951) this also applies to polythene. DePalma (1954) used a combination of nylon to cover the femoral condyles, and a vitallium prosthesis for the joint surface of the tibia.

Experiments with absorbable material were made by Giuntini (1946) and by Soave & Sabaino (1949). The former used gelatin, and the latter fibrin foam and oxigel.

Histologic studies have been made of the reactions in the joint tissues at varying periods after operation. It has then been found that insertion of organic material has led to formation of bursa-like fibro-cartilagenous tissue. It has not always been possible to determine with certainty whether this tissue derived from the graft, or whether it developed from the resected bone ends.

Most of the non-vital materials used have proved to be unsuitable, since they either give rise to tissue irritation, or have insufficient strength. Vitallium and acrylic resins seem to be best tolerated by the tissues, and they are at present the materials with the widest practical application.

Replacement Operation

In this type of operation, either the whole joint or one of the two joint ends is replaced. Both grafts and artificial joints (endoprotheses) have been used.

Grafting of whole and half joints has been done by Judet (1908), Lexer (1909) and Buchman (1908). Such an operation is stated to have been performed by Gluck as early as 1897. Lexer's grafts consisted of the sawn-off joint surfaces of the femur and tibia, with the cruciate ligament in place, taken from both amputation and autopsy cases. He achieved acceptable results in two cases, but of brief duration only (13 months). Bürkle de la Camp (1950) examined these patients 14 and 16 years after operation, respectively. The functional results were poor, but the graft had healed in. One patient had a knee brace, and in the other it had been necessary to resect the joint.

Attempts have been made to replace one of the two joint surfaces of the knee with an endoprosthesis. Campbell (1940) designed a mould of vitallium for the femoral condyles. He operated on four cases, but obtained poor results and therefore abandoned the method. Rocher (1952) and Kraft & Levinthal (1954) each replaced the distal end of the femur with an acrylic prosthesis in one case, with good results. Aufranc (1955) also constructed a vitallium prosthesis for this purpose.

A prosthesis has also been used to replace the joint surface of the tibia. Marquardt (1951) used V-2-A steel, Kiær (1953) acrylic resin, and Larsson (1953). DePalma (1954) and McKeever (1955) used vitallium. Only scanty data are available regarding the results of these operations in a few cases. They do not seem to be promising. McKeever (1955) also used a vitallium prosthesis to replace the joint surface of the patella.

An endoprosthesis consisting of a whole joint was inserted by Majnoni d'Intignano (1950) with poor results. Diamant-Berger (1951) suggested insertion of an acrylic cylinder, lying horizontally in the joint. This operation was performed on one patient by Huguier with good results in one knee and poor in the other.

Endoprotheses constructed as hinge-joints have been inserted in the knee by d'Aubigné (1953), Walldius (1953), Moeys (1954), Seddon (1955), Heinze (1955) and MacAusland (1955). Lacheretz (1953) has stated that it is still too early to judge the results in d'Aubigné's cases, in which a metal prosthesis was used. Good results were obtained by Walldius with an acrylic prosthesis in four cases. Seddon inserted an acrylic prosthesis with a poor result in one case, and obtained a good result with a metal prosthesis in another. Heinze performed arthroplasty with an acrylic prosthesis in two cases, in one of them with good results. Moeys used his metal prosthesis in animal experiments.

Indications

As far as the knee joint is concerned, arthroplasty has had a relatively small range of indications as compared to arthrodesis. Only few surgeons have advocated its use, and they have never been able fully to convince the advocates of arthrodesis of the advisability of the former operation. The knee was found to be the joint in which it was exceedingly difficult to achieve successful arthroplasty, owing to its complicated structure and the great mechanical stress to which it is exposed.

Formerly, indications for operation were generally considered to exist in bilateral ankylosis of the knee, in ankylosis of the hip and knee of the same leg, and in general when the function of the extremities was severely impaired and mobility of the knee would bring about a fundamental improvement. The age of the patient should be between 20 and 40 years, and his occupation should not involve any great stress on the knees. It was also considered essential for the patient to have a lively desire to achieve a mobile joint, and to be prepared to take an energetic part in postoperative treatment. It was gradually found that the best results were obtained in post-traumatic ankylosis and in healed acute arthritis.

Contraindications were regarded to be a sensitive mentality, adiposity, muscular atrophy, poor condition of the skin over the joint, and a recent history of an inflammatory process in the joint. This also applied to rigidity after osteomyelitis, tuberculosis or rheumatoid arthritis.

Mayr (1954) stated with respect to rheumatoid arthritis that in scarcely any other disease would successful results of arthroplasty of the knee be more desirable but that, according to the masters of the techniques hitherto used, the prospects could hardly be less favourable. Several authors have expressed the view that it has been more difficult to achieve good results in joints with fibrous ankylosis or rigidity than in cases of bony ankylosis.

Results

As is frequently the case when a new type of operation is introduced, the results of the first arthroplasties of the knee were not particularly satisfactory. It proved difficult to achieve both good mobility and stability. If flexion was 90° or more, the joint often lacked stability. If stability was adequate, it was, at the cost of mobility. The best functional results were considered to be present when the knee could be flexed about 70°. As a rule, stability was then adequate as well. Optimal function of the knee was not attained until at earliest about a year after operation. During this time, a bandage was often used to save the knee from undue stress and strain. Once a good result had been obtained, it was generally permanent.

Nowadays, a good result is taken to mean flexion of at least 70° , freedom from pain and complete stability. By these standards, the results of the 6 arthroplasties described by Murphy in 1905 would be judged as poor, since the mobility was only 10° to 30° . Payr (1914) had good results in 17 of 23 operations. Lange (1917) obtained good results in one out of 9 arthroplasties, and stressed that the large number of unsuccessful cases prompted to the utmost caution in mobilization of the knee.

Henderson (1918) made inquiries of the orthopaedic surgeons practising in the U.S.A. at the time, and published a survey of their results. In 117 arthroplasties of the knee, good results had been obtained in 18 cases, fair in 30 and poor in 69 cases. Baer (1918) had better results with his method. He reported good results, by which he meant mobility of at least 25° , in 15 of 28 arthroplasties. Lexer (1919) had results graded as excellent in 7 of 34 cases. Hohlbaum (1921) stated 48 of 85 arthroplasties to have been successful. Ryersson (1921) had poor results in 9 cases and good in one.

Groves (1923) stated that in 18 cases operated on in England during a five-year period, the results had been good in 4, fair in 4 and poor in 10 cases. Putti (1926) reported a good result in 52 of 63 arthroplasties. In 1921, Campbell expressed doubts regarding the value of the method, since he had been successful in only 5 of 24 arthroplasties. He also suggested that trials should be made with a mechanical joint. In 1928 he was more optimistic, since he had achieved good results in 43 cases and fair in 3, out of 87 operation. Albee (1928) reported good results in 9 of 10 cases.

Courvoisier (1937) made a survey of the cases operated on by 14 surgeons in France since 1926. They amounted to 23, the result being good in 17. Steindler (1939) reported, after 51 operations, 13 good, 13 fair and 25 poor, Hass (1944) 7 of 9 good, and Platou (1948) 10 excellent and 6 poor in 16 operations. Samson (1949) gave an account of 47 cases, with excellent results in 26, fair in 13 and poor in 8. Speed & Trout (1949) reported 65 cases; 29 were good, 17 fair and 19 poor. Bürkle de la Camp (1950) had 67 cases, with 36 good results, 26 fair and 5 poor.

Kuhns & Potter (1950) stated that grafting with fascia lata in 12 patients with rheumatoid arthritis had led to poor results. Ankylosis had appeared in every case. Using their new method (a nylon membrane) they obtained a good result in 22 of 25 joints with the same indication for operation. Lange (1952) reported successful results in 30 per cent of 20 arthroplasties performed in a five-year period. Miller & Friedman (1952) had 36 cases; the results were good in 11, fair in 8 and poor in 17. Roasenda (1953) reported 26 cases; the results were excellent in 10, good in 4, fair in 3 and poor in 9. Lacheretz (1953) stated that of 15 cases operated on at three French clinics, good results were achieved in 6, fair in 1 and poor in 8.

A survey of the cases reported by the aforementioned authors is given in

Table 1. Results of Arthroplasty of the Knee in the Series of Different Authors

Year of Publication	Author	No. of Cases	No. of Good Results
1914	Payr	23	17
1917	Lange	9	1
1918	Baer	28	15
1918	Henderson	117	18
1919	Lexer	34	7
1921	Hohlbaum	85	48
1921	Ryersson	10	1
1923	Groves	18	4
1926	Putti	63	52
1928	Albee	10	9
1928	Campbell	87	43
1937	Courvoisier	23	17
1939	Steindler	51	13
1944	Hass	9	7
1948	Platou	16	10
1949	Samson	47	26
1949	Speed & Trout	65	29
1950	de la Camp	67	36
1950	Kuhns & Potter	12	0
1950	Kuhns & Potter	25	22
1952	Lange	20	6
1952	Miller & Friedman	36	11
1953	Roasenda	26	14
1953	Lacheretz	15	6
		896	412 (46 %)

Table 1. It is seen that the total number of cases in which excellent or good results were obtained amounts to 46 per cent of the arthroplasties performed. If we exclude Henderson's figure, which is so low, the incidence figure for good results rises to 50.6 per cent.

To sum up, it can be stated that the first 50 years in the approximately 100-year long history of arthroplasty of the knee were characterized by a search for a practicable method of operation. The interposition method met

this requirement. Various kinds of interposition material were tested, and fascia lata was found to be the most suitable. The results have not, however, been so good with this method that it has been applied to any great extent. It is only during recent years that trials have been made with essentially new techniques in operations of the replacement type. The future will show whether they can lead to better results than those of earlier methods.

CHAPTER II

The Prosthesis

Construction

The prosthesis* is made of acrylic resin and consists of a femoral part and a tibial part, joined together by a stainless steel rod to form a hinged joint (Fig. 1). Its range of movement is 185° to 90° . The central portion is 38 mm high, 68 mm wide and 51 mm deep. The surfaces in contact with the bone are plane, and when the joint is at an angle of 180° they are parallel to each other. The contact surface of the femoral part is $2,380 \text{ mm}^2$, and that of the tibial part is $1,970 \text{ mm}^2$.

A medullary pin, 65 mm long and 12.2 mm in diameter, projects at right angles from each of these surfaces. On the anterior aspect of the femoral part and the posterior aspect of the tibial part there is a projecting lip, which fits around the bone margins in order to prevent rotation of the prosthesis. The lip on the femoral part also serves as a joint surface for the patella. It continues into an anteriorly convex surface on the central portion, which also has a central slope, corresponding to the patellar surface of the femur, to prevent dislocation of the patella.

The steel rod is 53 mm long and 9.95 mm in diameter. One end is half-spherical and the other is plane, with a short threaded hole in the centre to accommodate a handle, which is one of the special instruments used for operation. The rod lies in a channel 10 mm in diameter, one end of which terminates in another channel 2 mm in diameter. The other end is threaded, to fit an acrylic screw which covers the end of the rod. When the screw has been inserted and is in contact with the rod, there is a cavity 2 mm deep above its head. Because of the difference between the diameter of the rod and that of the channel, the movements of the joint are extremely smooth. Within the joint is an inner axle journal around the rod, with a supporting surface of 440 mm^2 , and an outer axle journal with a supporting surface of $1,500 \text{ mm}^2$ (Fig. 2).

The prosthesis used in the first 16 operations differed from that just described in the following respects (Fig. 4). The height of the central part was 46 mm. In the later model, it has been reduced by 8 mm in order to avoid such extensive resection of the joint. Moreover, its outer contours were more projecting and angular. They have been rounded in the later

* The prosthesis is manufactured by Carl Thunér, Karlskoga, Sweden.

model, to give them some resemblance to the condyles. Closure of the capsule at operation is also facilitated by this means.

The medullary pins were 93 mm long; they have thus been made 28 mm shorter, to decrease the risk of conflict with the cortex. If this occurs, the prosthesis is driven in out of alignment, and its contact surface is not completely congruent with the resected surface. — The earlier medullary pins were reinforced with a central metal core. The reason why metal has not been used in the latest prostheses except for the central rod will be given under the heading of reinforcement.

In the earlier model, two short metal pins were present on each contact surface instead of the lip. — The channel for the metal rod was completely closed at one end, so that any blood which accompanied it into the channel on insertion of the rod had no possibility of flowing out once the acrylic screw had been fixed in position. This might have limited the mobility of the prosthesis. — The acrylic screw could not be sunk into the prosthesis, but had to be soldered to it. The sunken screw used in the present model can be expected to be fixed to the prosthesis by ingrowth of connective tissue into the cavity above its head.

Material

One of the difficulties in arthroplasty using interposition material of a non-biologic nature has been to obtain material which is sufficiently resistant to stress and strain, and yet will not give rise to foreign-body reactions in the tissues. The strength of the Judet prostheses has not always been sufficient, but their tissue tolerance has proved to be relatively good. On reoperation after arthroplasty with a Judet prosthesis, a fibrous, almost cartilagenous tissue was observed to have been formed on the femoral neck below the prosthesis (Judet *et al.* 1954). Histologic examination disclosed no signs of inflammation or foreign-body reaction. It has, however, been observed that worn-off acrylic particles can be a source of irritation, leading to fibrosis and foreign-body reactions (Mittelmeier & Singer 1956).

An attempt has been made to compensate for the lack of strength of acrylic material by making the knee-joint prosthesis relatively large and robust. One question which arose was whether acrylic surfaces would glide against each other and against metal. Another matter was that acrylic resin softens when heated, its softening point being at about 125° C. The heat produced in the prosthesis by friction was therefore a potential source of damage to it. To ascertain whether this was actually the case, a test was made; an account of it is given on pages 22 to 25.

The material originally chosen was a polymethyl methacrylate, Bono-

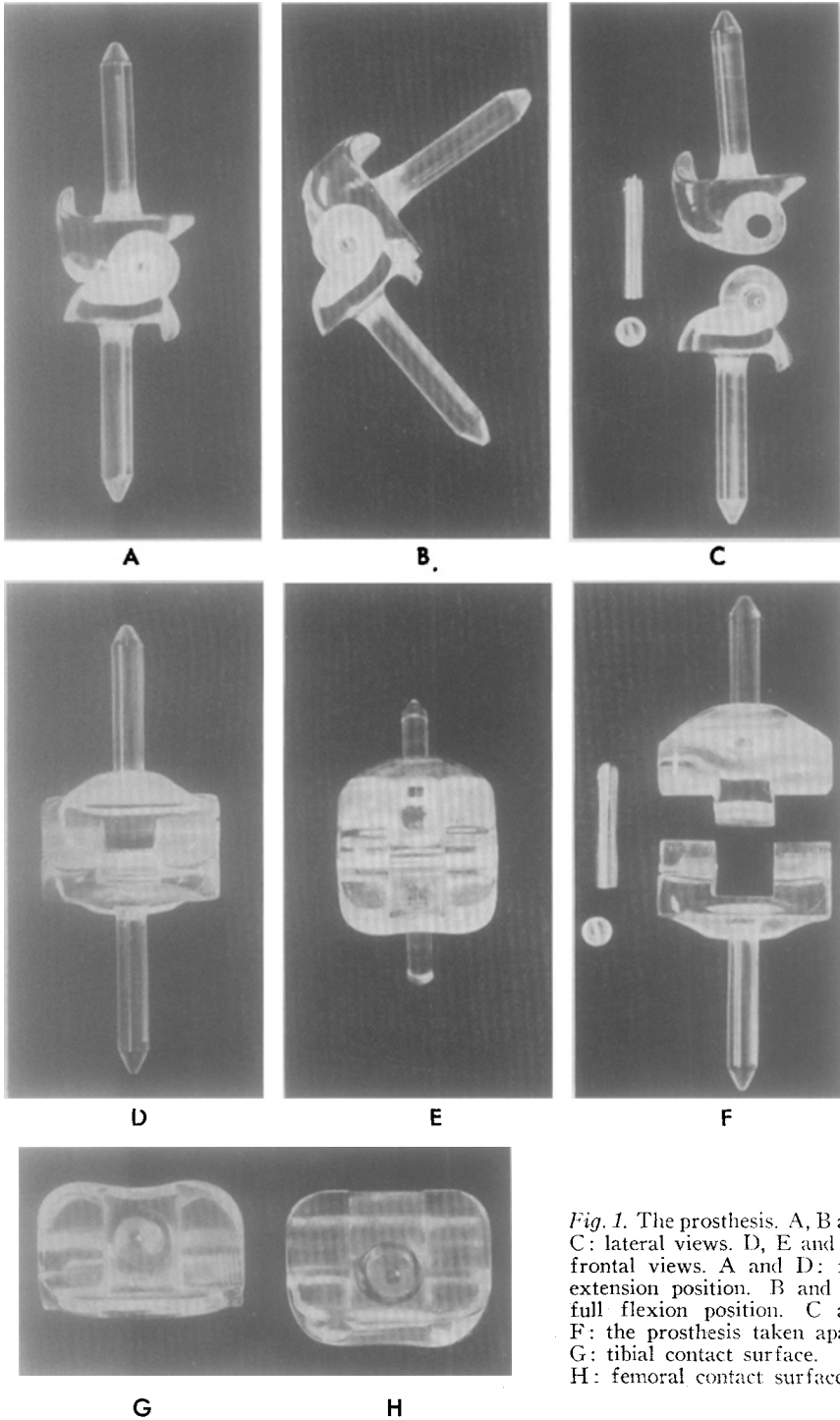
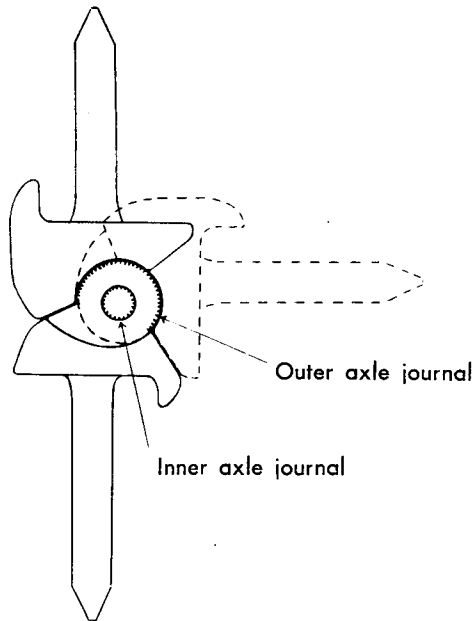


Fig. 1. The prosthesis. A, B and C: lateral views. D, E and F: frontal views. A and D: full extension position. B and E: full flexion position. C and F: the prosthesis taken apart. G: tibial contact surface. H: femoral contact surface.

*Fig. 2.*

plex.* This was used for the first 10 prostheses. It was, however, found desirable to have a roentgen-opaque material, a requirement which was not fulfilled by Bonoplex. The acrylic material known as M 9373** has this property. Prostheses made of this material have been used in all the arthroplasties from no. 11 onwards; they are fully roentgen-opaque, without masking the underlying bone to any great extent.

A material which vies with acrylic resin with respect to its tissue tolerance, and which is also stronger, is vitallium. Negotiations are in progress with the Austenal Laboratories, New York, regarding the construction of a vitallium knee-joint prosthesis.

Obviously, it is possible that a material will be produced in the future that has still better properties than the aforementioned.

Reinforcement

In all except the last 5 prostheses, the medullary pins had a central core of stainless steel. This reinforcement nevertheless proved to be a weakness rather than otherwise when the prosthesis had been in place for some time.

* Manufactured by AB Bofors Nobelkrut, Karlskoga, Sweden.

** Manufactured by Röhm und Hass Co., Darmstadt, Germany.

Experience of this matter had been gained from Judet prostheses examined after fracture and removal. According to Scales & Zarek (1954), the following factors influence the strength of that part of the prosthesis reinforced by a metal core.

The coefficient of expansion of acrylic material is approximately eight times greater than that of steel. Consequently, when the prosthesis is sterilized by boiling, changes in tension take place in the borderline zone between the two materials, and may lead to loosening of the metal core.

Even stainless steel can rust if it is subjected to great and prolonged stress. The material becomes fatigued and corrosion fatigue arises. A brown deposit, consisting of iron oxide, is then formed on the steel core. It appears first at the sites on which the stress has been greatest.

The ratio of the modulus of elasticity of steel to that of acrylic resin is 86:1. For this reason as well, it is unsuitable to use metal for reinforcement.

The aforementioned reactions lead to a disturbance in the firm contact between the two materials. This appreciably reduces the strength of the prosthesis. For this reason, the prosthesis is constructed without the steel core for reinforcement (from operation 28 onwards).

Stability

With the techniques hitherto used for arthroplasty, one of the greatest problems has been to obtain sufficient stability in the joint. When operating, it has been necessary — in order to remove all the diseased areas and to insert an interposition material between the ends of the joint — to cut or excise those ligaments which give stability to the joint. These are the tibial and fibular collateral ligaments and the cruciate ligaments. Since the knee joint is spiral and closely resembles a hinge, it was natural to try to make the prosthesis as a hinged joint. Its construction implies that it takes over the function of the collateral and cruciate ligaments. Consequently, with the use of such a prosthesis, their removal need not have a detrimental effect on the stability of the joint. An obvious prerequisite is that the prosthesis is firmly fixed in the bone.

Fixation

The mechanical conditions for obtaining good fixation of the prosthesis seem to be considerably better in the knee joint than in the hip joint. The prosthesis can be inserted axially in the longitudinal direction of the leg, parallel to the longitudinal axis of the body, and thus bear the weight approximately in this direction. Consequently, there need not be the lever

effect on the prosthesis, with its loosening as a result, that can be seen with a prosthesis of the hip joint.

Moreover, the knee joint offers much larger and more massive areas of bone for fixation of the prosthesis than does the hip joint. A far larger contact surface is obtained between the prosthesis and the bone. The resected areas can be made entirely plane, and at right angles to the direction of weight bearing. The contact surfaces of the knee-joint prosthesis to the bone are 2 to 2½ times larger than those of the largest Judet prosthesis. The surface of the femoral part is 2,380 mm² and that of the tibial part 1,970 mm², whereas that of the Judet hip-joint prosthesis is 920 mm².

This is of paramount importance for the biological processes in that part of the bone lying in contact with the prosthesis. According to Wolff's law, slight permanent pressure on the bone leads to new formation of bone, whereas constant strong pressure leads to its destruction. It is therefore expedient for the pressure of the prosthesis per surface unit of bone to be as small as possible. If it is excessive, the bone around the prosthesis atrophies, and the latter loosens. This has been observed to occur with the Judet prosthesis; the channel for its stem undergoes funnel-shaped widening, and the prosthesis loosens. If the vitality of the bone is good, and the prosthesis is correctly inserted, a roentgenologically visible, sclerotic zone is formed in the bone around the prosthesis (Judet *et al.* 1954). According to these authors, the first sign of loosening of the prosthesis is disappearance of this zone. These reactions occur in agreement with the Arndt-Schulz law, *i.e.*, that weak stimuli increase the activity of the cells, and strong stimuli decrease the vitality of the tissues.

Surface Wear

It has been found that the Judet prostheses are not altogether able to withstand undue wear at the points subjected to the greatest stress. Small flattened areas are apt to appear, particularly if the bone of the acetabulum is exposed and if there is any lack of congruence between it and the head of the prosthesis. Since the joint surfaces of a hinged joint can be made entirely congruent, the wear and tear on them can be reduced.

Test of the Frictional Heat, Surface Wear and Strength

In order to ascertain the frictional heat within the prosthesis, and its surface wear and strength, a machine roughly corresponding to the lower limb was constructed. It represented the thigh, the knee joint with the prosthesis attached, and the lower leg (Fig. 3). An electric motor drove the

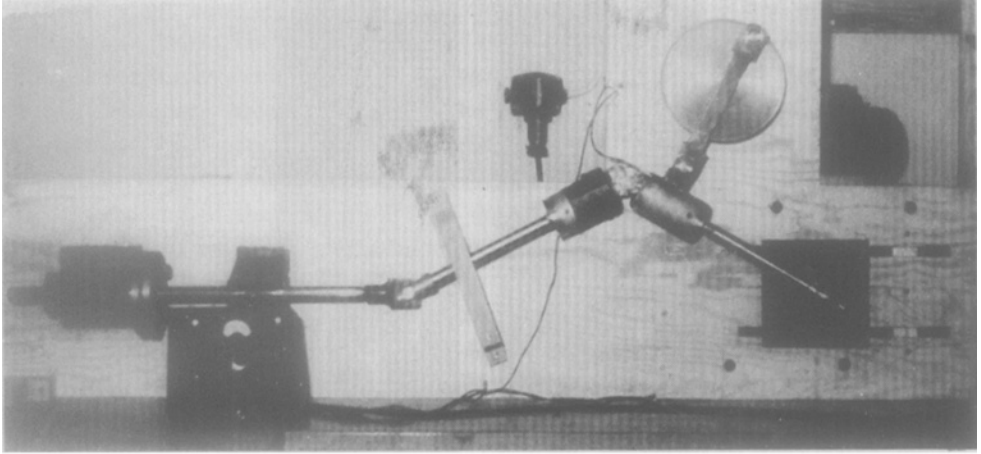
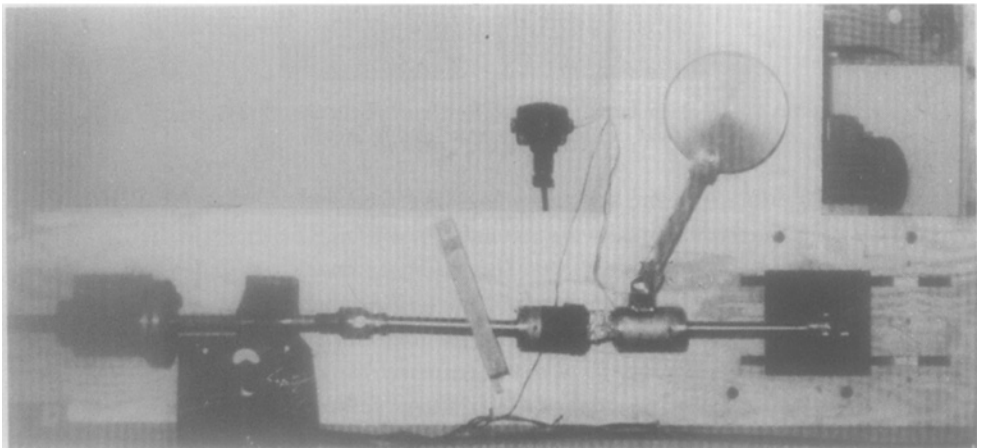
**Fig. 3 A.***Fig. 3 B.*

Fig. 3. Machine for testing the prosthesis. A : prosthesis in flexion position.
B : prosthesis in extension position.

joint backwards and forwards in extension and flexion movements. In the extension movement, the "lower leg" was pressed against a spring corresponding to the body weight. The temperature in the prosthesis due to friction was measured with a thermopile. An attempt was made to lubricate the prosthesis by surrounding it with rubber tubing, through which physiologic saline was injected. Unfortunately, the tubing did not withstand the strain, and it was therefore necessary to refrain from lubrication. The strain was therefore considerably greater than normally.

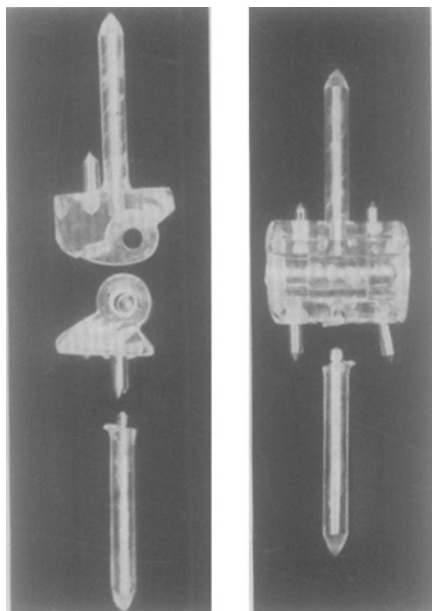


Fig. 4. Prosthesis of older model (Case 2) after functioning for 4 years 7 months. Tibial medullary pin fractured in accident.

In the beginning of the test, a spring was used which exerted a pressure of 90 kg on the knee joint in the extended position. The machine had a rate of 47 strokes per minute, corresponding to an ordinary walking rate.

The machine was first run for 54 hours (7.5 hours a day) and the temperature read off every other hour. The highest temperature recorded in the prosthesis was 36°C . The room temperature at the time was 25°C . There was thus a rise in temperature in the prosthesis of 11°C . As a rule, the temperature in the prosthesis remained at about 30°C and the room temperature between 21° and 25°C . After 54 hours, the spring broke, and was replaced by a new one with the same dimensions. This spring lasted for only 24 hours. During this time, the maximum temperature in the prosthesis was 44°C and the maximum room temperature 26°C . The temperature in the prosthesis thus rose by 18°C . The temperature in the prosthesis usually remained at 35°C and that of the room at 24°C .

The broken spring was replaced by a stronger one, which required a load of 140 kg to be driven in. The prosthesis was driven with this spring for 8 hours, with a maximum temperature in the prosthesis of 42°C and a room temperature of 25°C . The former temperature thus rose by 17°C . This heavy load caused the planks on which the machine was mounted to sag. As a result, the whole system began to sway, thus applying a lateral strain on the prosthesis. The machine was allowed to continue running, in order

to ascertain what part of the prosthesis would break down under this abnormal load. The screws in the lower part of the cross-piece which regulated the movements of the "lower leg" gradually worked loose. When the cross-piece became detached, the lateral swaying increased and the prosthesis broke at the point of attachment of the femoral medullary pin to the central part.

At the end of the experiment, the diameter of the central rod was found to have been worn down by 0.01 mm, and the diameter of the channel by 0.02 mm.

The greatest rise in temperature recorded was 18° C. If the prosthesis, after insertion in the knee, were to undergo the same stress as in this test, it would imply an increase in temperature from a body temperature of 37° C to $37^{\circ} + 18^{\circ} = 55^{\circ}$ C. In the leg, the prosthesis is, however, "lubricated" by the joint fluid, so that a smaller rise in temperature can reasonably be expected. Moreover, this rise in temperature should not have a detrimental effect on the material of the prosthesis, since Bonoplex is resistant to heat up to 60° C and M 9373 to heat up to 70° C.

Wear and Tear on Two Prostheses After 3 and 4½ Years' Function, Respectively

In Cases 1 and 2, it was possible to record the changes that had taken place in a prosthesis after it had been inserted in the knee for 3 years 3 months and 4 years 7 months, respectively. In both cases the joint had functioned to the full satisfaction of the patient. In Case 1 the prosthesis was removed at autopsy, and in Case 2 at reoperation after the patient had fallen down and "fractured" her knee. In the latter case the knee had been subjected to normal stress. The patient walked without support; she lived on the third floor of a house without a lift, and went out and did her shopping daily. The prosthesis had withstood this stress for 4¼ years before the fall which fractured it.

The tibial pin of both prostheses was found to be fractured at the base. In Case 2, one of the stabilizing pins was bent sideways (Fig. 4). Measurements of the dimensions of the prostheses showed the following. In Case 1 there were no changes in the dimensions of the steel rod. In Case 2 it tapered slightly to a cone, so that the diameter at one end of the 53 mm long steel rod was 0.10 mm less than at the other end. In Case 1, the inner axle journal in both the inner and the outer part of the hinge was worn down 0.4 mm in the vertical direction and 0.25 mm in the horizontal direction. The corresponding figures in Case 2 were 0.5 mm and 0.2 mm (Fig. 5). In neither case could any signs of wearing down be observed on the outer axle journal. This also applied to both contact surfaces of the two prostheses, although

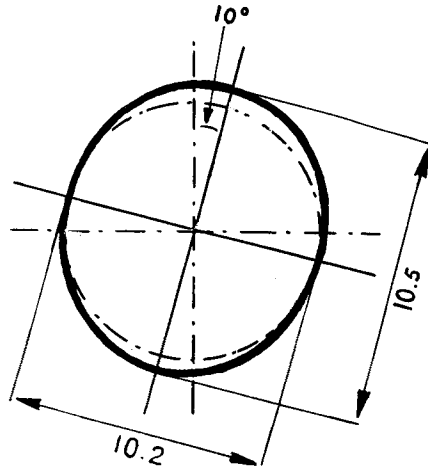


Fig. 5. Wear and tear in the inner axle journal. The broken circle represents the cross-section of the metal rod, and the unbroken oval the cross-section of its channel.

Case 2: *cf.* Fig. 4.

a few small pits and scratches were visible in each case. In both prostheses the surface of the steel core in the two medullary pins was veiled by a faintly brown deposit.

The rate at which wearing down occurs in the inner axle journal of the hinge joint will diminish when weight bearing is taken over successively in the outer axle journal as well, its surface being more than three times as great as that of the inner axle journal. The wearing down in the vertical direction in the channel of the inner axle journal can be calculated approximately to amount to 1 mm in 10 years. This is of an order of magnitude that need not be detrimental to the function of the joint even in the course of several decades.

Elicitation of Pain

One of the pain-sensitive tissues in the joint is the spongy bone (Bonica 1954), which may lie entirely unprotected, as for instance in rheumatic joints after destruction of the cartilage (Figs. 23 and 24). Bone will then be in contact with bone, and will give rise to severe pain on movement. By inserting a hinge joint in which the joint surfaces consist of non-vital material insensitive to pain, considerable alleviation of the pain can be expected.

CHAPTER III

Instruments Required for the Operation

In addition to the instruments used in ordinary orthopaedic operations, only a few special instruments are required, *i.e.*, an auger, a measuring block, two punches, and a handle (Fig. 6).

The *auger* is 11.7 mm in diameter, and is used to drill a channel in the medullary cavity of the femur and tibia, into which the medullary pins of the prosthesis are driven.

The *measuring block* is made of acrylic resin, and is used for two purposes. It is the same height (38 mm) as the central, massive part of the prosthesis, and is inserted between the resected surfaces to determine whether the correct amount of the condyles has been resected, and that the alignment of the limb is accurate when the block rests against the two resected surfaces simultaneously. This check must show that there is no flexion or hyper-extension position, nor any genu varum or valgum. The measuring block also serves as a guide for the auger, so that it enters at right angles to the resected surface. A channel with a diameter 0.1 mm greater than that of the auger

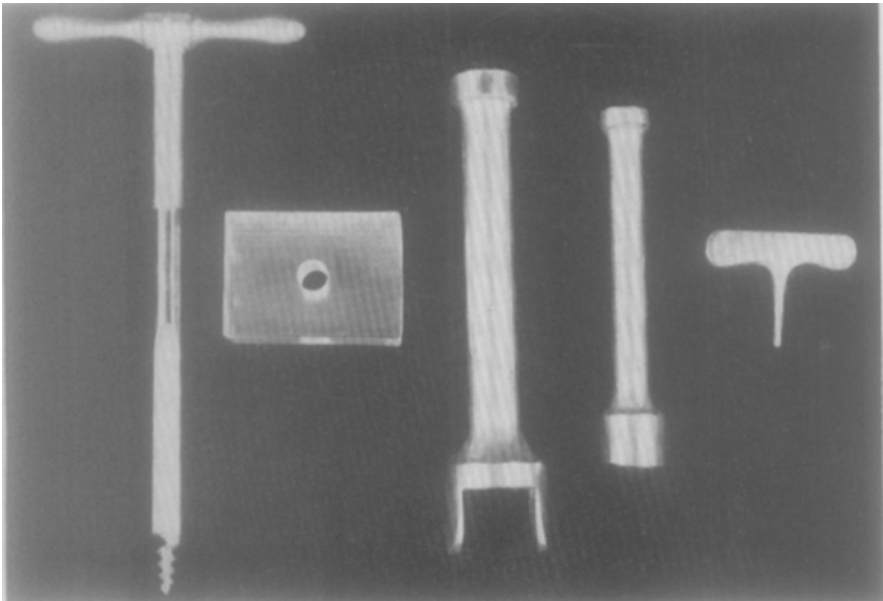


Fig. 6. Instruments used for operation: auger, measuring block, two punches and handle.

runs through the centre of the block, at right angles to its contact surfaces. When the channels are to be bored in the medullary cavity, the auger is introduced through this channel, so that its tip impinges on the resected surface in the centre of the medullary cavity. The block is thus held firmly against the resected surface, and ensures precision in drilling.

Two *punches* are used for insertion of the two parts of the prosthesis, one for the femoral part and one for the tibial part. Their contact surfaces are shaped to fit into the pattern of the respective parts of the prosthesis.

A *handle* provided with a hinged peg, which fits into a groove in one end of the steel rod in the centre of the prosthesis, is used to facilitate management of the rod.

In the first 16 operations, the prosthesis used had two small stabilizing pins on each of its two parts, in addition to the long medullary pin. Two pins on each of its two parts, in addition to the long medullary stift. Two stainless steel patterns were therefore used. They corresponded to the contact surfaces of the prosthesis, and had holes directly opposite each of the medullary pins and the small stabilizing pins. The patterns were placed against the resected surfaces, and the channels for the respective pins were drilled through the holes in the patterns.

CHAPTER IV

Indications for Operation

When a new surgical technique is introduced, the first operations must be somewhat in the nature of an experiment, of which the outcome is uncertain. Consequently, one of the difficulties is to find a patient material in which the intervention can be performed with the minimum of risk. There exists a category of patients in whom the present operation seems to be justified. They consist of the highly disabled patients with rheumatoid arthritis, who have pain and severe destructive changes in the knee joints, accompanied by rigidity and deformities, which make them unable to walk. Despite all customary conservative therapy, they are almost total invalids. Many spend most of their time in a wheel chair, and are dependent on others for their care.

In this category of patients, successful arthroplasty of the knee would greatly reduce their invalidism by restoring their ability to walk. Their condition is already so poor that it can scarcely become worse. They have everything to gain and little to lose by operation. On the other hand, earlier experience of arthroplasty of rheumatic joints has been unfavourable, so that the prospects of obtaining good results with a new technique cannot, *a priori*, be regarded as hopeful. Arthrodesis has been the operation chiefly used hitherto. As a rule, both knee joints are involved, and are not infrequently in need of operative treatment. In this event, bilateral arthrodesis is scarcely the ideal solution for relieving the disability. Evidently, it is possible to walk with two stiff knees but it is difficult, for example, to get in and out of a chair. This requires good mobility and strength in the arms and hands, which is far from often present in these severely disabled patients with rheumatoid arthritis.

The remaining alternatives are arthrodesis of one knee and arthroplasty of the other, or arthroplasty of both. Should arthroplasty be unsuccessful, arthrodesis can be undertaken later. Consequently, should the question of a bilateral operation arise, arthroplasty should be done first. If it does not succeed, it can be followed by arthrodesis, and later by arthroplasty of the other knee.

Present series. Arthritic joint lesions were the indication for operation in 29 of the 32 in the present series. These operations were performed on 23 patients, all with bilateral involvement of the knee joint, most of the other

joints also being affected. One patient (Case 18) also had achondroplasia, and another (Case 1) chondromatosis of the capsule.

Two patients (Cases 10 and 26) were operated on for severe arthrosis deformans, and one (Case 7) for post-traumatic ankylosis.

The indications for operation were based on two symptoms in particular, *i.e.*, pain and limitation of movement. Pain was elicited by both weight bearing and movement, so that the patient was incapable of walking, or could do so only with great discomfort. Limitation of movement consisted in most cases of an extensor defect ranging from 5° to 90°, and had not infrequently been present for many years.

Ankylosis of both knees was present in two patients (Cases 13 and 17), and of one knee in five patients (Cases 3, 6, 10, 16, 19 and 20). In the former group arthroplasty was performed on one knee, and in the latter group on the non-ankylosed knee, in which there was pain and limitation of movement.

Bilateral arthroplasty was performed on six patients (Cases 1, 8, 18, 22, 23 and 24), all of whom had pain and limitation of movement caused by rheumatoid arthritis. Two of them (Cases 8 and 23) had an extension defect of about 90° in both knees. Arthroplasty of one knee and arthrodesis of the other were carried out in two patients (Cases 12 and 14). Arthroplasty of one knee and arthrolysis of the other were done in one case (Case 4).

Walking capacity. Before operation, 11 patients had been unable to stand or walk for several years, two of them (Cases 8 and 17) for 10 years, four (Cases 14, 15, 23 and 24) for 3 years, and five (Cases 4, 21, 11, 20 and 3) for 5 years, 2 years, 1 year, 1 year, and 4 months, respectively. Four patients (Cases 1, 7, 9 and 12) could only walk a short distance (50 to 500 m) out of doors. The other 11 patients were only able to take a few steps indoors. Of those able to walk, all except two used some kind of support, *i.e.*, one stick in five cases, two sticks in one, a crutch and a stick in two, two crutches in two cases, and a helper in one case. Two patients used a knee brace and one had the whole leg bandaged.

Sex and age distribution. The series comprised 17 women and 9 men. Their age ranged from 29 to 79 years, the average age being 53 years. This is a somewhat higher age than that hitherto regarded as suitable for arthroplasty of the knee, namely, 20 to 40 years.

Duration of disease. The duration of the disease varied from 3½ to 37 years, with an average of 17 years.

The *S. R.* ranged from 7 to 115 mm/1 hr, with an average value of 42 mm/1 hr.

Earlier treatment. Prior to operation, all the patients had undergone various forms of current conservative treatment. Most of them had repeatedly spent

long periods in a general hospital or in special departments for rheumatic diseases.

When the operation was discussed with the patient, it was stressed that it was a new one, and that little experience of it had been gained. It was also made clear that, should arthroplasty be unsuccessful, the possibility of performing an arthrodesis remained, this having been the only alternative earlier. Those patients who underwent bilateral arthroplasty were operated on the second time at their own request, after the other knee had been operated on with good results.

CHAPTER V

Operative Technique

Preparations for Operation

Spinal anaesthesia was used in 27 operations. In 16 of them it was given as a hyperbaric solution (Tetracaine grave, Aco) and in 11 as a hypobaric solution (Nupercaine, Ciba, 1:1,500). The duration of anaesthesia with these preparations is generally 2½ and 3½ hours, respectively. Since the operation took between 45 minutes and 3 hours 10 minutes (mean: 1 hour 43 minutes), this form of anaesthesia usually sufficed. In 4 operations it was, however, necessary to complement it with Narkotal (isopropyl-β-bromallyl-N-methylmalonylcarbamide sodium, Astra), and nitrous oxide. In 5 operations, general anaesthesia was given at the patient's request, using ether, or Narkotal and nitrous oxide, or a combination of both.

In 25 operations, an intravenous drip infusion was set up preoperatively, and 5 per cent glucose solution administered, with 500 mg of Terramycin per 1,000 ml as a prophylactic against infection. This intravenous therapy was continued for 1 to 4 days. In 19 operations, blood (350—800 ml) was also given through the tube, in order to prevent shock.

An Esmarch bandage was applied in 28 operations, and removed just before the prosthesis was definitely mounted in the leg.

The skin round the knee joint was prepared on the same principles as in other operations on the joints.

Skin and Joint-Capsule Incision

In 29 operations, a curved transverse incision according to Textor was made. The vertex of the arch lies on a level with the centre of the tuberosity of the tibia, and its two end-points about 2 cm proximal to the joint space on its medial and lateral aspects, at the level of the collateral ligaments (Fig. 7). The proximal skin flap is not detached from the capsule, since this would cut off part of the blood supply to the skin, with a resulting risk of necrosis. The joint capsule is cut through medially and laterally on a level with the skin incision, as far as the ligamentum patellae. The incision is then deviated distally, beside the ligament, and continued downwards on both sides of the tuberosity of the tibia. This is chiselled off from the side with a broad chisel, so that a rectangular piece of bone is obtained, measuring

about 1.5 by 2.5 cm and 6 to 8 mm thick (Fig. 8). It remains attached to the ligamentum patellae, and is reflected upwards with it when the joint is opened (Fig. 9). The collateral ligaments can be severed, since their stabilizing function is taken over by the inserted prosthesis.

The tibial attachment of the capsule is freed subperiosteally for 1 to 2 cm downwards, every effort being made to keep the capsular margin intact. This facilitates suturing the capsule after the prosthesis has been mounted in position. Otherwise, it may be difficult to achieve complete covering of the prosthesis with the capsule. Any adhesions in the capsule are freed bluntly or dissected out, and excised together with other pathologic excrescences. In other respects, the capsule is retained and treated as leniently as possible.

In three operations, a different incision was used, *i.e.*, a medial (nos. 11 and 14) and a lateral (no. 13) slightly curved longitudinal incision. The capsule was incised at the level of the skin incision, except in operation 11, in which a straight, longitudinal incision over the patella was continued up into the tendon of the quadriceps femoris and down into the ligamentum patellae. In this case, the patella was excised after being sawn through longitudinally.

These longitudinal incisions do not give fully as good exposure of the knee joint as does the transverse curved incision. In particular, they do not give enough access to permit resection of the articular surface of the tibia with a saw, but a chisel must be used instead. The articular surface of the femur, on the contrary, can easily be sawn off. The advantage of these incisions is that they lie in the longitudinal direction of the extensor apparatus, so that they are not subjected to strain to the same extent as the transverse incision, with a risk of tearing when movements are started post-operatively. Although operation is easier from the technical point of view with the transverse incision, the longitudinal incisions may be used. It can, in fact, be left to the surgeon to choose the incision to which he is most accustomed.

For and Against Excision of the Patella

The patella was excised in one operation only (no. 11). One of the reasons for retaining the patella is to avoid the operation being unnecessarily extensive, with a risk of haemorrhage from the quadriceps tendon into the joint. Furthermore, the fulcrum effect of the quadriceps muscle remains, without which its strength is somewhat impaired.

It might be assumed that a retained patella could be a pain-eliciting factor, particularly if a lack of congruence between the patella and the prosthesis were to arise. This has not, however, proved to be the case. Only in one

case (no. 2) was pain localized to the base of the patella, and was felt only on movements approaching maximal flexion (110° — 90°). It is reasonable to infer that the pain was elicited by an irregularity in the gliding surfaces on the borderline between the upper anterior edge of the central part of the prosthesis and the femoral condyles. In order to ensure a more even gliding surface for the patella, a prosthesis with an anterior lip, along which the patella runs, has been used in recent operations (no. 17 and thereafter).

As a rule, only the greatest irregularities on the patella were removed, to obtain good congruence between it and the prosthesis. Complete congruence could not always be achieved. Only in cases in which difficulty is found in obtaining a reasonable fit between the patella and the prosthesis — *e.g.* when bony ankylosis between the femur and patella necessitates chiselling away the patella — can it be advisable to excise the patella wholly or partially.

In three cases (nos. 5, 10 and 13), excision of the patella was subsequently performed, on the grounds of lack of mobility of the joint. This operation was done 11, 4 and 1 month, respectively, after the primary operation. The patella was then found to be adherent to the femur, which accounted for the lack of mobility. Unfortunately, infection of the joint supervened in all three cases, and could not be overcome by antibiotic therapy. It was therefore necessary to extract the prosthesis and to perform arthrodesis. This was done 2 years 9 months, 2 years 8 months and 1 year 9 months, respectively, after insertion of the prosthesis.

As stated earlier, a prosthesis provided with an anterior lip has been used in operations from no. 17 onwards. This lip prevents such fusion of the patella and femur, and good mobility has been achieved in all these later cases.

There is, however, reason to anticipate good results even if the operation is combined with excision of the patella. In the case in which primary excision of the patella was carried out, it was evident how training relatively quickly restored mobility of the joint.

Resection of the Articular Surfaces

The articular surfaces of the tibia and femur are resected so that they are completely plane and at right angles to the longitudinal direction of the diaphysis (Figs. 10 and 11). This is best done with an ordinary saw. It is relatively easy to estimate a plane at right angles to the longitudinal axis of the tibia, and it is therefore suitable to start by resection of this bone. Estimation may be more difficult in the femur, but it is facilitated if, after resection of the tibia, the knee is stretched out straight, and the resection surface on the femur is measured parallel to that on the tibia.

The height of the prosthesis is 38 mm, and the combined height of the

Figs. 7—22. The operation



Fig. 7. Skin incision.



Fig. 8. The tuberosity of the tibia is chiselled off.



Fig. 9. The joint is opened.

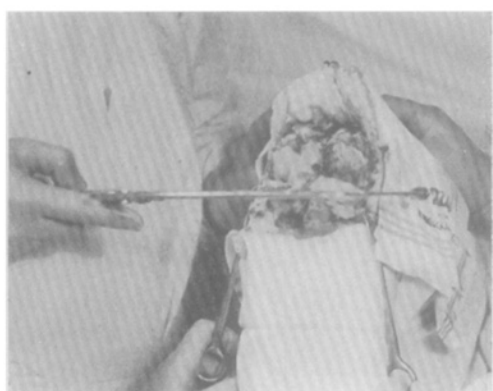


Fig. 10. The joint surface of the tibia is sawn off.

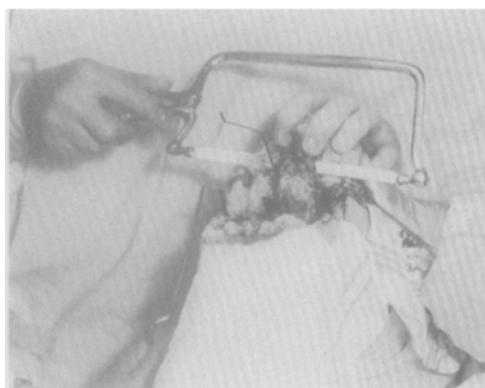


Fig. 11. The joint surface of the femur is sawn off.



Fig. 12. The measuring block is used to check the alignment.

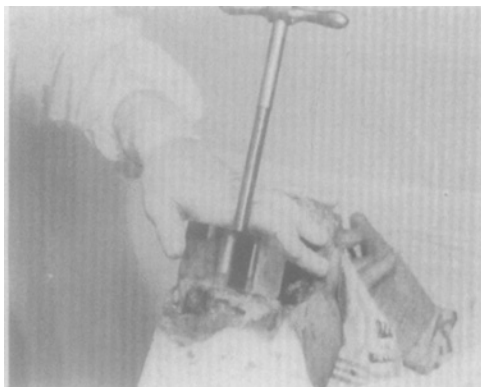


Fig. 13. Drilling the channel in the tibia.

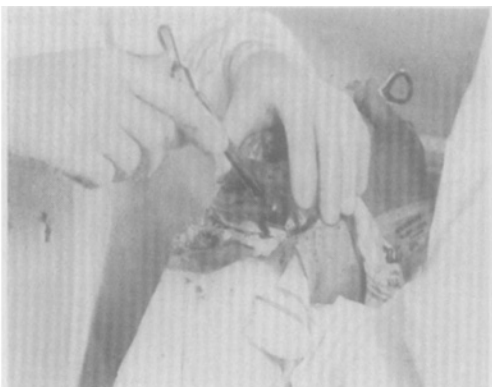


Fig. 14. Drilling the channel in the femur.



Fig. 15. The femoral part of the prosthesis is driven in with the punch.



Fig. 16. The tibial part of the prosthesis is driven in.



Fig. 17. The two halves of the prosthesis are joined.



Fig. 18. The metal rod is introduced.

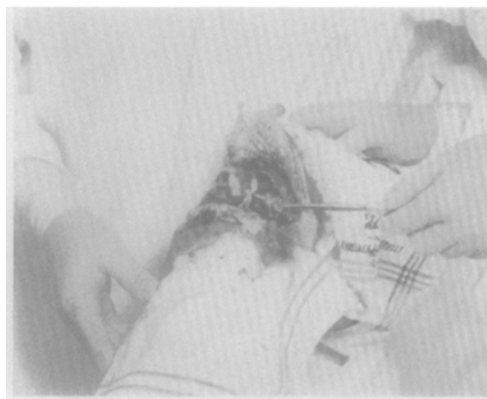


Fig. 19. The plastic screw is tightened.



Fig. 20. The joint capsule and tuberosity of the tibia are sutured.



Fig. 21. Skin suture.



Fig. 22. Plaster cast for the knee.



Fig. 23. The resected parts of the condyles (C a s e 16).



Fig. 24. The resected parts of the condyles (C a s e 22).

resected areas of bone should therefore not be less than 38 mm. About 10 to 15 mm are removed from the tibia and a layer 23 to 28 mm thick from the femur. These are naturally approximative measures, estimated visually in the course of operation. In some cases a considerably greater amount must be resected, as in Case 8, in which high-grade backward dislocation of the tibia was present. After resection of the tibial condyle, the head of the fibula

may occasionally present an obstacle to insertion of the prosthesis. It is then necessary to excise part of the head of the fibula.

As a check that a sufficient amount of bone has been resected, and that the resected surfaces are at the correct angle, the measuring block (of the same height as the prosthesis) is inserted between them. When the block rests against the two resected surfaces simultaneously, the knee should be in the position of full extension, with no genu varum or valgum (Fig. 12). If this is not the case, further resection must be done until correct alignment is achieved.

In two operations (nos. 8 and 17, Case 8), resection of the condyles was insufficient, owing to total backward dislocation of both tibias, and marked contraction of the flexor muscles. When the knee was extended after resection, the distance between the resected surfaces was too small for the measuring block. It was therefore necessary to make Z-shaped tenotomies on the flexor tendons, after which the prosthesis could be mounted in place.

Figs. 23 and 24 show the resected articular surfaces in Cases 16 and 22.

Insertion of the Prosthesis

The channels in the medullary cavities are bored with an auger (Figs. 13 and 14). The measuring block is used to orient the auger, so that it enters at right angles to the resected surface. The centre of the medullary cavity is determined by means of a guide pin, with which the cavity is explored. The broad end of the measuring block is placed against the resected surface, so that its channel lies directly above the centre of the medullary cavity. The auger is inserted through the channel in the measuring block and the channel in the medullary cavity is drilled. It should be 65 mm deep, which is the length of the medullary pin of the prosthesis.

If the resected area is not at right angles to the longitudinal axis of the bone, the auger may impinge on the cortex. The auger then has a tendency to change its direction, which is noticed by the measuring block being forced out of contact with the resected surfaces. Resection must then be corrected with a saw or chisel, in order for the auger to enter without resistance. Another possibility is that the auger penetrates the cortex, as occurred in Case 1 (Fig. 32).

In the first 16 operations, a prosthesis was used which had two small stabilizing pins extending from the two contact surfaces, instead of the aforementioned lips. Its appearance is shown in Fig. 4. When it was inserted, two stainless steel patterns were used, corresponding to the contact surfaces of the prosthesis, with holes opposite the thick medullary pin and the small stabilizing pins. The patterns were placed against the resected surfaces, and

channels for the stabilizing pins drilled through the holes in the patterns. It was, however, found that the small metal pins in the tibial part of the prosthesis sometimes pressed hard against the cortex, making it difficult to fit this part. Occasionally, one of the pins entered exactly in the margin of the resected surface or even beyond it. Insertion was therefore somewhat complicated and time-consuming. For this reason, the prosthesis was modified, so that instead of the small metal pins, it was provided with two lips, which serve the same purpose and also form a joint surface for the patella on the femoral part.

This type of prosthesis is inserted by chiselling out small grooves for its lips on the anterior margin of the resected surface of the femur, and on the posterior margin of that of the tibia. The fit of the two parts of the prosthesis is tested, and the resected surfaces are reshaped with a chisel if necessary, until good congruence is obtained between them and the contact surfaces of the prosthesis. Any defect in contact can be filled out with a sliver of bone from the resected condyles.

Before the parts of the prosthesis are definitely driven in, the Esmarch bandage is removed, and all bleeding is carefully stilled. The punches are used for driving in the parts of the prosthesis (Fig. 15).

The two halves of the prosthesis are joined with the steel rod (Figs. 17 and 18). Its outer tip is covered with an acrylic screw (Fig. 19). In the first 16 operations, this was fixed by softening the screw and the part of the prosthesis adjacent to it with a hot soldering iron, so that fusion occurred. In the subsequent operations, the prosthesis was constructed in such a way that when the screw was fully driven in, it sank a few millimetres below the surface. The resulting small cavity will become filled with connective tissue, which will prevent the screw from working loose.

After driving in the screw, the mobility of the knee is tested. It should be possible to extend it fully and to flex it to 90° . It must be warned against testing the mobility before the rod has been inserted. If this is done, and an attempt is made to overcome any resistance — particularly in attempting full extension in cases with flexion contracture — it may result in a lever effect in the joint instead of a hinge movement. Extension will then be still more difficult, and the prosthesis is subjected to abnormal strain.

The posterior parts of the femoral condyles may occasionally form an impediment to maximal flexion through conflict with the posterior portion of the tibial part of the prosthesis. In this event, the necessary amount is removed with a chisel.

The position of the foot is a detail to be borne in mind. When inserting the prosthesis, the foot is placed in alignment with the sagittal axis of the

prosthesis. If attention is not focused on this matter, the foot may become fixed in a position of outward or inward rotation. The latter occurred to some degree in Case 2.

Closure of the Joint

When the prosthesis had been mounted in position, a rubber drainage tube was inserted in the posterior part of the joint in 19 operations, and a large-bore cannula in 2. In the other cases, no drainage was used. The capsule, together with the patella, the ligamentum patellae and the tuberosity of the tibia, is turned down over the joint. The tuberosity is fixed at its former site, or if possible somewhat more distally, with two strong silk sutures through the bone. In the first operation the tuberosity was fixed with a wing-screw, and in operation 6 with a Rissler pin; both the screw and the pin were subsequently extracted. The capsule is sutured carefully with catgut, so that the whole prosthesis is covered (Fig. 20). The skin is closed with isolated steel sutures, sometimes reinforced with a rolled strip of gauze (Fig. 21). A dressing and cotton wool are applied to the wound, and the whole leg is wrapped in cotton wool.

Knee Cast

A plaster of Paris cast is applied to the knee or to the whole leg, with the knee in the extension position (Fig. 22). It is important when padding the cast to place plenty of wool under the heel and the Achilles tendon, to prevent decubitus. The plaster is immediately cut on the medial and lateral aspects, and wound with a gauze bandage. In 10 operations, the leg was only placed in a splint. This proved to be a questionable procedure, which will be discussed in the chapter on complications.

CHAPTER VI

Postoperative Treatment

On the day after operation, the drainage tube is withdrawn. The bandage is usually soaked through; it is changed and the wound dressed. The plaster encasing the knee as a split circular cast should be retained for three weeks. In some cases the anterior part was removed after a shorter time, but the posterior part of the cast was generally left for 3 to 5 weeks. The sutures are removed after 2 to 3 weeks. It generally takes around three weeks for the wound to heal properly, and there is no reason to remove the sutures too early, with a risk of the wound opening.

Exercise is not started until the wound has healed adequately. It consists first of passive movements, aided by the patient. This gives the best guarantee that the joint will not be overstretched. The mobility is usually 20° to 30° when the cast is removed after three weeks. After this time, chief importance is attached to active movements. The quadriceps muscle in particular must be trained. Limbering up the joint is best done by the patient himself in a hot bath. Brisement forcé under anaesthesia is warned against. If this is done, ruptures in the joint capsule are apt to occur, and the wound may open. The risk of infection is then imminent.

When the patient is able to straighten the leg and to carry out active, well-controlled movements of the joint, weight bearing on the leg can be started, first with a "walker", and later with crutches or sticks. This is usually 6 to 8 weeks after operation. As a rule, the mobility of the joint is about 180° to 120° by this time. A somewhat longer time is required to train the last 30° of flexion. About six months after operation, the patient is generally able to flex the knee 90° .

The mean duration of hospitalization in all patients was 5 months 8 days. The corresponding figure for the patients who had no complications which prolonged the stay in hospital was 4 months 7 days, that for each operated knee in this group being 2 months 22 days.

CHAPTER VII

Complications

It is evident that when a new surgical technique is introduced, this by no means implies that it has been worked out in its final form. This can only be done gradually, as experience is gained. It is in particular the complications which arise that necessitate various modifications being made. Such complications may appear early, in close connexion with operation, or they may appear late, even after many years. It would naturally be desirable to have a considerably longer observation period — preferably several decades — than is the case here.

In order to evaluate the risk of complications correctly in the present series, it should be borne in mind that the general condition of rheumatic patients is often poor, so that wound healing is slow, and resistance to infection is lowered.

An account is given in the following of the complications that have hitherto been observed in the present cases. The majority occurred in the first half of the series, when prostheses of the original model were used, and little experience had been gained. After introduction of the modified prosthesis, and from operation 19 onwards, there have been no late complications, and postoperative complications in two cases only, thrombosis and paralysis of the peroneal nerve, respectively.

Paralysis of the Peroneal Nerve

In Case 25, in which the prosthesis was inserted in the right knee, paralysis of the anterior tibial and peroneal muscles appeared. In addition, there was decreased superficial sensation on the dorsum of both feet, extending somewhat upwards onto the lower leg, more marked in the right leg. The paralysis successively regressed almost completely, but at the time of writing there is still a partial decrease in sensitivity of both feet.

The bilateral involvement indicates the possibility of spinal anaesthesia as the responsible factor. The fact that recovery from paralysis is almost complete nevertheless argues against this possibility. Another conceivable cause is nerve damage by the Esmarch bandage. This was, however, applied for only 50 minutes, and could be expected to result in more marked paralysis of the whole leg.

At the stage of operation when the joint surface of the tibia must be

sawn off, there may be conflict with the head of the fibula. It is sometimes necessary to resect part of it, in order to obtain an even surface. This did not apply in the present case. Otherwise, bleeding from this region might in the later course compress the peroneal nerve where it runs close to the head of the fibula.

After resection of the joint, there is considerable instability between the bones of the thigh and the lower leg. The possibility exists that incautious handling of them may result in overstretching of the nerve. It is therefore advisable, during this stage of the operation, for one of the assistants to have the sole task of supporting the thigh and the lower leg, and coordinating the necessary movements in the operative field.

In patients with long-standing, severe flexion contractures, it is also conceivable that the peroneal nerve is overstretched when the joint is straightened after insertion of the prosthesis. Finally, a too tight plaster cast may exert pressure on the peroneal nerve, with resulting paralysis.

None of the three last-mentioned possibilities seems to have existed in the present case. The neurologist consulted came to the conclusion that the complication might, to some extent, be ascribed to spinal anaesthesia.

Pulmonary Embolism

Case 9, a 61-year-old man with rheumatoid arthritis, died suddenly, presenting a picture of pulmonary embolism, on the 5th day after arthroplasty and the 13th day after stretching of the knee under anaesthesia. No manifest symptoms of thrombosis were present. Autopsy disclosed an embolus, about 7 mm in diameter and 3 cm long, in the right pulmonary artery. Its origin could not be established. In addition, there was severe generalized arteriosclerosis and an old posterior myocardial infarction. Judging by the time, it is more likely that the thrombus was formed in connexion with stretching of the knee than after arthroplasty.

Thrombosis

In Case 19, diffuse swelling of the operated leg appeared on the 10th post-operative day. The temperature was subfebrile. Thrombosis was diagnosed, and dicumarol was administered for one week, after which the swelling subsided. No post-thrombotic sequelae have hitherto developed.

Wound Disruption

In operations 6 and 18, the wound disrupted on the 5th and 13th day, respectively, after operation. A splint only had been used for fixation in

both cases, and had evidently failed to produce sufficient immobilization. The wound was resutured, but healed in neither case, and infection supervened. In Case 6, it was subsequently necessary to amputate the leg, and in Case 18 pyaemia developed and led to death. The wound also disrupted in Case 10, in which the leg had been fixed in a splint alternately in a position of flexion and extension, in order to hasten mobilization of the joint. Skin necrosis also developed, but the wound healed after five weeks.

Since the soft tissues over the anterior aspect of the knee joint, *i.e.*, the joint capsule and skin, are relatively thin, their failure to heal may have severe consequences. The path of infection from the skin into the joint is short. It is thus of the utmost importance for the joint to be adequately immobilized by means of a plaster cast encasing the knee, for a sufficiently long time (three weeks) to ensure satisfactory healing of the soft tissues.

Skin Necrosis

In four cases (nos. 1, 7, 10 and 12) skin necrosis developed in the wound. In Case 1, the contributory factors were too extensive freeing of the proximal skin flap, and the presence of a wing-screw which fixed the tuberosity of the tibia. The head of the screw forced up the skin from below. Necrosis of the bone also appeared. A small sequestrum detached spontaneously 16 months after operation, after which the wound healed. In Case 7, the skin was greatly scarred after an earlier injury, and was adherent to the bone, so that the vitality was impaired. Case 10 has already been accounted for under the heading of wound disruption. No definite cause of necrosis could be established in Case 12. Healing finally occurred in all four cases.

In order as far as possible to prevent development of skin necrosis, the skin margins should be freed to the minimum extent permissible from the underlying tissue, to avoid cutting off the blood supply to them.

Rigidity

In four cases (nos. 5, 7, 10 and 13), considerable rigidity of the joint was present postoperatively. In some of the first prostheses constructed, the hinge movement of the joint was slightly stiff. Moreover, one end of the channel in which the transverse rod was inserted was completely closed. When the rod was introduced at operation, some blood could accompany it into the channel, and had no possibility of flowing out once the acrylic screw had been fixed in position. A blood clot at this site can suffice to lock the joint completely. In prostheses of the later model, the channel in question continues into a narrower one, through which the blood can flow out. In

addition, these prostheses are so constructed that the hinge movement is considerably freer.

In the first prostheses, the edges were sharper and more projecting, so that it was necessary at operation in some cases to smooth them off with an electric cutter. In doing this, it was not possible to prevent some shavings finding their way into the joint. These may be a source of irritation, leading to fibrosis and adhesions, as has been demonstrated by Mittelmeier & Singer (1956) among others.

The patella also has a tendency to adhere to the femur unless it is allowed, as in the later model, to glide against the joint surface of the prosthesis intended for this purpose.

In Cases 5, 10 and 13, all the aforementioned factors were probably responsible for the rigidity. The patella was subsequently excised in all these cases, but the rigidity persisted.

In Case 7, a large retracting scar on the anterior aspect of the joint may have contributed to limiting the mobility of the joint to 160° to 130° .

Infection

At our clinic, antibiotics are administered to a fairly great extent, as prophylaxis against infection. Some resistant strains of bacteria have developed, i.e., *Staph. aureus*, coliform organisms, *B. proteus* and *B. pyocyaneus*. These organisms were responsible for the infections which appeared, with one exception (Case 7), in connexion with a surgical intervention. In Cases 5 and 10 it developed after excision of the patella, in Cases 1 (operation 18), 6 and 15 after arthroplasty, and in Case 13 after repeated intra-articular injections of cortisone. In Case 7, infection appeared 14 months after arthroplasty. In this case, the infection probably lay latent after the primary gonitis. Infection led to death in Case 1 (operation 18), to amputation in Cases 6 and 7, and to arthrodesis followed by ankylosis and healing of the infection in Cases 5, 10, 13 and 15.

Fracture of the Prosthesis

Four years and 3 months after arthroplasty, one patient (Case 2) fell and "fractured" the knee. At operation, the tibial pin was found to be fractured at the base and one of the small stabilizing pins was bent sideways (Fig. 4). The fracture was thus due to great force that the prosthesis could not withstand, and was not a fatigue fracture.

Three fatigue fractures were, however, disclosed although the patient had not noticed any impairment in the function of the joint. In Case 1. the

prosthesis in the right knee, which had functioned perfectly, was found at autopsy to be fractured at the same site as that in Case 2. In Case 23 (operations 25 and 26) the tibial medullary pin of both prostheses can be seen on the roentgenograms to be fractured at the base (Figs. 97 and 98). The patient nevertheless has fully adequate function in the operated knees.

Loosening of the Prosthesis

Some time after operation, osteophytes are usually visible roentgenologically around the central part of the prosthesis (Fig. 49). They must contribute to its fixation, which may explain why fracture of a medullary pin need not imply any functional impairment.

No definite loosening of the prosthesis of the type seen in Judet prostheses of the hip joint, with widening of the channel for the medullary pin, has been observed. After reoperating on a number of hips and knees in which arthroplasty with an acrylic prosthesis has been performed, and seeing the layer of connective tissue a few millimetres thick which invariably surrounds the prosthesis, one nevertheless has the impression that all prostheses are more or less loosely fixed. Under the load of the body weight, the prosthesis sways a few millimetres in its covering of connective tissue. As long as this swaying does not exceed a certain limit, and takes place in the right direction, it does not seem to have any detrimental effect on the bone tissue. This connective tissue membrane has the same shock-absorbing effect as that of cartilage. Consequently, it should, if possible, be preserved at reoperation.

CHAPTER VIII

Case Reports

A brief report is given in the following of the history, operation and subsequent course in the 26 patients in whom arthroplasty of the knee was performed, using the acrylic prosthesis described in Chapter II. A survey of the age and sex distribution in the present series, as well as of the indications for operation, is found in Chapter IV (pp. 29—31).

The diagnosis given in the case reports is confined to the pathologic conditions motivating the operation. In the account of the actual operation, mention is made only of any salient features of particular interest in the individual case. In other respects, the procedure was that described in Chapter V (pp. 32—41).

Case 1. (G.J. no. 4992/40). A man, aged 55 years. Former bookbinder.

Diagnosis. Flexion contracture and genu valgum of right knee, rigidity of left knee due to rheumatoid arthritis, and chondromatosis of right knee. *Hospitalization:* Sept. 28, 1951—Feb. 2, 1952, and Nov. 12, 1954—Jan. 12, 1955.

History. The patient had suffered from rheumatoid arthritis for 37 years, and had been unable to work for the past 11 years. Most of the joints were involved. The right knee had been in a considerable flexion and genu valgum position for 11 years. During the past 4 years he could walk at most 50 m with the help of a crutch and a stick, and could not bear weight on his right leg, owing to pain and instability. He had been treated in several rheumatologic clinics and convalescent homes. Tenotomy of the flexor tendons of the right knee had been performed 10 years previously. He subsequently used an unarticulated knee brace. — One year before the present examination, he was operated on for prostatic enlargement by transvesical electroresection, and later transurethral electroresection.

Preoperative examination (Fig. 25). General condition poor. Small and thin; musculature atrophic. S.R. 36 mm/1 hr. — Right knee: 10 cm long operation scar postero-laterally. Capsular thickening. Lateral subluxation of patella. Genu valgum 25°, flexion contracture 35°. Active and passive flexion 145° to 70° with pain and considerable crepitus. Considerable lateral instability and positive "drawer sign". — Left knee: capsular thickening. Flexion 180° to 70° with pain and crepitus. — Contracture and limitation of movement in other joints. — Walked very slowly and cautiously with a crutch and stick, without bearing weight on the right leg. — Roentgenologic examination of right knee (Fig. 31): high-grade destruction of joint cartilage. A number of calcified bodies in the soft tissues: chondromatosis.



Fig. 25. Case 1: before operation.

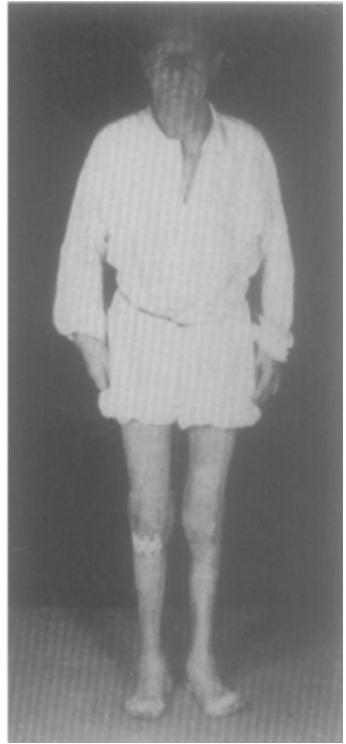


Fig. 26.

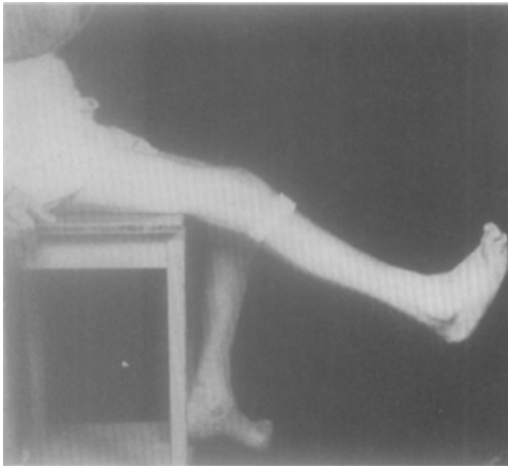


Fig. 27.



Fig. 28.

Figs. 26—28. Case 1: 3 months after arthroplasty of right knee.



Figs. 29 and 30. Case 1: 15 months after arthroplasty of right knee.

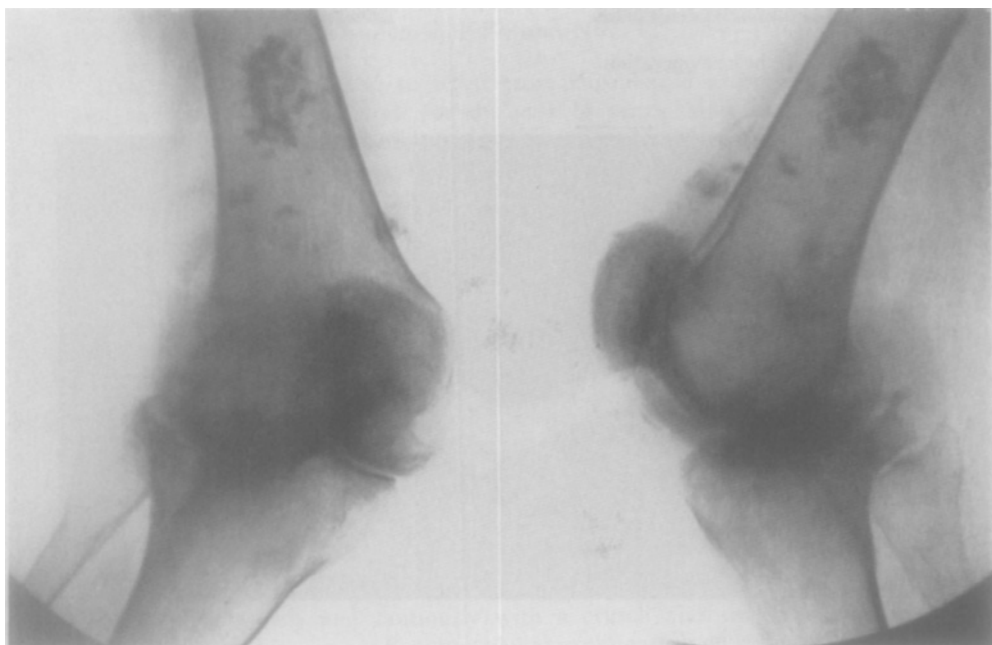


Fig. 31. Case 1: preoperative roentgenograms of right knee.

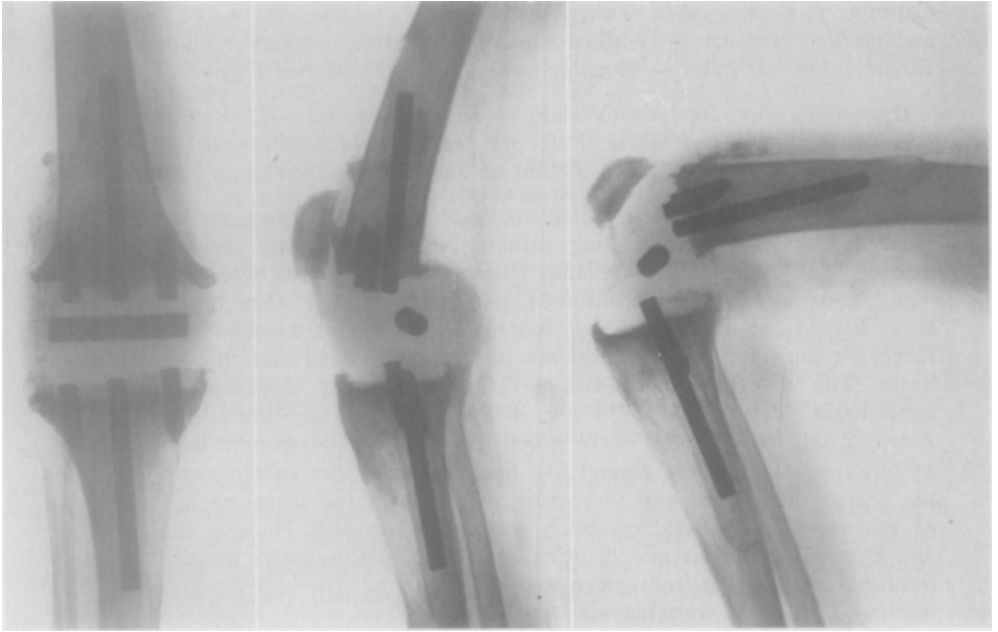


Fig. 32. Case 1: roentgenograms 3 years 1 month after arthroplasty of right knee.

Operation. Oct. 12, 1951 (Friberg and Walldius). Arthroplasty (no. 1) of right knee. On insertion of the femoral part of the prosthesis, its medullary pin penetrated the anterior cortex of the shaft of the femur, so that a gap appeared between the prosthesis and the posterior part of the resected surface. It was filled with a triangular piece of bone. The tuberosity of the tibia was fixed with a screw. The mobility of the prosthesis was 190° to 90° .

Postoperative course. Skin necrosis developed over the head of the screw, so that it lay bare; it was extracted 3 weeks after operation. The necrosis did not heal until 16 months postoperatively, after spontaneous expulsion of a small sequestrum. On discharge, the patient was able to walk without support and painlessly, with complete stability of the operated knee. Flexion 170° to 90° . The genu valgum was eliminated (Figs. 26—28).

Rehospitalization. Three years and 1 month after operation the patient was readmitted on account of pain in the left knee. He was very pleased with the results in the right, operated knee. He had been able to walk 1 km with only one stick, and had no pain even when bearing weight on the leg (Figs. 29 and 30). Following operation for hernia 6 months previously, the general condition had deteriorated. Severe pain was present in the left knee, and was not alleviated by an unarticulated brace.

Examination on admission. General condition poor. S.R. 89 mm/1 hr. Hb 57 per cent. R.B.C. 4 million. — Right knee: no tenderness. Moderate capsular thickening. Active flexion 150° to 70° , passive 170° to 70° . Complete stability. Marked crepitus. Patellar reflex positive. — Left knee: diffuse tenderness.

Capsular thickening. Active flexion 150° to 50°, passive 170° to 50°, with pain and marked crepitus. — Walked slowly and cautiously without support, except for brace on left knee. — Roentgenologic examination: see Fig. 32.

Operation. Nov. 26, 1954 (Walldius). Arthroplasty (no. 18) of left knee. Leg immobilized in plaster splint. Five per cent glucose solution with 500 mg of terramycin/1,000 ml I.V., and 350 ml of blood during operation.

Postoperative course. The patient had difficulty in urinating and was catheterized repeatedly; an indwelling catheter was subsequently inserted. — The sutures were removed on the 13th postoperative day. The wound had healed. The plaster splint was discontinued. On the same day, when the patient was to be helped out of bed, the leg was inadvertently left unsupported. The knee therefore underwent forced flexion, so that the wound and the joint capsule burst. The prosthesis was visible. The wound was resutured under local anaesthesia. Terramycin (250 mg, 4 times a day) and penicillin (Penditan Astra, 2 ml, once a day) were given for 5 days. The sutures were removed after 22 days, when the wound had healed. During the subsequent two weeks, the patient had fever and increasing decubitus in the sacral region and nape of the neck. His general condition deteriorated rapidly. He was unable to eat and became somnolent and disoriented. The decubitus ulcers increased rapidly in size. The non-protein nitrogen was 85 mg/100 ml, Hb 44 per cent, R.B.C 3.11 million. Two blood transfusions were given (400 ml each), in addition to 1,000 ml of bicarbonate solution I.V. — The patient died on Jan. 12, 1955, presenting a picture of progressive marasmus.

Autopsy led to the following diagnoses: rheumatoid arthritis and marasmus, bilateral arthroplasty of the knee, operated hypertrophy of the prostate, and diverticulum of the urinary bladder. There was also acute cystitis and diverticulitis, pyaemia, and bilateral, acute suppurative arthritis, *Staph. aureus* and *Proteus vulgaris* being the infecting organisms throughout, acute osteomyelitis of both knees, and bilateral pulmonary abscess.

The pathologist summed up the situation as follows. Cystitis was presumably the primary infection, and the operated knees constituted a site of lessened resistance when pyaemia supervened.

The bacteriologist stated that the course was probably the following. A urinary tract infection with *Proteus vulgaris* developed in connexion with prostatectomy. When the patient was subsequently in an environment in which tetracyclines were commonly used (*i.e.*, at our clinic), he contracted a *Staph. aureus* infection of the type resistant to these antibiotics. Neither of the infecting organisms was affected by the tetracycline administered.

The prosthesis in the right knee, which had functioned faultlessly for three years, was removed at autopsy; the tibial medullary pin was found to be fractured at the base.

Case 2 (E.B. no. 3289/50). A woman, aged 58 years. Housewife.

Diagnosis. Flexion contracture of left knee due to rheumatoid arthritis.
Hospitalization: Jan. 29—May 21, 1952, and Sept. 20—Dec. 20, 1956.

History. The patient had a 31-year history of rheumatoid arthritis. Most of the joints were involved. For the past 2 years, she had only been able to get about indoors supported on a stick, owing to pain in the left knee. She had been treated five times at a rheumatologic clinic.

Preoperative examination. General condition relatively good. Corpulent. S.R. 21 mm/1 hr. — Left knee: increased local temperature and capsular thickening. Slight hydrops. Diffuse tenderness. Active and passive flexion 150° to 100° in slow movement and with intense pain. — Rheumatic changes of moderate degree in other joints. — Walked very slowly and painfully with small steps, supported by a stick. — Roentgenologic examination of left knee: marked destruction of joint cartilage. Slight subchondral sclerosis.

Operation. Feb. 20, 1952 (Walldius). Arthroplasty of left knee (no. 2). On insertion of the tibial part of the prosthesis, it was forced out of alignment due to the lateral stabilizing pin impinging on the cortex. This was drilled through, and the prosthesis could then be inserted in the right position. Its projecting parts were smoothed off with an electric grinder.

Postoperative course. The limb was mobilized twice under anaesthesia. On discharge, the patient could walk without support and painlessly. The flexion was 180° to 90°, with some subpatellar pain on maximal flexion.

Follow-up examination was made 2¾ years after operation. The patient was very pleased with the results. She was able to walk painlessly indoors without support, and outdoors with one stick.

Active flexion 180° to 90° with moderate crepitus. Complete stability. There was slight inward rotation of the lower leg when the patella was straight forwards. Patellar reflex positive. — She walked with rapid steps without a stick. — Roentgenologic examination: see Fig. 33.

Rehospitalization. The patient was readmitted 4 years and 7 months after operation, following a fall 4 months previously, when she had "fractured" the knee. Until then, she had been in excellent condition. She could walk for 2 hours at a stretch and do her shopping. She was able to walk up three flights of stairs to her flat and to do her housework. She had no pain, even when bearing weight on her leg. After the accident, she had a genu varum deformity, lack of stability in the joint and pain on walking.

Examination on admission. Left knee: slight hydrops. Tender area about 3 cm in diameter on the lateral aspect of the joint. Genu varum 10°. Considerable instability on medial movement of the lower leg. Flexion 180° to 105° with pain. Walked very cautiously, supported by a stick. — Roentgenologic examination of left knee: see Fig. 34.

Operation. Sept. 25, 1956 (Walldius). Extraction of fractured prosthesis and insertion of a new one of the later model. The tibial medullary pin of the old prosthesis was fractured at the base, and one of the stabilizing pins was bent sideways (Fig. 4). A meniscus-like tissue was present between the two halves

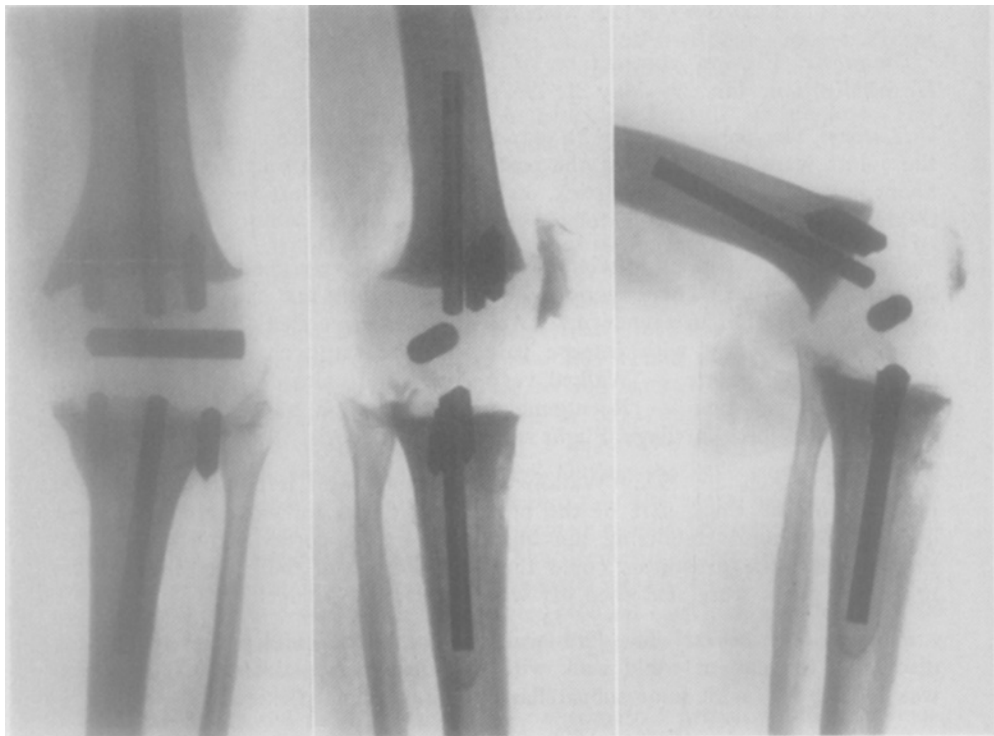


Fig. 33. Case 2: roentgenograms 23¼ years after arthroplasty of left knee.

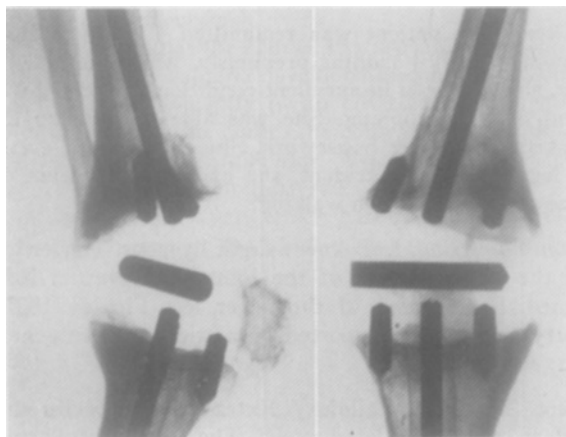


Fig. 34. Case 2: roentgenograms 4 years 7 months after operation (4 months after accident).

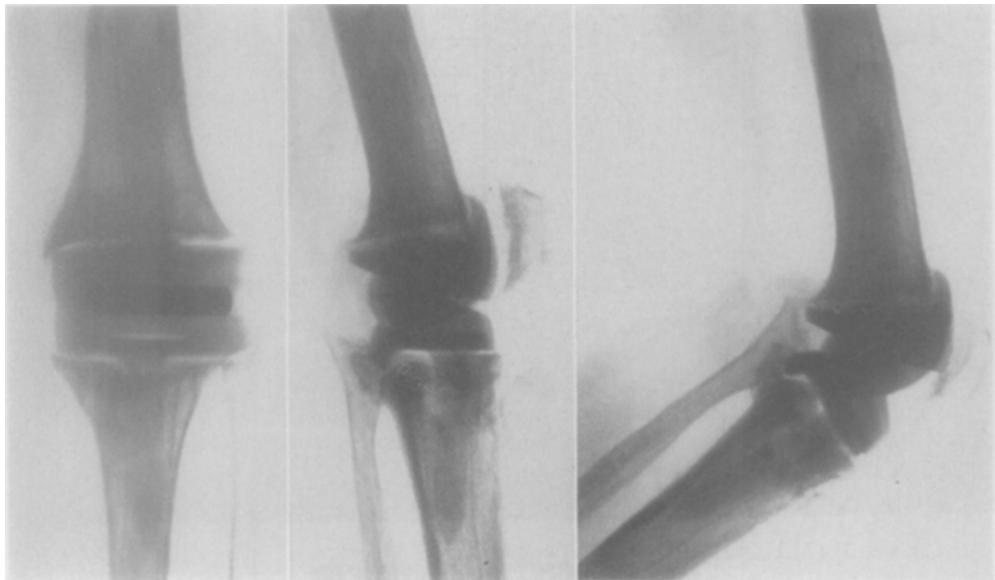


Fig. 35. Case 2: roentgenograms 3 months after reoperation (insertion of new prosthesis).



Figs. 36 and 37. Case 2: 3 months after reoperation (insertion of new prosthesis).

of the prosthesis. The joint capsule had even surfaces with no signs of inflammation. The resected surfaces were covered with fibrous tissue 2—4 mm thick. — A layer of bone about 5 mm thick was chiselled off from the lateral condyle of the tibia, in order to correct the slight genu varum. This was sent, together with pieces of the "meniscus", for histologic examination.

Histologic examination showed fibrinoid masses in the soft tissue; they contained some small particles resembling bone shavings. The tibial sample consisted of vital, spongy bone. Some slightly fibrous areas with a number of macrophages and round cells were present in the bone marrow. These foci thus represented a foreign-body reaction with slight inflammatory changes.

Postoperative course. The course was uneventful. On discharge, the patient was able to walk with the help of a stick and had no pain on weight bearing. Flexion 180° to 110° (Figs. 36 and 37). There was complete stability of the joint. The patient stated that the movements of the knee were smoother than with the old prosthesis; the new one had a joint surface to accommodate the patella. — Roentgenologic examination: see Fig. 35.

Case 3 (M.E. no. 5859/49). A woman, aged 53 years.

Diagnosis. Rheumatoid arthritis and post-traumatic instability of left knee, and ankylosis of right knee. *Hospitalization:* March 13—July 18, 1952.

History. The patient had suffered from rheumatoid arthritis for the past 26 years. Spontaneous ankylosis of the right knee had occurred 6 years prior to the present examination. Four months before this examination, she fell and injured the left knee. Since then, she had been unable to bear weight on the leg, owing to pain and lack of stability in the joint. At the local hospital the knee had been punctured and a large quantity of exudate aspirated. The patient had been treated for arthritis at several clinics.

Preoperative examination. The patient was small and thin with atrophic musculature. S.R. 115/mm 1 hr. — Left knee: the skin was atrophic and had brown pigmentations following X-ray therapy. Increased local temperature and capsular thickening. Tenderness medially above the joint. Genu valgum 10°. Flexion 175° to 110° with pain. Considerable lateral instability and positive "drawer sign". — Right knee: ankylosis in position of 15° flexion and 20° genu valgum. — Unable to stand or walk. — Roentgenologic examination of left knee: severe arthritis with great destruction of cartilage.

Operation. April 2, 1952 (Walldius). Arthroplasty (no. 3) of left knee.

Postoperative course. Course uneventful. On discharge the patient was able to walk painlessly without support. Flexion 180° to 100°. Complete stability. Genu valgum corrected.

Follow-up examination 4 years and 8 months after operation. The patient was very pleased with the results. She had no pain even on weight bearing. She no longer used a stick. She could go for a two-hour walk and managed stairs without difficulty.

Left knee: no tenderness, hydrops or capsular thickening. Active flexion 180° to 90°. Complete stability. Moderate crepitus. Patellar reflex positive. Able to



*Figs. 38—40. Case 3: 4 years 8 months after arthroplasty of left knee.
Spontaneous ankylosis of right knee.*

stand on the operated leg alone and to bend the knee 30° to 40° (Figs. 38—40). — Walked rapidly without support. — Roentgenologic examination: no resorption round the medullary pins. Osteophytes on the resected surface of the femur.



*Figs. 41 and 42. Case 4: before operation.
Unable to walk for 5 years.*



Fig. 43.

Fig. 44.



Fig. 45.



Fig. 46.

Figs. 43—46. Case 4: 4 years 4 months after arthroplasty of right knee, and 4 years 5 months after arthrolysis and excision of patella of left knee.

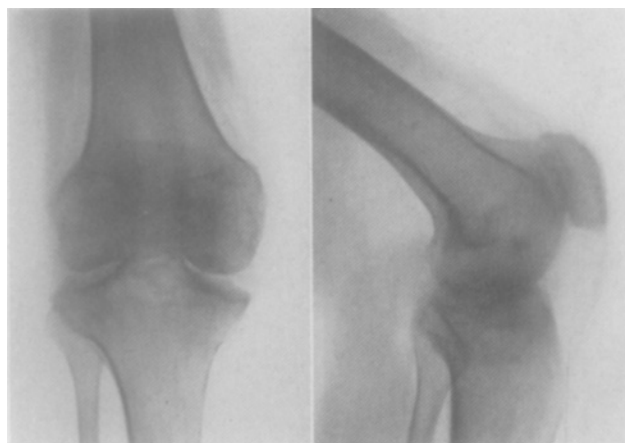


Fig. 47. Case 4: roentgenograms of right knee before operation.

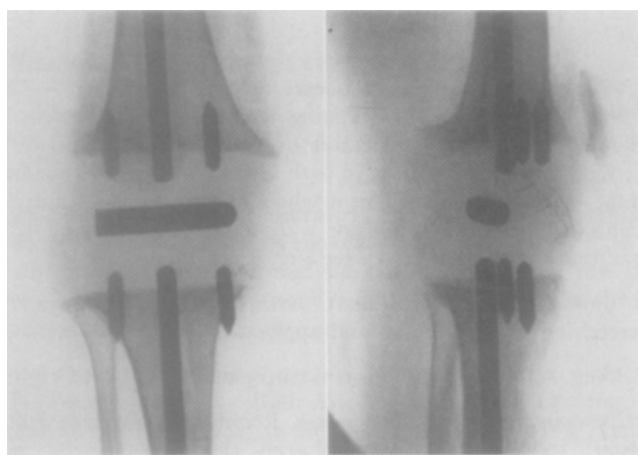


Fig. 48. Case 4: roentgenograms of right knee 10 days after arthroplasty.

Case 4 (B.L. no. 2567/51). A woman, aged 34 years.

Diagnosis. Flexion contracture of both knees due to rheumatoid arthritis.
Hospitalization: June 19—Oct. 9, 1952.

History. The patient had suffered from rheumatoid arthritis for 18 years and had been unable to work for 8 years. For the past 5 years she could neither walk nor stand, owing to flexion contracture of both knees. There was pain, limitation of movement and contracture of most joints. The patient had been cared for in a rheumatologic clinic five times. She had spent the past year at the department of occupational therapy, Norrbackainstitutet.

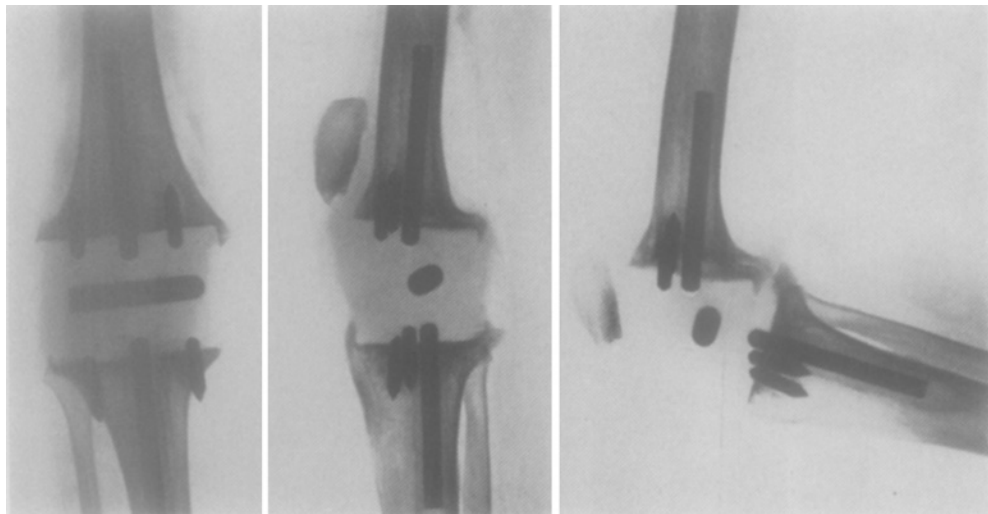


Fig. 49. Case 4: roentgenograms of right knee 4 years 4 months after arthroplasty.

Preoperative examination. Fairly obese. S.R. 68 mm/1 hr. — Both knees: slight hydrops, marked capsular thickening with diffuse tenderness. The patella was immobile laterally. Passive flexion of right knee 125° to 90°, left knee 145° to 100°, with pain and crepitus in both knees. — Marked rheumatic changes in other joints. — The patient sat in a wheel chair and could not get in or out of it alone. She could neither stand nor walk alone (Figs. 41 and 42). — Roentgenologic examination of right knee: see Fig. 47.

Operation. June 27, 1952 (Walldius). Arthrolysis and excision of patella of left knee. Stretching of both knees and application of plaster cast.

Operation. Aug. 6, 1952 (Walldius). Arthroplasty (no. 4) of right knee.

Postoperative course. Uneventful course. Roentgenologic examination 10 days after operation: see Fig. 48. On discharge, the patient could walk without support and without pain. Flexion of left knee 170° to 120°; right knee 180° to 90°.

Follow-up examination was made 4 years and 4 months after operation (Figs. 43—46). The patient was very pleased with the results. She had some pain in the left knee but none in the right. She walked without support and had been able to walk 1 km outdoors in the summer. Could manage stairs.

Right knee: active flexion 180° to 90°. Full stability. Moderate crepitus. Patellar reflex positive. — Walked with fairly small steps without support; no limp. — Roentgenologic examination of right knee: see Fig. 49.

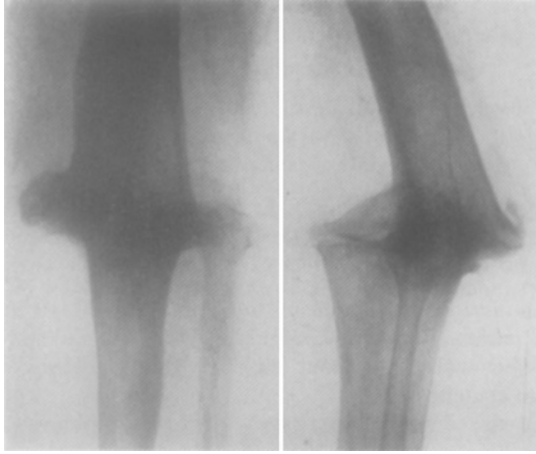


Fig. 50. Case 5: roentgenograms of right knee; ankylosis after arthrodesis.

Case 5 (N.H. no. 6263/50). A woman, aged 57 years.

Diagnosis. Flexion contracture of both knees due to rheumatoid arthritis. *Hospitalization:* July 15—Oct. 30, 1952, June 23—Sept. 22, 1953, and May 10—Sept. 3, 1955.

History. Rheumatic fever at 9 years of age. Rheumatoid arthritis for past 15 years, with pain and limitation of movement in most joints. Pain and flexion contracture of both knee joints, so that she could only walk a few steps indoors with crutches. — Hospitalized repeatedly. For the past 3 years she had been in a home for persons with disability pensions.

Preoperative examination. Below average height. Corpulent. Somewhat feeble-minded. S.R. 74 mm/1 hr. — Both knees: capsular thickening. Active and passive flexion of right knee 135° to 90° , left knee 160° to 140° , both with pain. — Rheumatic changes of moderate degree in other joints. — The patient sat in a wheel chair and could not get out of it alone. Could walk very slowly and cautiously with crutches. — Roentgenologic examination of both knees: considerable reduction of cartilage and subchondral erosions.

Operation. Aug. 15, 1952 (Walldius). Arthroplasty (no. 5) of right knee. A gap between the prosthesis and the anterior resected surface of the femur was filled with a triangular wedge of bone. The projecting parts of the prosthesis were smoothed with an electric grinder.

Postoperative course. There was considerable rigidity of the joint, which could not be overcome by massage and exercise or by mobilization under anaesthesia. On discharge, the patient could walk with two crutches. Flexion 160° to 140° .

Rehospitalization. The patient was rehospitalized 10 months after operation, since the rigidity persisted. Flexion 165° to 155° .

Operation. July 2, 1953 (Walldius). Excision of patella and of adhesions. The patella was adherent to the femur and numerous adhesions were present in the joint.

Postoperative course. A fistula developed in the operative wound and did not respond to antibiotic therapy. Operation brought about no improvement in the joint.

Operation. May 20, 1955 (Walldius). Extraction of prosthesis and arthrodesis. — On discharge, less instability of the joint. The patient could walk with a knee brace and two crutches. The heel of the right shoe was raised 4 cm.

Follow-up examination was made at the local hospital 18 months after the arthrodesis. The patient had no pain in this knee and did not wear the knee brace. Indoors, she walked without support, and outdoors she could walk 30—50 m with two crutches.

Right knee: ankylosed in full extension. — Roentgenologic examination: see Fig. 50.

Case 6 (K.H. no. 3402/52). A man, aged 48 years. Artist.

Diagnosis. Ankylosis of left knee and rigidity of right knee due to rheumatoid arthritis. *Hospitalization:* Dec. 3, 1952—Feb. 21, 1953, March 20—Dec. 12, 1953, and Jan. 12—Feb. 20, 1954.

History. Rheumatoid arthritis for past 20 years. Arthrodesis of the left knee was performed 8 years ago. For the past year he had only been able to walk indoors with a stick, owing to pain in the right knee. — Had been treated several times at rheumatologic clinics.

Preoperative examination. Ordinary body build. Thin. S.R. 31 mm/1 hr. — Right knee: active and passive flexion 175° to 90° with pain. The patella could not be displaced laterally. He could not bear weight on his leg when he got up from a chair. — Left knee: ankylosis in 25° flexion. — Slight arthritic changes in other joints. — He walked cautiously and slowly with small steps, using one stick. — Roentgenologic examination of right knee: severe destruction of joint cartilage and subchondral erosions.

Operation. Dec. 8, 1952 (Friberg and Walldius). Arthroplasty (no. 6) of right knee. A gap between the prosthesis and the resection surface of both the femur and tibia was filled with spongy bone. The tuberosity of the tibia was fixed with a Rissler pin. The leg was splinted.

Postoperative course. On the 5th day the wound burst in one place, and necessitated resuturing. The Rissler pin was extracted 4 weeks after operation. On discharge, the wound was not healed.

Rehospitalization. The patient was readmitted 1 month later, since the secretion from the wound had increased. S.R. 90 mm/1 hr. Bacteriologic culture of the discharge showed a growth of coliform organisms and *B. pyocyaneus*. Antibiotic therapy had no effect.

Operation. Aug. 27, 1953 (Friberg). Contraincision and drainage.

Operation. Oct. 23, 1953 (Friberg). Extraction of prosthesis. — Despite traction, subluxation of the joint developed.

Operation. Feb. 1, 1954 (Friberg). Amputation of the leg. — The patient was fitted with a prosthesis with a suction socket, and could walk fairly well with it.

Follow-up examination almost 3 years after amputation. The patient stated that he could walk indoors with one stick, and outdoors with two. He could manage a one-hour walk.

Case 7 (G.K. no. 1952/52). A man, aged 33 years. Telephone linesman.

Diagnosis. Post-traumatic rigidity of left knee and partial absence of left foot following amputation. *Hospitalization:* Jan. 13—June 24, 1953, and March 31—June 4, 1954.

History. The patient had sustained a fracture of the os calcis and a complicated intra-articular fracture of the knee in a fall from a telegraph post 3 years and 5 months earlier. He had been hospitalized for 19 months. Owing to gangrene, the left foot was amputated at Chopart's joint. A discharging fistula was present in the knee for several months. The knee healed in 10° genu varum, with persistent pain and instability. He had pain in the phantom foot, unrelieved by various kinds of bandage. He was able to walk a short distance (< 500 m) with the whole leg bandaged and with the help of a stick.

Preoperative examination. General condition good. S.R. 12 mm/1 hr. — Left knee: a 3 by 5 cm scar on the anterior aspect, adherent to the underlying tissues. Genu varum 10°. Active and passive flexion 160° to 155° with pain on movement. — Left foot: amputated at Chopart's joint. Equinovarus deformity; the patient could only rock the foot slightly. — Roentgenologic examination of left knee: earlier comminuted crush fracture of the upper end of the tibia. The medial condyle was depressed more than 1 cm, and the contours of the joint were distinctly irregular. Sclerotic changes in the subchondral skeletal tissue. Several cystic foci of thinning more distally in the metaphysis. Moderately pronounced osteophytic deposits of a secondary deformans nature on the margins of the joint surfaces.

Operation. Feb. 6, 1953 (Friberg and Walldius). Arthroplasty (no. 7) of left knee.

Postoperative course. Superficial skin necrosis in the wound, which gradually healed. On discharge, active flexion 160° to 130°. Passive flexion 170° to 120°. He was fitted with a foot brace. He walked with one stick and then had pain laterally in the joint, since the 10° varus deformity was uncorrected.

Rehospitalization. Fourteen months after operation, pain and swelling developed in the knee, together with fever. On admission to hospital, there was every indication of acute arthritis. The condition did not respond to antibiotic therapy.

Operation. April 14, 1954 (Hiertonn). Amputation at the thigh. — The patient was fitted with a prosthesis with which he was able to walk well.

Follow-up examination was made 2 years 1 month after amputation. He can walk with a prosthesis with a suction socket without support. Can walk 1 km at a stretch.

Case 8 (P.P. no. 4939/48). A man, aged 52 years. Builder.

Diagnosis. Flexion contracture and dislocation of both knees due to rheumatoid arthritis. *Hospitalization:* Feb. 4—April 21, 1953, and Nov. 17, 1954—Feb. 18, 1955.

History. Rheumatoid arthritis for 15 years. He had spent the past 10 years in a wheel chair, and could neither stand nor walk on account of flexion contracture of both knees. All the joints were involved, with pain, limitation of movement and deformities. He had been treated twice at a rheumatologic clinic in the course of 1938 to 1940.

Preoperative examination (Figs. 51—53). General condition poor. Small and thin with poorly developed muscles. S.R. 25 mm/1 hr. — Knee joints: 90° flexion contracture and backward dislocation of both tibias. Active and passive flexion 90° to 70°. Positive "drawer sign". — Elbow joints: 90° and 50° extension defect, respectively. Wrists: 90° extension defect and 30° ulnar deviation. He could only grasp things very weakly between his index and middle fingers. He could not stand, walk or dress himself. — Roentgenologic examination: see Fig. 59.

Operation. Feb. 19, 1953 (Walldius). Arthroplasty (no. 8) of right knee. About 8 cm were sawn off from the femur and 2½ cm from the tibia. Tenotomy was performed on the flexor tendons. The tuberosity of the tibia was fixed 2 cm further distally.

Postoperative course. The course was uneventful. On discharge, there was 180° to 105° flexion. The patient was fitted with a pylon on the left leg and walked with two crutches. — The patient was very satisfied with the operated knee and requested operation on the other knee.

Operation. Nov. 25, 1954 (Walldius). Arthroplasty (no. 17) of left knee. The procedure was the same as in operation of the right knee. A prosthesis was used in which the stabilizing pins of the femoral part were replaced by a lip.

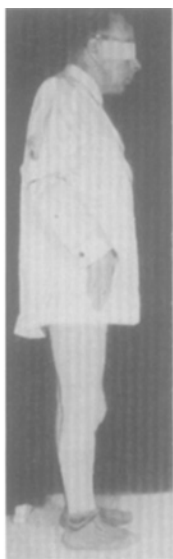
Postoperative course. The course was uneventful. On discharge, flexion was 180° to 90°. The patient could walk with two crutches.

Follow-up examination was made 3¾ years after the first arthroplasty and 2 years after the second (Figs. 54—58). The patient was very pleased with the results of both operations. He had no pain in the knees, even on weight-bearing, and no swelling. He walked without support indoors, but used two crutches outdoors to keep his balance. Rheumatic changes in his elbows and hands prevented him from using sticks. He could walk 1 km at a stretch. He could manage stairs and was able to get in and out of a chair alone.

Knees: no hydrops or capsular thickening. Active flexion 160° to 100° in right knee and 180° to 100° in left. Passive flexion 180° to 100° bilaterally. Complete stability in right knee, suggested positive "drawer sign" in left. No lateral instability. Moderate crepitus bilaterally. Good strength in quadriceps muscle of both legs. Patellar reflex positive bilaterally. — Roentgenologic examination: see Figs. 60 and 61.



Figs. 51—53. Case 8: knees, elbows and wrists in position of maximal extension before operation. Unable to walk for 10 years.



Figs. 54—58. Case 8: 3¾ years after arthroplasty of right knee, and 2 years after arthroplasty of left knee.

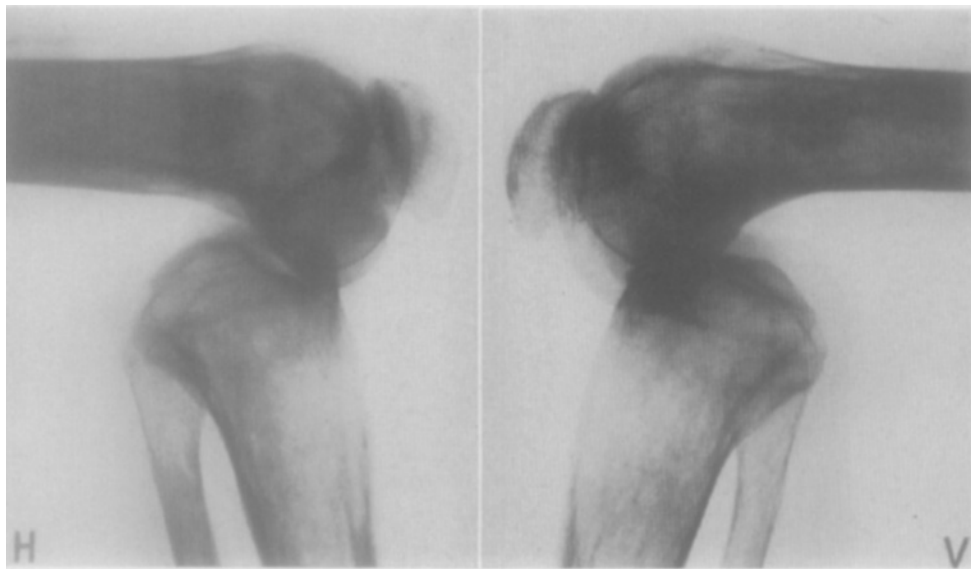


Fig. 59. Case 8: roentgenograms of right and left knee before operation.

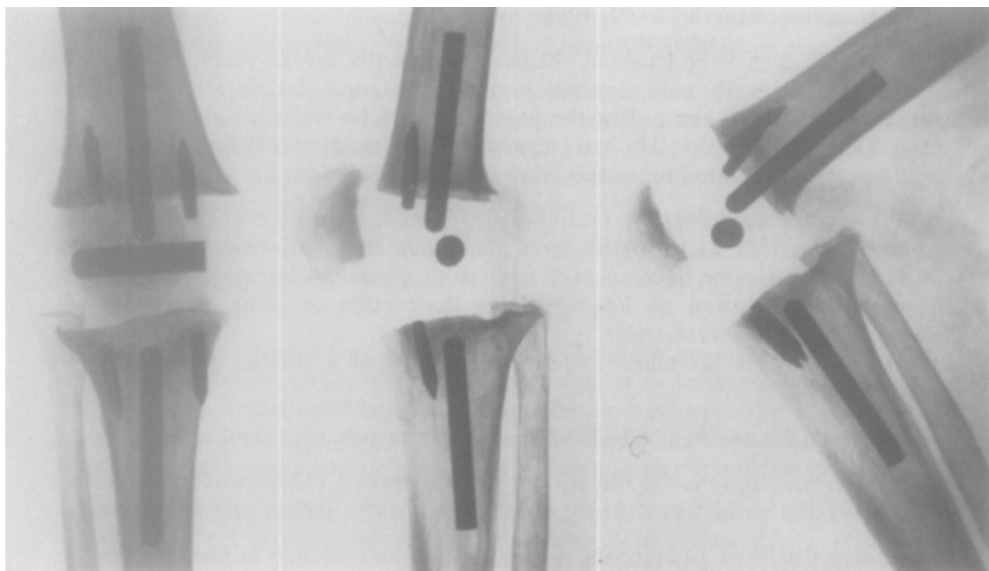


Fig. 60. Case 8: roentgenograms of right knee 3 $\frac{3}{4}$ years after arthroplasty.

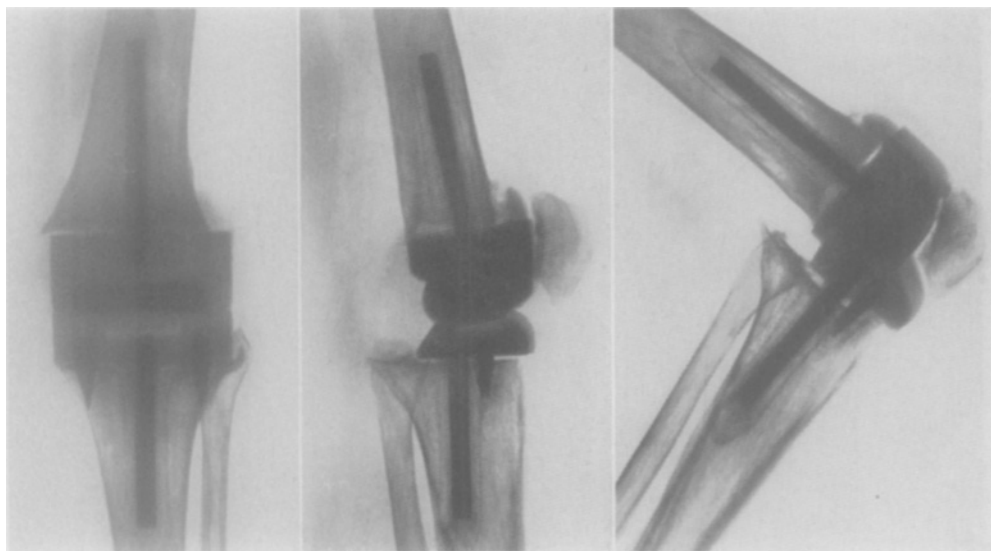


Fig. 61. Case 8: roentgenograms of left knee 2 years after arthroplasty.

Case 9 (K.S. no. 575/53). A man, aged 61 years. Former carpenter.

Diagnosis. Flexion contracture of both knees due to rheumatoid arthritis.

Hospitalization: March 11—31, 1953.

History. The patient had had rheumatoid arthritis for 17 years. Most joints were affected, with pain, limitation of movement and deformities. Flexion contracture of both knees. For the past few years he had been able to walk at most 500 m with a stick. He had been completely incapacitated for work for the past 3 years. — Treated repeatedly at rheumatologic clinics.

Preoperative examination. Ordinary body build. S.R. 70 mm/1 hr. — Right knee: flexion 150° to 130° with pain. Genu valgum 20°. Considerable crepitus. — Left knee: flexion 160° to 110° with pain. Considerable crepitus. — Roentgenologic examination of knees: severe destruction of joint cartilage, subchondral erosions and sclerosis.

The knees were stretched under anaesthesia and a plaster cast applied to both of them.

Operation. March 26, 1953 (Walldius). Arthroplasty (no. 9) of right knee.

Postoperative course. On the 5th day after operation (12 days after stretching the knees) the patient died of a pulmonary embolism within two minutes.

Autopsy disclosed an embolus, 3 cm long and about 7 mm in diameter, in the right pulmonary artery. There was also severe generalized arteriosclerosis and an old posterior myocardial infarction.



Fig. 62. Case 10: roentgenograms of right knee; ankylosis after arthrodesis.

Case 10 (G.N. no. 5907/52). A Woman, aged 50 years. Cook.

Diagnosis. Ankylosis of left knee and flexion contracture of right knee due to arthrosis deformans or rheumatoid arthritis. *Hospitalization:* April 9—Oct. 10, 1953, Dec. 14, 1953—April 24, 1954, and Nov. 14, 1955—March 16, 1956.

History. For past 5 years increasing pain, at rest and when walking, in both knees, as well as swelling and progressive stiffness. Unable to work for past 6 months. Used a stick indoors, but she could not walk outdoors or manage stairs. No other joints were affected. She had been hospitalized on two occasions.

Preoperative examination. Considerably overweight (114 kg). S.R. 22 mm/1 hr. — Right knee: diffuse tenderness. Capsular thickening. Active and passive flexion 155° to 135° . — Left knee: ankylosis at 160° . — She walked with great difficulty with a stick. — Roentgenologic examination of both knees: pronounced arthrosis deformans changes and large osteophytes.

Operation. April 15, 1953 (Walldius). Arthroplasty (no. 10) of right knee. The projecting parts of the prosthesis were smoothed off with an electric grinder.

Postoperative course. During the first few days the knee was splinted alternately in the flexion and extension position, in order to facilitate mobilization of the joint. The wound burst open, and skin necrosis developed. The wound healed after complete immobilization of the joint for 5 weeks. Exercise was ineffective, since the patella was completely adherent to the underlying structures.

Operation. Aug. 3, 1953 (Walldius). Excision of the patella. It was completely adherent to the femur. Numerous adhesions were removed. — Histologic examination of the adhesions showed them to consist of hyalinized fibrous tissue, with a moderate infiltration of round cells and leukocytes. There was no foreign-body reaction.

Postoperative course. A fistula developed in the wound. It was infected with *Staph. aureus* and *Proteus vulgaris*. Antibiotic therapy was given.

Rehospitalization. Antibiotic therapy was continued, but the fistula persisted.

Operation. March 9, 1954 (Walldius). Excision of fistula.

Rehospitalization. The patient was readmitted because of the formation of new fistulas.

Operation. Dec. 15, 1955 (Walldius). Extraction of the prosthesis and arthrodesis.

Postoperative course. When the patient was discharged 3 months later, the arthrodesis had healed with ankylosis, and the fistulas had cleared up.

Follow-up examination was made one year later. The patient could walk indoors without support, and about 500 m outdoors with a stick.

Right knee: ankylosed in full extension, with no signs of infection. Left knee: ankylosed at 150°. — The patient could walk unsupported, taking small steps. — Roentgenologic examination showed bony ankylosis (Fig. 62).

Case 11 (M.P. no. 3100/52). A woman, aged 48 years. Dressmaker.

Diagnosis. Flexion contracture of both knees due to rheumatoid arthritis.
Hospitalization: May 28—Aug. 29, 1953.

History. The patient had an 18-year history of rheumatoid arthritis. Most of the joints were affected, with pain, limitation of movement and deformity. During the past year she had been unable to walk, owing to pain and extension defects in both knees. She had been completely incapacitated for work for the last 3 years. Treated at a rheumatologic clinic on 4 occasions, and had been in a home for the last 7 months.

Preoperative examination. The patient had an appearance of ill-health. She was somewhat corpulent. S.R. 40 mm/1 hr. — Right knee: marked capsular thickening. Active and passive flexion 160° to 90°. Genu valgum 10°. — Left knee: marked capsular thickening. Active and passive flexion 170° to 150°. Genu valgum 15°. — Unable to stand or walk. — Roentgenologic examination of both knees: pronounced destruction of joint cartilage. Small osteophytes.

Operation. June 22, 1953 (Walldius). Arthroplasty (no. 11) of right knee. A parapatellar medial longitudinal incision was made. The patella was sawn through longitudinally, and the incision continued upwards into the quadriceps tendon and downwards into the ligamentum patellae. Both halves of the patella were excised. The joint surface of the tibia was resected with a chisel.

Postoperative course. The course was uneventful. On discharge, the patient could walk with a "walker". There was 180° to 90° flexion of the joint and complete stability.

Follow-up examination was made 3 years and 4 months after operation. The patient had spent the entire last 3 years bedridden in a medical clinic, owing to rheumatoid arthritis, cardiac involvement with auricular fibrillation, lengthy attacks of cystopyelitis, subcutaneous rheumatic granuloma and decubitus.

Her general condition was poor and she was emaciated. Bedridden. — Right knee: moderate capsular thickening. Diffuse tenderness. Active flexion 180° to 90° with pain in the extreme positions. Complete stability. — Left knee: ankylosis at an angle of 150° . — Roentgenologic examination: good adaptation of prosthesis. No resorption around the medullary pins.

C a s e 12 (E.J. no. 4491/43). A woman, aged 54 years. Housewife.

Diagnosis. Flexion contracture of both knees due to rheumatoid arthritis. *Hospitalization:* Jan. 18—June 2, 1954.

History. The patient had had rheumatoid arthritis for the past 14 years. An exacerbation had taken place during the past year, so that she could walk a maximum 100 m with help and could not look after her home. She spent most of her time in a chair and had great difficulty in rising from it. She had been treated in both medical and orthopaedic clinics.

Preoperative examination. General condition fairly good. Somewhat corpulent. S.R. 52 mm/1 hr. — Left knee: capsular thickening. Flexion 170° to 100° . — Right knee: capsular thickening. Flexion 150° to 120° . — Walked slowly and cautiously with bent knees. — Roentgenologic examination of both knees: severe destruction of cartilage. Osteophytes on margins of joint surfaces.

Operation. Jan. 25, 1954 (Friberg and Walldius). Arthroplasty (no. 12) of left knee. A gap between the femoral part of the prosthesis and the lateral part of the resected surface was filled with bone chips. The leg was fixed on a splint.

Postoperative course. Apart from skin necrosis, the course was uneventful.

Operation. March 5, 1954 (Friberg). Arthrodesis of right knee.

Postoperative course. On discharge, the arthrodesis had healed, and flexion of the left knee was 180° to 120° . She could walk without support.

Follow-up examination was made 2 years and 10 months after arthroplasty. The patient was very pleased with the results of both operations. She had no pain, even on weight bearing. Walked indoors without support and outdoors for 1—2 hours with a stick. Did her own housework.

Left knee: no tenderness or swelling. Active flexion 180° to 90° . Complete stability. Moderate crepitus. Walked with a slight limp, owing to ankylosis of right knee. — Roentgenologic examination of left knee: inappreciable gap between the tibial part of the prosthesis and the upper end of the tibia. Good congruence of femoral part of prosthesis. Osteophyte formations on anterior and posterior aspects of femur and posterior aspect of tibia.

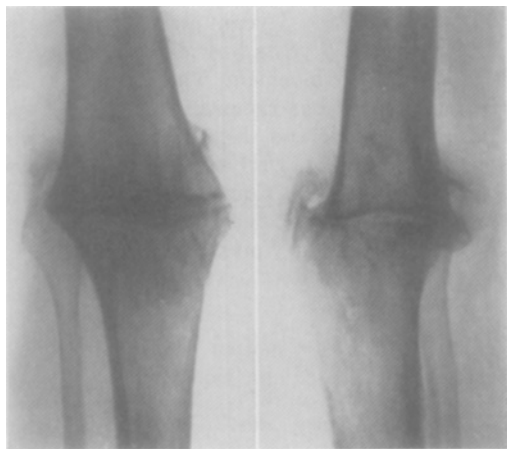


Fig. 63. Case 13: roentgenograms of right knee; ankylosis after arthrodesis.

Case 13 (K.H. no. 1488/36). A man, aged 57 years. Former ironworker.

Diagnosis. Ankylosis of both knees due to rheumatoid arthritis. *Hospitalization:* Feb. 15—May 4, 1954, and Nov. 1—Dec. 10, 1955.

History. Bilateral fracture of the os calcis 20 years earlier. Rheumatoid arthritis for past 14 years, with involvement of most joints. He had been unable to work for the past 11 years. Rigidity of hip and knee joints. He had used a wheel chair for the last 5 years. He had been treated repeatedly at both medical and rheumatologic clinics. A Judet prosthesis had been inserted in the right hip joint 3 months earlier with good results. He could walk indoors with two sticks.

Preoperative examination. General condition relatively good. Thin. S.R. 20 mm/1 hr. — Both knee joints ankylosed at 150°. — Right hip: flexion 180° to 120°. He walked with great difficulty, supported by two sticks. He could not rise from a chair. — Roentgenologic examination of both knees: high-grade destruction of cartilage and erosions. — Typical rheumatic changes in other joints. 45° extension defect in both elbows.

Operation. Feb. 18, 1954 (Walldius). Arthroplasty (no. 13) of right knee. A longitudinal, slightly curved incision was made laterally, beside the patella. The incision in the capsule was extended upwards into the quadriceps tendon and downwards into the ligamentum patellae. Bony ankylosis was present. The patella was freed from the femur with a chisel, and the joint surfaces were also resected with a chisel. After insertion of the prosthesis, its projections were smoothed off with an electric grinder.

Postoperative course. Rigidity of the joint developed.

Operation. March 25, 1954 (Walldius). Division of adhesions and partial excision of the patella, which was adherent to the femur.

Rehospitalization. Intra-articular injections of hydrocortisone had been given in the outpatient department in an attempt to overcome persisting rigidity of the knee. An inflammatory infiltrate appeared at the site of the injections, and became converted into a fistula, which did not respond to antibiotic therapy. The patient was therefore rehospitalized.

Operation. Nov. 3, 1955 (Walldius). Extraction of prosthesis and arthrodesis. The prosthesis was surrounded by large osteophytes. There was fibrous thickening of the capsule. Inflammatory changes were confined to the fistula, which was excised.

Postoperative course. The arthrodesis healed without complications. The right leg was 6 cm shorter than the left. Part of the shortening was due to arthroplasty of the hip. The patient was provided with a shoe with 4 cm elevation of the heel and 3 cm of the sole.

Follow-up examination was made 2 years and 10 months after arthroplasty. The right knee was painless. The patient was able to walk 1 km with two sticks and a built-up boot.

Right knee: ankylosed in full extension with no signs of inflammation. — Left knee: ankylosed at 150°. The patient walked bent forwards, somewhat slowly and supported by two sticks. — Roentgenologic examination showed bony ankylosis (Fig. 63).

Case 14 (E.G. no. 4000/52). A woman, aged 49 years. Former office worker.

Diagnosis. Flexion contracture of both knees due to rheumatoid arthritis.
Hospitalization: Jan. 8—Aug. 9, 1954.

History. The patient had suffered from rheumatoid arthritis for 21 years. She had flexion contracture of both knees and severe deformities of most other joints. She had been unable to work for the past 3 years and could neither stand nor walk. She had been treated repeatedly at rheumatologic clinics. She had spent the last year in a convalescent home, where she had attempted suicide. She was admitted to a psychiatric clinic, from which she had been referred to our orthopaedic clinic.

Preoperative examination (Figs. 64 and 65). General condition very poor. Emaciated. Considerable muscular atrophy. Marked depression. S.R. 72 mm/1 hr. — Both knees: diffuse tenderness. Decubitus-like reddening of the skin over the patella. Active and passive flexion with great pain and marked crepitus: left knee 150° to 70°, right knee 135° to 90°. — Severe deformities of other joints. — Unable to stand or walk alone. — Roentgenologic examination of both knees: severe destruction of cartilage, erosions, sclerosis and osteophytes.

Both knees were stretched under anaesthesia five times, and a plaster cast applied.

Operation. March 4, 1954 (Walldius). Arthroplasty (no. 14) of left knee. A medial, slightly curved longitudinal incision was made. The joint surfaces were resected with a chisel.

Operation. April 6, 1954 (Walldius). Arthrodesis of right knee.

Postoperative course. The course was uneventful after both operations.

Follow-up examination was made 2 years and 8 months after arthroplasty (Figs. 66—69). The patient was very pleased with the results of both operations. She had no pain even on weight bearing. She could walk indoors without a stick and 200—300 m outdoors with one stick. Could get out of a chair alone. She lived alone and was able to manage light household tasks.

Left knee: no hydrops or capsular thickening. No tenderness. Active flexion 180° to 90°. Complete stability. Moderate crepitus. — Right knee: ankylosis in good position. — Able to walk without support and with scarcely any limp. — Roentgenologic examination of left knee: prosthesis well adapted. Small areas of resorption round the stabilizing pins.



***Figs. 64 and 65. Case 14: before operation.
Unable to walk for 3 years.***

Fig. 66.

Fig. 67.



Fig. 68.



Fig. 69.

Figs. 66—69. Case 14: 2 years 8 months after arthroplasty of left knee, and 2 years 7 months after arthrodesis of right knee.

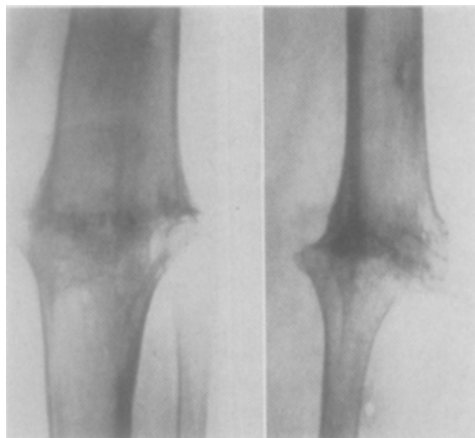


Fig. 70. Case 15: roentgenograms of left knee; ankylosis after arthrodesis.

Case 15 (E.E. no. 4392/51). A man, aged 44 years. Former fireman.

Diagnosis. Flexion contracture of both knees due to rheumatoid arthritis.
Hospitalization: April 1—Sept. 8, 1954.

History. The onset of rheumatoid arthritis was 5 years earlier. Most of the joints were involved. Flexion contracture of both knees. The patient was unable to work since the onset. Unable to stand or walk for past 3 years. Operated on for duodenal ulcer one year ago. He had been treated repeatedly at rheumatologic and orthopaedic clinics. Stretching of the knees under anaesthesia and plaster casts had failed to correct the deformity.

Preoperative examination. Thin and haggard, with atrophic muscles. S.R. 18 mm/1 hr. — Both knees: diffuse tenderness. Moderate capsular thickening. Movements slow and cautious, with marked pain reactions and considerable crepitus. Active and passive flexion of left knee 150° to 70° , right knee 150° to 85° . — Roentgenologic examination of both knees: marked reduction of cartilage. Subchondral sclerosis and patchy, irregular decalcification. — Typical rheumatic changes in other joints.

Operation. April 8, 1954 (Walldius). Arthroplasty (no. 15) of left knee.

Postoperative course. The leg was fixed in a splint, in flexion position during the day and extension during the night. On the 5th day after operation, an ill-smelling discharge from the wound was noticed. Bacteriologic culture showed a growth of coliform organisms and *Staph. aureus* and later of *B. pyocyaneus* as well. Antibiotic therapy was ineffective and two fistulas developed.

Operation. July 16, 1954 (Walldius). Extraction of prosthesis and arthrodesis.

Postoperative course. The arthrodesis led to ankylosis and healing of the fistulas. These nevertheless reappeared on four occasions but healed spontaneously in about a week.

Follow-up examination was made 2 years and 8 months after arthroplasty. The patient was able to walk 100 m at a time, both indoors and outdoors, with two sticks. He looked after a hot-dog stand.

Left knee: ankylosed in position of full extension. No functional shortening of the leg, since the right knee was ankylosed in flexion position. — Walked fairly slowly with two sticks. He could not get up from a chair alone. — Roentgenologic examination of left knee: ankylosis with no signs of osteitis (Fig. 70).

Case 16 (A.P. no. 2380/38). A woman, aged 63 years.

Diagnosis. Ankylosis of right knee and flexion contracture of left knee due to rheumatoid arthritis. *Hospitalization:* Aug. 12—Dec. 4, 1954.

History. The patient had suffered from rheumatoid arthritis for 21 years. Flexion contracture of the left knee had developed. For the past year she had used a crutch and a stick indoors, and could scarcely bear weight on the left leg, owing to pain. The other joints were involved, with limitation of movement and contractures.

Preoperative examination. The patient had an appearance of ill-health. She was somewhat corpulent. S.R. 60 mm/1 hr. — Left knee: diffuse tenderness. Pronounced capsular thickening. Active and passive flexion 135° to 100° with pain. — Right knee: ankylosed in position of full extension. — She walked very slowly and cautiously with a crutch and a stick, and could not rise from a chair alone. — Roentgenologic examination of left knee: marked chronic destructive arthritis, with subchondral erosions on the femoral and tibial condyles.

Operation. June 1, 1954 (Walldius). Arthroplasty (no. 16) of left knee. A cyst the size of a plum, containing adipose tissue, was present in the tibial condyle.

Postoperative course. The course was uneventful. On discharge, she could walk without support. Active and passive flexion of the left knee was 160° to 100°.

Follow-up examination was made 2 years and 2 months after operation. The patient was very pleased with the results. She had no pain, even on weight bearing. During the first year after operation, she had been able to walk indoors without help. During the past year she had had increasing aches, and pain on weight bearing, in the left hip, so that she walked with two Canadian crutches.

Left knee: no tenderness or capsular thickening. Patellar region somewhat projecting. Genu valgum 5° to 10°. Active flexion 160° to 90°, passive 180° to 90°. Inappreciable lateral instability. Moderate crepitus. — Left hip: flexion 150° to 105° with pain. Inhibition of other movements. — She walked slowly and cautiously owing to pain in the left hip, and used two Canadian crutches. — Roentgenologic examination of left knee: at the base of the prosthesis, a large osteophyte had formed on the tibia, and acted as a support. No resorption round the pins of the prosthesis. — Left hip: protrusion of the acetabulum, with severe reduction of cartilage.

Case 17 (K.L. no. 34337). A woman, aged 29 years.

Diagnosis. Ankylosis of both knees due to rheumatoid arthritis. *Hospitalization:* Sept. 17, 1954—Feb. 9, 1955.

History. The patient had suffered from rheumatoid arthritis for 24 years. All the joints were involved. She had been unable to walk for the past 10 years, owing to flexion contracture of both knees. She could not dress herself, and was confined to a wheel chair. Stretching of the knees and application of a plaster cast had been done at an orthopaedic clinic and knee bandages had been fitted. Despite these measures, the flexion contractures reappeared.

Preoperative examination (Fig. 71). Small and thin with atrophic muscles. — Both knees: ankylosed at 150°. — Other joints: marked deformities and severe limitation of movement. — Unable to stand or walk.

Operation. Dec. 1, 1954 (Walldius). Arthroplasty (no. 19) of right knee. The tibial part of the prosthesis was too large, so that one of the stabilizing pins projected slightly beyond the cortex.

Postoperative course. Uneventful course. She was referred to a rheumatologic clinic for postoperative treatment. When there, she was able to be up and could, to a great extent, manage alone. She had no pain in the operated knee.

Follow-up examination was made 2 years after operation (Figs. 72—75). The patient was very pleased with the results. She had no pain in the operated knee, even on weight bearing. She could go for a one-hour walk, and then used a stick to keep her balance, but could not support herself on it, owing to rheumatic changes in her arms and hands. Indoors, she did not use a stick. Was able to manage stairs.

Right knee: no hydrops or capsular thickening. No tenderness. Active and passive flexion 170° to 105°. Complete stability. No crepitus. Patellar reflex positive. — Left knee: ankylosed at 155°. — Walked without support, with short but rapid steps. — Roentgenologic examination of right knee: the prosthesis was well adapted. Osteophyte formation on both the tibia and the femur. No resorption round the medullary pins, but some round the stabilizing pins.



Fig. 71. Case 17: before operation; ankylosis of both knees. Unable to walk for 10 years.



Fig. 72.



Fig. 73.



Fig. 74.



Fig. 75.

Figs. 72—75. Case 17: 2 years after arthroplasty of right knee.

Case 18 (A.M. no. 167/55). A man, aged 63 years. Builder.

Diagnosis. Achondroplasia. Rigidity and subluxation of both knees due to rheumatoid arthritis. *Hospitalization:* Jan. 11—March 5, 1955, and Jan. 10—March 6, 1956.

History. Operation for loose bodies in the left knee joint had been performed 4 times, the first time when the patient was 17 years old. He had suffered from rheumatoid arthritis for the past 8 years, most of the joints being affected. Pain in the knees was so severe that he could only walk a few steps indoors on two crutches. He had been treated at several rheumatologic clinics.

Preoperative examination (Fig. 76). Typical achondroplasia. S.R. 15 mm/1 hr. — Knees: backward subluxation of both tibias. Active and passive flexion 170° to 80° with considerable pain and marked crepitus. — Severe rheumatic changes in other joints. — He walked slowly and cautiously with two crutches. — Roentgenologic examination of both knees: severe rheumatoid arthritis, with marked destruction of joint cartilage and subchondral erosions. Backward subluxation of both tibias.

Operation. Jan. 26, 1955 (Friberg and Walldius). Arthroplasty (no. 20) of right knee. A defect between the prosthesis and the posterior resected surface of the femur was filled with a triangular piece of bone.

Postoperative course. The course was uneventful. On discharge, the patient was able to walk. Active flexion of the right knee was 160° to 90° , and passive flexion 180° to 90° .

Rehospitalization. The patient was readmitted one year after arthroplasty. He was very pleased with the results, and requested the same operation on the left knee.

Operation. Jan. 18, 1956 (Friberg and Walldius). Arthroplasty (no. 29) of left knee. In order to obtain good congruence between the prosthesis and the tibia, it was necessary to resect a small part of the head of the fibula.

Postoperative course. The course was uneventful. On discharge, he was able to walk and to flex the left knee 175° to 90° .

Follow-up examination was made 1 year and 11 months and 1 year, respectively, after the operations (Figs. 77—80). The patient was very pleased with the result of both. He had no pain even on weight bearing. He walked without support indoors, but used a crutch outdoors to keep his balance. He could walk 1 km at a strength.

Knee joints: no hydrops, capsular thickening or tenderness. Active flexion of right knee 160° to 90° , left knee 180° to 90° ; passive flexion 180° to 90° bilaterally. Complete stability. — Walked without support, with short steps but no limp. He could rise from an ordinary chair. — Roentgenologic examination of both knees: prostheses well adapted. Small osteophyte formations on margins of resected surfaces. Small areas of resorption round the medullary pin in the left tibia.



Fig. 76. Case 18: before operation.



Fig. 77.



Fig. 78.



Fig. 79.



Fig. 80.

Figs. 77—80. Case 18: 1 year 11 months after arthroplasty of right knee, and 1 year after arthroplasty of left knee.

Case 19 (L.R. no. 6025/53). A woman, aged 50 years.

Diagnosis. Flexion contracture of left knee and ankylosis of right knee due to rheumatoid arthritis. *Hospitalization:* Jan. 13—March 31, 1955.

History. The patient had a 20-year history of rheumatoid arthritis, with involvement of most of the joints. The right knee had been stiff for 10 years. She had flexion contracture of the left knee, which was painful on movement and weight bearing. She could only walk indoors with the help of a stick. She had great difficulty in getting up from a chair. Had been treated repeatedly in rheumatologic clinics.

Preoperative examination. Corpulent. S.R. 7 mm/1 hr. — Left knee: capsular thickening. Active and passive flexion 170° to 150° with pain. — Right knee: ankylosed at 170° . — She walked slowly, cautiously and painfully, supported on a stick. — Roentgenologic examination of left knee: severe destruction of joint cartilage, subchondral erosions, and osteophytes.

Operation. Feb. 4, 1955 (Walldius). Arthroplasty (no. 21) of left knee.

Postoperative course. Swelling of the operated leg appeared on the 10th day after operation. Thrombosis was diagnosed, and dicumarol therapy instituted. The swelling subsided after about 14 days. — On discharge, the patient could walk without support. Flexion of left knee 180° to 100° .

Follow-up examination was made 1 year and 11 months after operation. Six months earlier, a Judet prosthesis had been inserted in the right hip joint. This considerably relieved the pain, but weakness of the joint persisted. She had no pain in the left knee, even on weight bearing. She could walk indoors without support, and outdoors with a stick, and could manage a half-hour walk. She could manage stairs. Found it difficult to get up from an ordinary chair, but could do so if she had a cushion.

Left knee: no hydrops or capsular thickening. No tenderness. Flexion 180° to 90° . Complete stability. No crepitus. Patellar reflex positive. No swelling of the leg. — Walked with one stick and used the left leg normally. She limped on the right leg, in which the Judet prosthesis was inserted in the hip. — Roentgenologic examination of left knee: prosthesis well adapted. Small osteophytes surrounded its central part. No resorption round the medullary pins.

Case 20 (J.L. no. 2385/54). A woman, aged 63 years.

Diagnosis. Ankylosis of left knee and rigidity of right knee due to rheumatoid arthritis. *Hospitalization:* Feb. 7—April 6, 1955.

History. The patient had a 28-year history of rheumatoid arthritis, with on the right leg, in which the Judet prosthesis was inserted in the hip. — Roent-involvement of most of the joints. There was ankylosis of the left knee, and she could make only small, painful jerks of the right knee. During the past year she could neither stand nor walk, and spent her time in a wheel chair. She had been treated several times at rheumatologic and orthopaedic clinics.

Preoperative examination (Fig. 81). Corpulent. C.R. 35 mm/1 hr. — Right knee: capsular thickening. Active and passive flexion 150° — 145° . — Left knee: ankylosed at 160° . — Marked deformities of other joints. Unable to stand or



Fig. 81. Case 20: before operation; ankylosis of left knee, flexion of right knee 150°—145°. Unable to walk for 1 year.



Fig. 82.



Fig. 83.



Fig. 84.

Figs. 82—84. Case 20: 1 year 9 months after arthroplasty of right knee.

walk. — Roentgenologic examination of right knee: severe rheumatoid arthritis, with complete destruction of joint cartilage.

Operation. Feb. 15, 1955 (Walldius). Arthroplasty (no. 22) of right knee.

Postoperative course. The course was uneventful. On discharge, she could walk with trestles. Flexion of right knee 180° to 100°.

Follow-up examination was made 1¾ years after arthroplasty (Figs. 82—84). The patient was very pleased with the results. She had no pain, even on weight bearing. She could walk unsupported indoors and about 300 m with a stick outdoors. Able to manage stairs and to do light housework.

Right knee: no tenderness, hydrops or capsular thickening. Active flexion 180° to 90°. Complete stability. Inappreciable crepitus. Patellar reflex positive. — Walked unsupported with rapid steps and no actual limp. — Roentgenologic examination of right knee: good adaptation of prosthesis. Osteophyte formations round base of prosthesis, on both the femur and the tibia. Very slight resorption round the medullary pins.

Case 21 (E.L. no. 6005/52). A woman, aged 61 years.

Diagnosis. Flexion contracture of both knees due to rheumatoid arthritis. *Hospitalization:* March 29—June 8, 1955.

History. The patient had suffered from rheumatoid arthritis for 7 years, most of the joints being affected. Flexion contracture of both knees had developed, so that she had been unable to walk for the past 2 years. She spent her time in a wheel chair. She had been treated in a medical clinic.

Preoperative examination (Fig. 85). General condition relatively good. Corpulent. S.R. 72 mm/1 hr. — Both knees: capsular thickening. Active and passive flexion of left knee 140° to 75°, right knee 140° to 90°. — Unable to stand or walk. — Roentgenologic examination of both knees: rheumatoid arthritis with destruction of joint cartilage and subchondral erosions.

Operation. April 4, 1955 (Walldius). Arthroplasty (no. 23) of left knee.

Postoperative course. Course uneventful. Stretching of right knee and application of plaster cast. On discharge, the patient could walk with two sticks. Active and passive flexion of left knee 180° to 110°.

Follow-up examination was made 1 year and 8 months after arthroplasty (Figs. 86—88). The patient was very pleased with the results. She had no pain, even on weight bearing. She could walk unsupported indoors and with one stick outdoors. Had walked over 1 km at a stretch. She could manage stairs and do her housework.

Left knee: no tenderness, hydrops or capsular thickening. Active flexion 180° to 90°. Complete stability. No crepitus. Patellar reflex positive. — Walked rapidly with no limp. Could get up from a chair without difficulty. — Roentgenologic examination of left knee: good adaptation of prosthesis. Osteophytes round the margins of the prosthesis.



Fig. 85. Case 21: before operation.
Unable to walk for 2 years.



Fig. 86.



Fig. 87.



Fig. 88.

Figs. 86—88. Case 21: 1 year 8 months after arthroplasty of left knee.

Case 22 (E.P.L. no. 3615/55). A woman, aged 67 years. Former schoolteacher.

Diagnosis. Flexion contracture of both knees due to rheumatoid arthritis.
Hospitalization: July 4—Sept. 19, 1955, and Nov. 21, 1955—March 5, 1956.

History. The patient had suffered from rheumatoid arthritis for 12 years. During the past year, she had been unable to go out, owing to pain in both knees. Indoors, she used no support. She had been treated at a medical clinic and at several rheumatologic clinics.

Preoperative examination. General condition relatively good for her age. S.R. 53 mm/1 hr. — Both knees: capsular thickening. Active and passive flexion of left knee 140° to 90°, right knee 140° to 80°. Marked crepitus. — She walked without support, but greatly bent forwards with her knees flexed at 45° and with shuffling steps. — Roentgenologic examination of both knees: complete destruction of joint cartilage. Subchondral sclerosis and cystic thinning. Small osteophytes.

Operation. July 11, 1955 (Walldius). Arthroplasty (no. 24) of left knee.

Postoperative course. Course uneventful. On discharge, she could walk without support. Active and passive flexion of left knee 170° to 90°.

Rehospitalization. The patient was readmitted 4 months after arthroplasty. She was very pleased with the results, and requested the same operation on the right knee.

Operation. Nov. 29, 1955 (Walldius). Arthroplasty (no. 27) of right knee.

Postoperative course. Course uneventful. On discharge, she could walk, and the mobility of the right knee was 170° to 110°.

Follow-up examination was made 1 year and 10 months, and 10 months, respectively, after the operations. The patient was very pleased with the results. She had no pain, even on weight bearing. She could walk without support and could manage a 20-minute walk.

Knee joints: no capsular thickening. No tenderness. Active flexion 170° to 90° bilaterally, passive flexion 180° to 90° bilaterally. Complete stability. Inappreciable crepitus. — She walked upright without support and no limp, but with some caution. — Roentgenologic examination of both knees: prostheses well adapted. No resorption round the medullary pins.

Case 23 (E.K. no. 2766/55). A man, aged 58 years. Farmer.

Diagnosis. Flexion contracture of both knees due to rheumatoid arthritis.
Hospitalization: July 5—Nov. 19, 1955.

History. The patient had a 13-year history of rheumatoid arthritis, with involvement of most joints. Flexion contracture of both knees had developed. For the past 3 years he had been unable to stand or walk, and had been confined to a wheel chair. He had been treated at several rheumatologic clinics.

Preoperative examination (Fig. 89). General condition relatively good. S.R. 115 mm/1 hr. — Both knees: marked hydrops and capsular thickening. Active

and passive flexion of left knee 115° to 55° , right knee 110° to 50° with pain bilaterally. Considerable crepitus. Unable to stand or walk. — Typical rheumatic changes in the other joints. — Roentgenologic examination of both knees: severe destructive rheumatic changes (Fig. 94).

Operation. July 13, 1955 (Walldius). Arthroplasty (no. 25) of left knee.

Postoperative course. The course was entirely uneventful.

Operation. Sept. 28, 1955 (Walldius). Arthroplasty (no. 26) of right knee.

Postoperative course. Uneventful course. On discharge, the patient could walk with two sticks, with no pain on weight bearing. Active and passive flexion of left knee 180° to 90° , right knee 170° to 90° .

Follow-up examination was made 16 and 14 months, respectively, after the operations (Figs. 92—95). The patient was very pleased with the results. He had no pain, even on weight bearing. No swelling. He could walk without support indoors and with two sticks outdoors. He was able to be out in the woods and fields, which had not been possible for 10 years, and to walk 1 km at a stretch. He could drive a car and a tractor, and managed stairs well.

Both knees: no hydrops or capsular thickening. No tenderness. Active mobility 180° to 90° with good power. Complete stability. Moderate crepitus. Patellar reflex positive. — He walked unsupported without limping, and could rise from a chair without difficulty. — Roentgenologic examination of both knees: fracture at the base of the tibial medullary pin of both prostheses (Figs. 95 and 96).



Fig. 89. Case 23: before operation; both knees in position of maximal extension. Unable to walk for 3 years.



Fig. 90 and 91 (see next page).

*Fig. 92.**Fig. 93.*

Figs. 90—93. Case 23: 1 year 4 months after arthroplasty of left knee, and 1 year 2 months after arthroplasty of right knee.

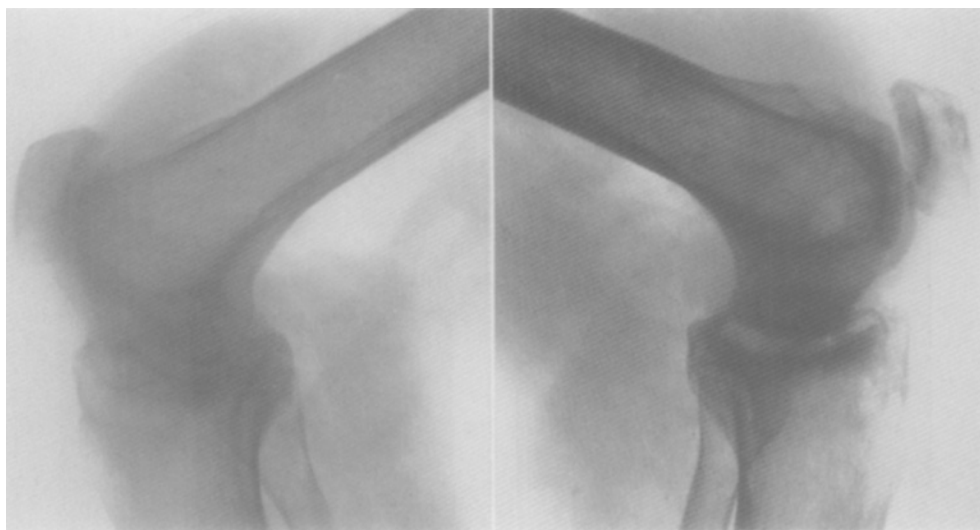


Fig. 94. Case 23: roentgenograms of right and left knee in position of maximal extension before operation.

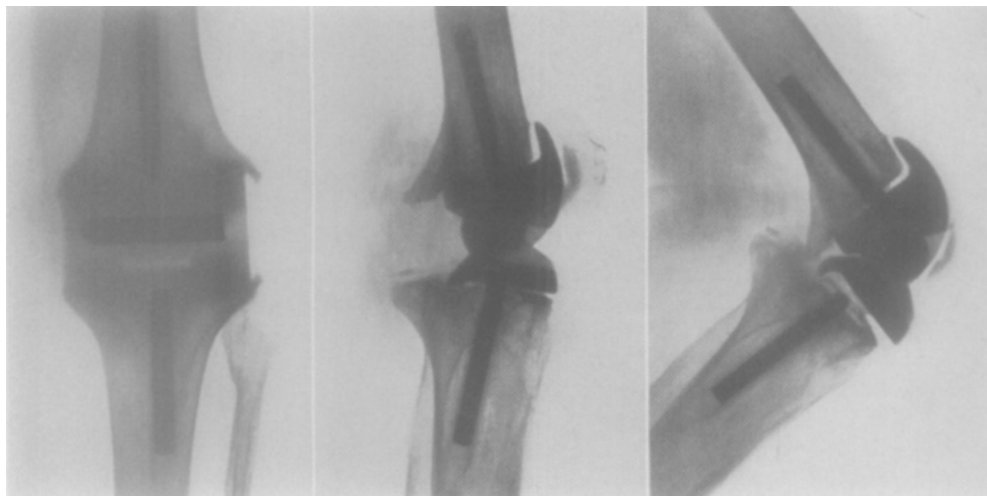


Fig. 95. Case 23: roentgenograms of left knee 1 year 4 months after arthroplasty.

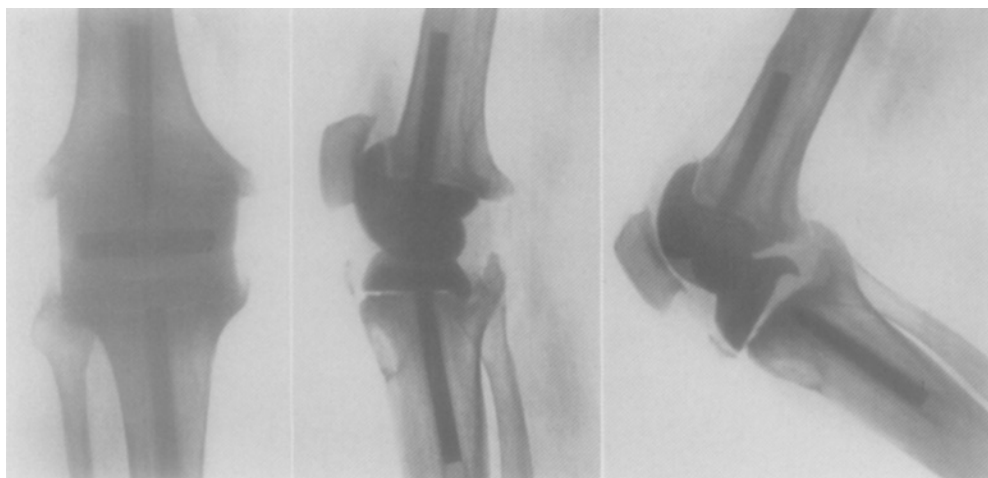


Fig. 96. Case 23: roentgenograms of right knee 1 year 2 months after arthroplasty.

Case 24 (E.E.L. no. 6881/55). A woman, aged 66 years.

Diagnosis. Flexion contracture of both knees due to rheumatoid arthritis.
Hospitalization: Dec. 29, 1955—April 4, 1956, and April 23—July 28, 1956.

History. The patient had a 26-year history of rheumatoid arthritis, with involvement of most joints. Flexion contracture of both knees had developed. During the past 3 years she had been unable to stand or walk, and had spent her time in a wheel chair. She had been treated at several rheumatologic clinics.

Preoperative examination. Corpulent. Asthenic mentality. S.R. 45 mm/1 hr. — Both knees: diffuse tenderness. Capsular thickening. Active and passive flexion of right knee 160° to 110° , left knee 145° to 110° . — Unable to stand or walk. — Roentgenologic examination of both knees: almost total destruction of joint cartilage. Generalized decalcification.

Operation. Jan. 4, 1956 (Walldius). Arthroplasty (no. 28) of left knee.

Operation. April 27, 1956 (Walldius). Arthroplasty (no. 32) of right knee.

Postoperative course. The course was uneventful after both operations. On discharge, she could walk with one trestle and one stick. Flexion of left knee 180° to 105° , right knee 180° to 120° .

Follow-up examination was made 10 and 7 months, respectively, after the operations (Figs. 97 and 98). The patient was very pleased with the results. She had some pain in the knees when taking the first steps after having sat for some time. Indoors she walked without support, outdoors with two sticks. She could walk 50—100 m at a stretch and could manage stairs.

Both knees: no hydrops or capsular thickening. Inappreciable diffuse tenderness. Active flexion 180° to 90° in both knees. Complete stability. — She walked unsupported without limping, although slowly and cautiously. — Roentgenologic examination of both knees (Fig. 99): prostheses well adapted. Inappreciable resorption round medullary pins.



Figs. 97 and 98. Case 24: 10 months after arthroplasty of left knee, and 7 months after arthroplasty of right knee.

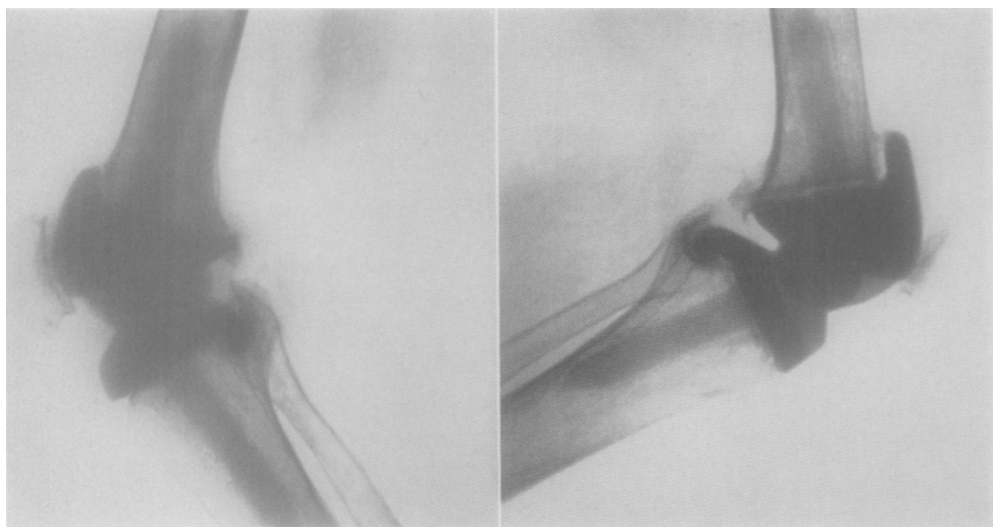


Fig. 99. Case 24: roentgenogram of right knee 7 months after arthroplasty, and of left knee 10 months after arthroplasty.

Case 25 (M.O. no. 23/56). A woman, aged 36 years.

Diagnosis. Flexion contracture of right knee owing to rheumatoid arthritis.
Hospitalization: Feb. 22—May 5, 1956.

History. The patient had rheumatic fever, from which she recovered, at the age of 15. She had had rheumatoid arthritis for the past 12 years, with involvement of most joints. Flexion contracture of the right knee developed, and caused great pain on movement and weight bearing. For the past few months she had not ventured outdoors. She did not use a stick.

Preoperative examination. General condition relatively good. S.R. 10 mm/1 hr. — Right knee: capsular thickening. Active flexion 150° to 100° , passive 170° to 100° . — Left knee: active and passive flexion 180° to 70° . — She walked bent forwards with the right knee flexed, and bore weight only on the anterior part of the foot. — Roentgenologic examination of right knee: almost total destruction of cartilage. Subchondral sclerosis.

Operation. Feb. 29, 1956 (Walldius). Arthroplasty (no. 30) of right knee.

Postoperative course. During the second week after operation, twitching and paraesthesia appeared in both feet and in the right lower leg. A plaster cast had been applied to the whole leg, and cut into an anterior and posterior portion immediately after operation. When this was removed three weeks postoperatively, the anterior tibial and peroneal muscles were found to be paralyzed. There was also decreased superficial sensation laterally over the right thigh and over the dorsum of the foot, extending to the big toe and the middle toe. Neither the little toe nor the sole of the foot was involved. Sensation was also slightly impaired on the dorsum of the left foot. The neurologist consulted was of the opinion that it was, to some extent, to be ascribed to spinal anaesthesia.

On discharge, the patient could walk unsupported. Active and passive flexion of the right knee was 175° to 100° . Paralysis of the dorsum of the foot persisted. The patient was fitted with a simple wire heel splint, and a night splint to prevent drop foot.

Follow-up examination was made 9 months after operation (Figs. 100 and 101). The patient was very pleased with the results. She had no pain, even on weight bearing. She was able to be out for 1—2 hours at a stretch, without a stick. Managed stairs well. She noticed very little of the former paralysis, and did not use the heel splint or the night splint. Some numbness in the dorsum of both feet persisted.

Right knee: no capsular thickening. No tenderness. Active flexion 180° to 90° . Complete stability. Moderate crepitus. Patellar reflex positive. — Walked with rapid steps and no limp. — Right foot: good strength in the anterior tibial and peroneal muscles, although somewhat weaker than in the left foot. Slightly impaired superficial sensation on the dorsum of the foot, extending about a handbreadth up on the lower leg, in front of the lateral malleolus. — Conditions similar in the left foot, but less pronounced. — Roentgenologic examination of right knee: prosthesis well adapted (Fig. 102).



Figs. 100 and 101. Case 25: 9 months after arthroplasty of right knee.



Figs. 102. Case 25: roentgenograms of right knee 9 months after arthroplasty.

Case 26 (B.W. no. 5849/55). A woman, aged 79 years.

Diagnosis. Severe arthrosis deformans and genu valgum of left knee. *Hospitalization:* April 19—June 21, 1956.

History. The patient had had pain in the left knee for the past 20 years, with increasing genu valgum. She walked with a knee brace and a stick, but could scarcely bear weight on the leg, owing to pain. All kinds of conservative therapy had been tried. Denervation of the knee had been performed 7 years earlier.

Preoperative examination. General condition good for her age. S.R. 18 mm/1 hr. — Left knee: genu valgum 20°. Active and passive flexion 170° to 40° with pain in the extreme positions. Considerable lateral instability, especially in the direction of the genu valgum. — She walked somewhat bent forward, supported on a stick, with cautious weight bearing on the left leg. — Roentgenologic examination of left knee: genu valgum and arthrosis deformans.

Operation. April 23, 1956 (Friberg and Walldius). Arthroplasty (no. 31) of left knee.

Postoperative course. The course was uneventful. On discharge she could walk with two trestles. The genu valgum was eliminated. Active and passive flexion 160° to 120°.

Follow-up examination was made 7 months after operation. The patient was extremely pleased with the results. She had no pain, even on weight bearing. Indoors she walked without support; outdoors, she could go for a 30-minute walk with one stick. Able to manage stairs.

Left knee: no capsular thickening. No tenderness. Active flexion 175° to 90°, passive 180° to 90°. Complete stability. Genu valgum < 5°. — She walked upright with long, rapid steps, without a stick. — Roentgenologic examination of left knee: good congruence between the prosthesis and the resected surfaces. Osteophytes round the margins of the prosthesis.

CHAPTER IX

Results

Altogether 32 knees were operated on; the results could not be evaluated in two of them, since both patients died in close connexion with the operation. Complications necessitated subsequent arthrodesis in four knees, and amputation of the leg in two. In the remaining 24 knees, *i.e.*, in 75 per cent of 19 patients, the results of arthroplasty were excellent. An account of the implications of this statement is given in the following (see also Tables 2 and 3).

Patients' Evaluation

All 19 patients were very pleased with the results of operation. They have been relieved of their aches, as well as of pain on weight bearing, they have attained good mobility and stability of the joint, and their walking ability has been regained or greatly improved. Whereas many of them were formerly dependent on others for their care, they are able after operation to manage by themselves to a great extent. Thus, those of them who are housewives are able to go out and do their shopping, and can do light housework. A 58-year-old farmer (Case 23) had sat in a wheel chair for three years, and had an extension defect in his knees of 65° and 70° , respectively; after bilateral arthroplasty he is able to be out in the fields and woods, and can drive a car and a tractor. Especially in those who had for years been confined to a wheel chair, the improvement has produced a more optimistic frame of mind. One of these patients stated that, after operation, he felt like a prisoner for life who had been granted a pardon.

Even those in whom arthrodesis or amputation was subsequently performed have declared themselves to be satisfied, in so far as they have been freed from pain, and can walk better.

Effect on Pain

Sixteen patients have stated that they are entirely free from pain, *i.e.*, they have no aching, nor any pain on movement or weight bearing. They have insisted that this is so, despite attempts to make them acknowledge that some pain must nevertheless persist.

One patient (Case 24) complained of slight pain on taking the first steps

after having sat still for a long time. Another (Case 2) had a little sub-patellar pain on maximal flexion during the first year after operation. In Case 11, some pain persisted, owing to progression of the rheumatoid arthritis. In all three cases the pain was, however, relatively inappreciable, and did not result in any impairment in the function of the joint.

A reasonable explanation of the freedom from pain is that the actual movement takes place in the prosthesis, in which the joint surfaces consist of non-vital material, insensitive to pain.

Mobility and Strength

Preoperatively, the flexion of the knee was tested when the patient made active flexion and extension movements in bed, with the foot sliding against the bedding. The movement was thus not a purely active one, but a supported one. Forced passive movement towards the extreme positions was then tested. At follow-up examination, the mobility was tested with the patient sitting on a chair. Purely active movements could thus be carried out, followed by passive forcing towards the extreme positions. Both the active and passive range of movement was recorded. The results are given in Table 2.

Good mobility was achieved in 24 knees, *i.e.*, 75 per cent. Passive mobility ranged from 65° to 100° (average 88°), and active mobility from 60° to 90° (average 84°).

Flexion from 180° to 90° is the range of movement of greatest functional importance. The prosthesis has this range. A comparison has been made between the passive mobility within these borderlines (bracketed figures in Table 2) before and after operation. The difference, *i.e.*, the "gain" in mobility, varied from 10° to 85° , with an average of 44° . This "gain" is chiefly to be ascribed to elimination or considerable reduction of the extension defect. Postoperatively, only two patients have a residual passive extension defect of 10° in each case, it having been 35° and 30° , respectively, before operation.

An extension defect on active movement, ranging from 5° to 30° , is present in 8 knees. In Case 1, this was due to the fact that the prosthesis was inserted slightly out of alignment, so that a posteriorly open angle was formed between the femoral medullary pin of the prosthesis and the longitudinal axis of the femur. In the other cases, it seems to be dependent on weakness of the quadriceps muscle.

It must also be mentioned that the mobility of the knee has not been reduced after operation in any of the cases, with the exception of Case 8. Here, the flexion of the left knee has been decreased by 10° , from 180° — 90° to 180° — 100° .

The strength of the quadriceps muscle has been remarkably good in most cases, in view of the atrophy of the muscle generally present prior to operation. Some patients (*e.g.* Cases 1 and 3, Figs. 30 and 40) were able to stand on one leg (the operated side) and flex and stretch the leg about 30°.

Patellar Reflex

After operation, the patellar reflex was positive in 13 knees. It can be regarded as a defence mechanism for the joint, by which it is prevented from undergoing uncontrolled and forced movements.

Stability

All 19 patients stated that there was complete stability of the knee after operation. This could be confirmed objectively, except that slight swaying towards a genu valgum position was recorded in Case 16, and a faintly positive "drawer sign" in Case 8 (left knee). This has not, however, had any detrimental effect on the function of the joint in either case. Roentgenologic examination disclosed neither fracture nor loosening of the prosthesis to account for this instability. Moreover, fracture of a prosthesis does not necessarily result in instability, as shown by Case 23, in which the tibial medullary pin was fractured in the prosthesis of both knees.

Roentgenologic Examination

No signs of loosening of the prosthesis were observed, such as may be the case with a Judet prosthesis in the hip. Nor was any funnel-shaped widening of the channel for the medullary pin seen on the roentgenogram, as occurs in such cases with the Judet prosthesis.

Fracture of the prosthesis in an accident occurred in Case 2 (Figs. 4 and 34). A fracture at the base of the tibial medullary pin, with no history of a definite trauma, was recorded in three prostheses (Cases 1 and 23). In Case 1, it was detected at autopsy, and in Case 23 at roentgenologic examination (Figs. 95 and 96). Despite this, stability and function had been adequate in all three knees. Since the central part of the prosthesis gradually becomes surrounded by small osteophytes, which contribute to its fixation, there need not be any instability even if the medullary pin should fracture.

Another indication that the prosthesis is relatively firmly fixed is the sclerosis of the resected surfaces visible roentgenologically. The fact that the bone is vital at this site is evident from the histologic examination of a piece of bone chiselled out from the resected surface of the tibia in reoperation on Case 2.

It is interesting to observe how the patella glides over the anterior aspect of the prosthesis to reach the positions of maximal extension and flexion. Measured on the roentgenogram, the mean value for this excursion is 3.6 cm.

In four cases in which arthroplasty was complicated by subsequent infection (Cases 5, 10, 13 and 15), the prosthesis was extracted and arthrodesis performed. This healed with bony ankylosis, as can be inferred from Figs. 50, 62, 63 and 70.

Walking Ability

The walking ability of the patients before and after operation is seen in Table 3. Arthroplasty with the present technique does not rule out the possibility of performing arthrodesis later, should arthroplasty be unsuccessful. Arthrodesis was done in four cases (nos. 5, 10, 13 and 15) and would probably also have been successful in the two cases (nos. 6 and 7) in which amputation was performed.

If the effect not only of arthroplasty, but also of arthrodesis and amputation, is taken into account, it is found that of the 11 patients who were unable to stand or walk preoperatively, all but one (Case 11) regained their walking ability. This was not possible in Case 11, owing to progression of the rheumatoid arthritis, as well as the presence of coincident illnesses, which greatly exacerbated the patient's general condition. In Case 16 the walking ability has remained unchanged, because of pain in the hip caused by rheumatoid arthritis. The remaining 23 patients (88 per cent) walk better after operation. Of the 19 patients in whom arthroplasty has led to good mobility, all except the aforementioned Cases 11 and 16 have shown improvement with respect to walking.

Eighteen patients are able to walk about indoors without any support; 9 of them were earlier confined to a wheel chair.

In order to judge the walking ability properly, it must be recalled that this is dependent not only on the state of the knee joints, but also on that of the other joints in both the upper and lower limbs. These rheumatic patients often have pain in their feet which makes it difficult for them to walk. Orthopaedic shoes were therefore provided in 15 cases. Pain in the hip joints is also a frequent cause of walking difficulties; this was most conspicuous in Cases 16 and 19. Cases 8 and 18 could not manage ordinary sticks, owing to flexion contracture of the elbow joints and weakness of the hand grip; they have to use crutches. Arthritic changes in the joints of the upper limb have prevented those who use sticks from bearing weight on them to any great extent, so as to relieve some of the weight on the leg. Consequently, the sticks are used more to keep their balance, since these patients are afraid of falling.

Results in Relation to Indications

Earlier experience of arthroplasty in rheumatic joints has, on the whole, been poor. In the present series, in which operation was performed on 29 such joints, excellent results have been obtained in 23, *i.e.*, 79 per cent.

Two of the patients had arthrosis deformans; in one of them (Case 10) complications appeared, so that it was necessary to perform arthrodesis later. In the other (Case 26) excellent results were achieved.

In the patient with post-traumatic rigidity after an intra-articular fracture and infective arthritis (Case 7) the results were also poor, and led to amputation. It is evident that the indications for operation were incorrect in this case. It was performed at the request of the patient, who was told that the remaining alternatives were arthrodesis or amputation.

Pain is one of the most important reasons for operating, and was present in every case with the exception of Cases 13 and 17, where the joint was ankylosed.

Limitation of movement existed in every case. Excellent results could be achieved even with severe flexion contracture (about 90°), as in Cases 8 and 23. Case 8 is presumably the first case described with dislocation of both knee joints in which bilateral arthroplasty was performed successfully. Two ankylotic joints were operated on; the results were good in one (Case 17) and poor in the other (Case 13).

It was possible by means of arthroplasty to correct both genu valgum and instability (Cases 1, 3 and 26).

Advanced age did not prove to be an obstacle to obtaining good results. Thus, one patient was 79 years old (Case 26). The average age in the present series was 53 years, which is higher than that earlier regarded as suitable for arthroplasty of the knee, *i.e.*, 20 to 40 years.

Lengthy inactivity, *e.g.* 10 years in a wheel chair in Cases 8 and 17, produced severe muscular atrophy, of the quadriceps muscle among others. This muscle which is of great importance for the knee joint could, however, be trained by exercise after arthroplasty, so that good function of the joint was attained.

No relation could be demonstrated between the level of the sedimentation rate and the results of operation.

A factor that has earlier been ascribed great importance for the success of arthroplasty is the temperament of the patient. It has been considered that the patient must have a strong determination to cooperate, particularly in the highly important postoperative treatment, when training of the mobility of the joint may be troublesome. In the present series, many patients were depressed and asthenic, as a result of lengthy and debilitating rheumatoid arthritis. For example, Case 14 was admitted directly from a psychiatric

clinic, to which she had been referred after attempted suicide. Despite this, excellent results were achieved. Earlier, when arthroplasty of the knee has failed, it has not infrequently been blamed on the patient's lack of active cooperation in postoperative treatment. The inadequacy of the actual surgical technique has less often been questioned.

Grading of Results

If the results are graded in the usual way as excellent, good, fair and poor, with the present method of arthroplasty they have been excellent in 75 per cent and poor in 25 per cent. By excellent is meant that the patient is satisfied with the results, the joint is free from pain, and has good mobility, stability and function. The poor results are due to complications which arose, necessitating arthrodesis or amputation. A remarkable feature is that none of the cases can be assigned to the category of good or fair. Consequently, it can be presumed that if the risk of complications can be reduced, the percentage of cases with excellent results can be increased.

Table 2. Mobility

Case no.	Op. no.	Passive Mobility in Degrees					Active Mobility in Degrees	
		Preop.	Postop.	"Gain" in mobility	Extension defect		Postop.	Extension defect
					Preop.	Postop.		
1	1	145—70 (55)	170—70 (80)	25	35	10	150—70 (80)	30
2	2	150—100 (50)	180—90 (90)	40	30	0	180—90 (90)	0
3	3	175—110 (65)	180—90 (90)	25	5	0	180—90 (90)	0
4	4	125—90 (35)	180—90 (90)	55	55	0	180—90 (90)	0
5	5	135—90 (45)	Ankylosis					
6	6	175—90 (85)	Amputation					
7	7	160—155 (5)	Amputation					
8	8	90—70 (0)	180—100 (80)	80	90	0	160—100 (60)	20
9	9	150—130 (20)	Death					
10	10	155—135 (20)	Ankylosis					
11	11	160—90 (70)	180—90 (90)	20	20	0	180—90 (90)	0
12	12	170—100 (70)	180—90 (90)	20	10	0	180—90 (90)	0
13	13	150—150 (0)	Ankylosis					
14	14	150—70 (60)	180—90 (90)	30	30	0	180—90 (90)	0
15	15	150—70 (60)	Ankylosis					
16	16	135—100 (35)	180—90 (90)	55	45	0	160—90 (70)	20
8	17	90—70 (0)	180—100 (80)	80	90	0	180—100 (80)	0
1	18	170—50 (80)	Death					
17	19	150—150 (0)	170—105 (65)	65	30	10	170—105 (65)	10
18	20	170—80 (80)	180—90 (90)	10	10	0	160—90 (70)	20
19	21	170—150 (20)	180—90 (90)	70	10	0	180—90 (90)	0
20	22	150—145 (5)	180—90 (90)	85	30	0	180—90 (90)	0
21	23	140—75 (50)	180—90 (90)	40	40	0	180—90 (90)	0
22	24	140—90 (50)	180—90 (90)	40	40	0	170—90 (80)	10
23	25	115—55 (25)	180—90 (90)	65	65	0	180—90 (90)	0
23	26	110—50 (20)	180—90 (90)	70	70	0	180—90 (90)	0
22	27	140—80 (50)	180—90 (90)	40	40	0	170—90 (80)	10
24	28	145—110 (35)	180—90 (90)	55	35	0	180—90 (90)	0
18	29	170—80 (80)	180—90 (90)	10	10	0	180—90 (90)	0
25	30	170—100 (70)	180—90 (90)	20	10	0	180—90 (90)	0
26	31	170—40 (80)	180—90 (90)	10	10	0	175—90 (85)	5
24	32	160—110 (50)	180—90 (90)	40	20	0	180—90 (90)	0

Table 3. *Walking Ability*

Case no.	Nature of operation	Support				Distance or Time	
		Indoors		Outdoors			
		Preop.	Postop.	Preop.	Postop.	Preop.	Postop.
1	APL right	1 Crutch 1 Stick Knee brace	1 Stick	1 Crutch 1 Stick Knee brace	1 Stick	50 m	1 km
2	APL left	1 Stick	0		0	Indoors	2 hrs
3	APL left	Bedridden	0		0	0	2 hrs
4	APL right	Wheel chair	0	Wheel chair	0	0	1 km
	AL left						
5	AD right	2 Crutches	0		2 Crutches	Indoors	50 m
6	AMP right	1 Stick	Prosthesis 1 Canadian crutch		Prosthesis 2 Canadian crutches	Indoors	1 hr
7	AMP left	1 Stick Leg bandage	Prosthesis	1 Stick Leg bandage	Prosthesis	500 m	1 km
8	APL right	Wheel chair	0	Wheel chair	2 Crutches	0	1 km
	APL left						
9	APL right	1 Stick		1 Stick		500 m	
10	AD right	1 Stick	0		1 Stick	Indoors	500 m
11	APL right	Bedridden	Bedridden			0	0
12	APL left	Helper	0	Helper	1 Stick	100 m	2 hrs
	AD right						
13	AD right	2 Sticks	2 Sticks		2 Sticks	Indoors	1 km
14	APL left	Bedridden	0		1 Stick	0	300 m
	AD right						
15	AD left	Bedridden	2 Sticks		2 Sticks	0	100 m
16	APL left	1 Crutch 1 Stick	2 Canadian crutches			Indoors	Indoors
17	APL right	Wheel chair	0	Wheel chair	1 Stick	0	1 hr
18	APL right						
	APL left	2 Crutches	0		1 Crutch	Indoors	1 km
19	APL left	1 Stick	0		1 Stick	Indoors	30 min
20	APL right	Wheel chair	0	Wheel chair	1 Stick	0	200 m
21	APL left	Wheel chair	0	Wheel chair	1 Stick	0	1 km
22	APL left	0	0		0	Indoors	20 min
	APL right						
23	APL left	Wheel chair	0	Wheel chair	2 Sticks	0	1 km
	APL right						
24	APL left	Wheel chair	0	Wheel chair	2 Sticks	0	100 m
	APL right						
25	APL right	0	0		0	Indoors	2 hrs
26	APL left	1 Stick Knee brace	0		1 Stick	Indoors	30 min

APL right = Arthroplasty of right knee; APL left = Arthroplasty of left knee; AL = Arthrolysis; AD right = Arthrodesis of right knee; AD left = Arthrodesis of left knee; AMP right = Amputation of right thigh; AMP left = Amputation of left thigh.

Summary

A survey of the development of arthroplasty of the knee shows the course to have been the following with respect to the types of operation: resection, arthrolysis, interposition and replacement. Interposition with fascia lata has been the method chiefly used. A collocation of the results in large series shows that they can be counted as good in about 50 per cent of the cases.

A new method of operation has been elaborated, consisting of resection of the joint and insertion of a whole artificial joint. This prosthesis is constructed as a hinge joint; it is made of acrylic resin, and has a femoral and a tibial part, joined together by a stainless steel rod. Its range of movement is 185° to 90° . Fixation in the femur and tibia takes place by means of medullary pins and lips in the prosthesis. It is constructed in such a way that mechanical and biologic prerequisites for firm fixation in the leg have been taken into account. Its construction implies that it takes over the functions of the collateral and cruciate ligaments. These ligaments can therefore be sacrificed at operation. In an earlier model, the prosthesis was reinforced by steel cores; these have been abandoned in the later model. The acrylic resin used is roentgen-opaque.

A test was made of the frictional heat, wear and tear and strength of the prosthesis under conditions similar to those expected to apply after its insertion in the knee. The results were considered to warrant insertion of the prosthesis.

Two prostheses could be examined after having been inserted and functioned normally for 3 years and $4\frac{1}{4}$ years, respectively. The wear and tear was found to be of an order of magnitude that need not be detrimental to function of the joint, even in the course of several decades.

Since the prosthesis is constructed as a hinge joint of non-vital material, and friction between the joint surfaces occurs within the prosthesis, one of the pain-eliciting factors is eliminated.

The special instruments required for the operation are few and simple.

In 29 operations, the indications were destructive changes in the knees due to rheumatoid arthritis, with pain, rigidity, extension defects, and sometimes ankylosis, which had failed to respond to conservative treatment. In every case the walking ability was greatly impaired or inhibited. Severe arthrosis was present in two cases, and post-traumatic rigidity in one.

The operation is relatively simple, and consists briefly of the following stages. A Textor incision is made. The tuberosity of the tibia is chiselled off, and the joint capsule cut through parallel to the skin incision. The patella is retained. A saw is used to make the joint surfaces plane. Using the special

instruments, channels for the medullary pins of the prosthesis are drilled in the medullary cavity of the femur and tibia. The two halves of the prosthesis are driven in and connected with the steel rod, which is covered by a plastic screw. The tuberosity of the tibia is sutured with silk. The joint capsule and skin are sutured. A plaster cast is applied to the knee for three weeks, with the leg in the extension position.

Postoperative treatment, consisting of gymnastic treatment, baths and training of the walking ability for two months, causes no great inconvenience to the patient.

In uncomplicated cases, the average duration of hospitalization has been 2 months 22 days.

Complications consisted of pulmonary embolism in one case, and septicæmia in another, both with a fatal outcome. Infection in the joint necessitated amputation in two cases and arthrodesis in four. Fracture of the prosthesis in an accident led to reoperation with insertion of a new prosthesis in one case. Other complications had no detrimental effect on the function of the joint.

The present series comprises 26 cases, with arthroplasty of 32 knees. Bilateral arthroplasty was performed in 6 patients.

The results of operation can be regarded as very good, if it is taken into account that in the majority of cases (29 knees) the indication was rheumatoid arthritis with severe destructive changes. In 75 per cent of the operated knees, freedom from pain was achieved, as well as average active mobility of 84°, full stability and regained or improved walking ability. The patients in whom these results were obtained, in particular the greatly disabled rheumatic patients who had been unable to walk for many years, were very satisfied with the results of operation.

After operation, the patellar reflex was positive in 13 knees.

Roentgenologic examination shows the prosthesis to be surrounded by a zone of sclerosed bone at the resected surfaces, and by small osteophytes, which contribute to its fixation. No reactions have been observed in the bone tissue indicating that the prosthesis would become successively loosened.

The surgical technique hitherto commonly used, with fascia lata as interposition material, has led to good results in about 50 per cent of the cases. Using the method in question here, this figure can be raised to 75 per cent. The observation period is, however, relatively short, ranging from 7 months to 4 years 10 months. Consequently, the future will show whether the results are permanent.

The surgical technique can be regarded as finally elaborated. On the other hand certain details in the construction of the prosthesis can be improved. In particular, it would be desirable to find some material for the prosthesis with better properties than those of materials hitherto used.

Résumé

Une vue d'ensemble sur le développement de l'arthroplasie du genou fait état des opérations-types suivantes: résection, arthrolysis, interposition et remplacement. C'est l'interposition usant du fascia lata qui est la méthode généralement usitée. Une compilation des résultats tels qu'ils apparaissent dans les grandes statistiques indiquent que ceux-ci peuvent être jugés satisfaisants dans 50 % des cas environ.

L'auteur a mis à point une nouvelle méthode opératoire consistant en la résection de l'articulation et l'échange de celle-ci contre une articulation entièrement artificielle en forme de charnière, en acrylic avec un axe d'acier inoxydable. Elle permet un déploiement de 185° à 90° . La fixation au niveau du fémur et du tibia se fait au moyen de pivots médullaires et de lèvres. Dans la construction de cet appareil, il a été tenu compte des conditions d'ordre mécanique et biologique que représente une situation permanente dans un tissu osseux. Puisque la prothèse supplée aux fonctions des ligaments collatéraux et croisés, ceux-ci peuvent être sacrifiés à l'opération. Dans un modèle antérieur, la prothèse avait été muni d'un renforcement de tiges d'acier, abandonné par la suite. L'acrylic composant la prothèse est opaque à la radiographie.

Il fut procédé à un essai en vue d'évaluer le chaleur de friction, l'usure et la solidité de la prothèse lors de sa mise en place. Le résultat de cet essai fut jugé favorable à tous les points de vue.

Deux prothèses purent être examinés après avoir servi et fonctionné normalement pendant respectivement 3 et 4 ans et demi. L'appareil se montra si peu usé qu'il aurait pu servir encore des dizaines d'années sans mettre en péril le fonctionnement articulaire.

La prothèse étant faite d'une charnière de matière avitable et le frottement entre les surfaces articulaires s'effectuant à l'intérieur de l'articulation, on élimine par là-même un des facteurs générateur de douleur.

Les instruments exigés par l'opération sont ordinaires et peu nombreux.

Pour les 29 interventions relatives, les indications opératoires ont été des altérations destructives du genou dues à l'arthrite rhumatoïde, accompagnées de douleur, de rigidité, d'un défaut d'extension et d'ankylose, réfractaires à tout traitement conservatif, supprimant ou restreignant la faculté de marcher. Chez deux patients, il y avait une arthrose grave et dans un cas, une rigidité à la suite d'un traumatisme.

L'opération est relativement simple et se fait par les étapes suivantes: Incision textorienne. Tubérosité du tibia aplaine au ciseau, incision de la

gaine synoviale parallèlement à l'incision cutanée. La rotule est conservée. Les surfaces articulaires sont aplanies à la scie. A l'aide d'instruments spéciaux on crée des canaux dans les cavités moelleuse du fémur et du tibia pour la mise en place des pivots. Les deux moitiés de la prothèse sont introduites et reliées par l'axe d'acier, lequel est recouvert par une vis de plastique. La tubérosité du tibia est ensuite recousue. Points de sutures dans la gaine et la peau. La jambe est fibalement plâtrée pendant trois semaines avec le genou en état d'extension.

Le traitement physiothérapeutique, les bains et les exercices de marche pendant les deux mois suivants ne représentent pas de grands désagréments pour les patients.

Pour les cas sans complications la durée moyenne d'hospitalisation a été de 2 mois 22 jours.

Les complications ont consisté en un cas d'embolisme pulmonaire et un cas de sépticémie, tous deux avec suite létale. L'infection de l'articulation a nécessité l'amputation dans deux cas et l'arthrodèse dans 4 cas. Une rupture de la prothèse par suite de traumatisme nécessita une nouvelle intervention avec échange de la prothèse. Les autres complications n'ont pas eu d'influence préjudiciable sur le bon fonctionnement de l'articulation.

La série comprend 26 cas de plastie avec un total de 32 articulations. Six patients ont été opérés aux deux genoux.

Le résultat de ces opérations doit être jugé comme très satisfaisant spécialement si l'on considère que l'indication opératoire a été dans la majorité des cas (29 articulations) une arthrite réumatoïde avec fortes destructions. Dans 75 % des articulations opérées les résultats suivants ont été obtenus : disparition des douleurs, mouvements actifs atteignant une envergure de 84° en moyenne, bonne stabilité, faculté de marche retrouvée et améliorée. Les patients chez lesquels ces résultats ont été obtenus et particulièrement les rhumatisants fortement invalidisés, n'ayant pas pu marcher pendant des années, ont montré une très grande satisfaction.

Le réflexe rotulien a été, après l'intervention, positif pour 13 genoux.

A la radiographie, on observe que la prothèse est entourée d'une zone osseuse sclérotique au voisinage de la surface de résection ainsi que de petits ostéophytes, contribuant à sa fixation. Il n'y a pas de réaction indiquant que la prothèse montrerait une tendance à bouger.

La méthode opératoire ordinaire avec le fascia lata comme interpositum a donné de bons résultats dans 50 % de cas environ. La méthode décrite dans notre travail a élevé ce taux à 75 %. La durée d'observation étant néanmoins courte (de 7 mois à 4 ans 10 mois), l'avenir montrera si ces résultats tiendront.

La méthode décrite peut être considérée comme définitivement élaborée. Par

contre le prothèse demande un perfectionnement des détails. Il serait surtout désirable de trouver une matière ayant de meilleures propriétés que celle dont on s'est servi ici.

Zusammenfassung

Eine Übersicht über die Entwicklung der Arthroplastik zeigt, dass folgende Arten von Operationen ausgeführt worden sind: die Resektion, die Arthrololyse, die Interposition und der Ersatz. Die Interposition mit fascia lata war die am meisten angewendete Methode. Eine Zusammenstellung der Resultate grösserer Statistiken zeigt, dass diese Methode mit ca. 50 % guten Resultaten rechnen kann.

Der Verfasser hat eine neue Operationsmethode ausgearbeitet. Diese besteht in einer Gelenkresektion und der Einsetzung eines ganzen künstlichen Gelenkes, welches wie ein Scharniergelenk konstruiert ist und aus Acryl mit einer Achse aus rostfreiem Stahl besteht. Dieses hat einen Bewegungsumfang von 185° — 90° . Die Fixation derselben in Femur und Tibia wird bewerkstelligt durch je einen von der Prothese ausgehenden Knochenmarkstift und Lippen. Die Prothese wurde so konstruiert, dass auf die mechanischen und biologischen Bedingungen für eine feste Verankerung im Knochen Rücksicht genommen wurde. In ihrer Konstruktion sind die Funktionen der Kollateral- und Kreuzbänder eingeschlossen. Diese Bänder können deshalb bei der Operation geopfert werden. In einem früheren Modell war die Prothese mit Stahlstäben armiert, was jedoch später aufgegeben wurde. Es wird ein Acrylstoff verwendet, der im Röntgenbild sichtbar ist.

Eine Belastungsprobe wurde ausgeführt, um die Reibungswärme, die Abnutzung und die Deformität der Prothese zu untersuchen, die nach deren Einsetzung entstehen könnten. Das Resultat war, dass die geprüften Prothesen eingesetzt werden konnten.

Zwei Prothesen konnten, nachdem sie eingesetzt und während 3 resp. $4\frac{1}{4}$ Jahren normal funktioniert hatten, untersucht werden. Die Abnutzung der Prothesen war so minim, dass eine Gefährdung der Gelenkfunktion auf Jahrzehnte hinaus nicht befürchtet zu werden braucht.

Dadurch, dass die Prothese wie ein Scharniergelenk konstruiert ist, aus leblosem Material besteht und sich die Reibungen zwischen den Gelenkoberflächen innerhalb, des Gelenkes abspielen, wird einer der schmerzauslösenden Faktoren ausgeschaltet.

Die für die Operation notwendigen Instrumente sind wenige und einfach.

Die Operationsindikationen waren für 29 Operationen destruktive Veränderungen in den Kniegelenken auf Grund einer rheumatischen Arthritis

mit Schmerzen, Rigidität, Streckausfall und Ankylose, die jeder konservativen Behandlung trotzten und zu starker Verschlimmerung oder Verunmöglichung des Gehens führten. In zwei Fällen lag eine schwere Arthrosis deformans und in einem Fall eine posttraumatische Rigidität vor.

Die Operation ist relativ einfach und besteht kurz gesagt in folgenden Etappen: Textorschnitt. Die Tuberositas tibiae wird abgemeisselt und die Gelenkkapsel parallel zum Hautschnitt durchtrennt. Die Patella wird belassen. Die Gelenkflächen werden mit der Säge plan reseziert. Mit Hilfe des Instrumentariums werden die Kanäle in die Markhöhle von Femur und Tibia für den Knochenmarkstift ausgebohrt. Beide Prothesenhälften werden eingetrieben und durch die Stahllachse, die mit einer Plastikschraube bedeckt wird, miteinander verbunden. Die Tuberositas tibiae wird mit Seide angenäht. Kapsel- und Hautnaht. Es wird ein Kniegips für 3 Wochen angelegt, wobei das Gelenk in Streckstellung steht.

Die Nachbehandlung durch Krankengymnastik, Bäder und Gehübungen während 2 Monaten verursacht den Patienten keine grösseren Schwierigkeiten.

Die Pflegezeit im Krankenhaus betrug in unkomplizierten Fällen durchschnittlich 2 Monate und 22 Tage.

Die Komplikationen bestanden in einem Fall in einer Lungenembolie, in einer Sepsis in einem andern, beide mit letalem Ausgang. Eine Infektion im Gelenk machte eine Amputation in zwei und eine Arthrodese in vier Fällen notwendig. Ein Prothesenbruch durch Trauma gab Anlass zu einer Reoperation mit Auswechslung der Prothese. Die übrigen Komplikationen hatten keinen schädlichen Einfluss auf die Gelenkfunktion.

Die Kasuistik umfasst 26 Fälle von Knieplastik in insgesamt 32 Gelenken. In sechs Fällen wurde die Operation doppelseitig ausgeführt.

Das Resultat der Operationen darf als sehr gut bezeichnet werden, wenn man bedenkt, dass die Operationsindikationen in der Mehrzahl der Fälle — bei 29 Gelenken — eine rheumatischen Arthritis mit hochgradiger Destruktion war. In 75 % der operierten Gelenke konnte Schmerzfreiheit, eine aktive Beweglichkeit von durchschnittlich 84° und eine volle Stabilität mit Wiederaufnahme oder Verbesserung des Gehvermögens erzielt werden. Diejenigen Patienten, die dieses Resultat erreicht haben und ganz besonders die stark invalidisierten Rheumatiker, die während vieler Jahre nicht imstande waren zu gehen, waren mit dem Resultat der Operation sehr zufrieden.

Die Patellarreflexe waren nach der Operation bei 13 Kniegelenken positiv.

Auf dem Röntgenbild beobachtet man, dass die Prothese von einer sklerotischen Schicht und kleinen Osteophyten im Bereich der Resektionsfläche umgeben wird. Im Knochengewebe konnte keinerlei Reaktion beobachtet werden, die darauf schliessen liesse, dass sich die Prothese lösen könnte.

Die bisher gewöhnlich angewendeten Operationsmethoden mit fascia lata als Interpositum haben in ca. 50 % der Fälle zu guten Resultaten geführt. Mit der hier beschriebenen Methode konnte der Prozentsatz auf 75 % erhöht werden. Die Beobachtungszeit war relativ kurz, variierend zwischen 7 Monaten und 4 Jahren und 10 Monaten, weshalb die Zukunft erweisen muss ob das Resultat bestehen bleibt.

Von der Operationsmethode kann gesagt werden, dass ihre Ausarbeitung abgeschlossen ist, während die Konstruktion der Prothese immer noch in gewissen Details verbessert werden kann. Vor allem wäre es wünschenswert, ein Prothesenmaterial mit besseren Eigenschaften zu bekommen als zur Zeit zur Verfügung steht.

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CORRIGENDA

Page	For	Read
10, line 1:	X	Z
47, line 4:	97 and 98	95 and 96
54, Fig. 34:	Both roentgenograms should be turned upside down.	
82, line 37:	The whole line should be deleted.	
87, line 12:	92—95	90—93
92, line 27:	dorsum	dorsiflexion
107, line 6:	ausgefürth	ausgeführt
107, line 13:	konstruirt	konstruiert
107, line 34:	innerhalb, des	innerhalb des
109, line 7:	gesegt	gesagt
111, line 13:	CXIVI	146

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