

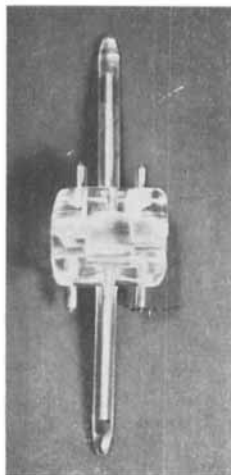
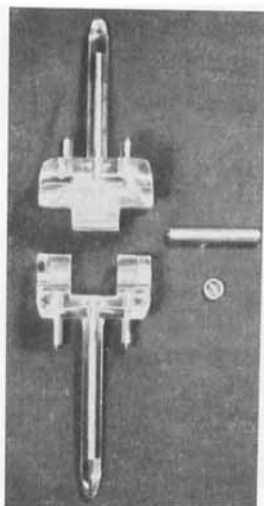
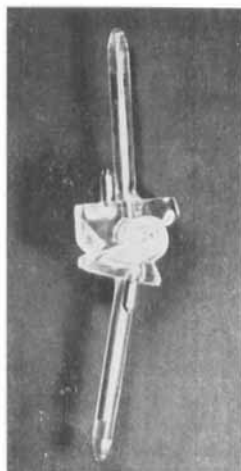
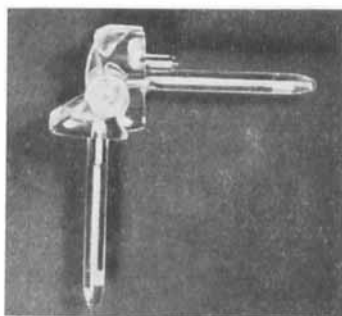
ARTHROPLASTY OF THE KNEE JOINT EMPLOYING AN ACRYLIC PROSTHESIS

By

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In the Orthopaedic Department at Karolinska Institutet for the past four years arthroplasty of the hip joint has been carried out with the aid of an acrylic prosthesis following the technique of Judét. More than 300 such operations have been performed. The primary results have on the whole been good. It was found that the acrylic material is relatively non-irritating to the body tissues.

We were tempted therefore to try to develop an acrylic prosthesis for arthroplasty of the knee joint. One of the difficulties with earlier operative methods was to obtain sufficient stability in the joint. For this reason I have constructed a prosthesis like a hinge joint which is stable forwards and backwards as well as laterally. It is manufactured by a precision mechanic, Carl Thunér in Karlskoga and is distributed through Stille-Werner AB in Stockholm. It is made of Bonoplex, an acrylic material produced by A.B. Bofors Nobelkrut (fig. 1). It has a femoral part and a tibial part, joined together by a stainless steel transverse axle. The joint permits a range of movement from 185° to 90°. The height of the central part is 38 millimeters, and represents the total length which must be resected from the condyles of the femur and tibia. This is more than is usually resected in an ordinary knee joint arthrodesis, but it should be possible to perform an arthrodesis later if the arthroplasty should prove unsuccessful. Three stabilizing pins extend from the central portion in each direction: one long and two short. These are inserted into the medullary cavities and the condyles respectively. The femoral portion of the prosthesis has a convex anterior surface, along which the patella moves. In addition, it has been made somewhat concave in the middle to prevent luxation of the patella.

*Fig. 1 a.**Fig. 1 b.**Fig. 1 c.**Fig. 1 d.*

The instruments required for the operation are simple (fig. 2): a drill to bore a canal for the medullary pin, a punch for the insertion of the femoral part and one for the tibial part, and an acrylic measuring block of the same height as the central part, for use in determining whether the resection of the condyles is sufficient (fig. 3). This block also serves to orientate the drill so that it enters at right angles to the surface prepared after resection. There is a canal of the same diameter as the drill, running through the middle of the block and at right angles to the sides of the block. The patterns for the resected surfaces of the femur and tibia are placed against their respective surfaces. It is then possible to explore the center of each medullary cavity with a guide pin of the same length as the stabilizing pin

(fig. 4). This is done to prevent the medullary pin, when it is driven in, from striking the cortex of the bone and changing its direction. In this event the resection does not rest against the prosthesis over its entire surface, and a poor fit is obtained.

The operation is performed in a bloodless field, using an Esmarch's bandage. A curved transverse incision is made inferior to the patella. The tuberosity of the tibia is detached. The joint capsule is opened

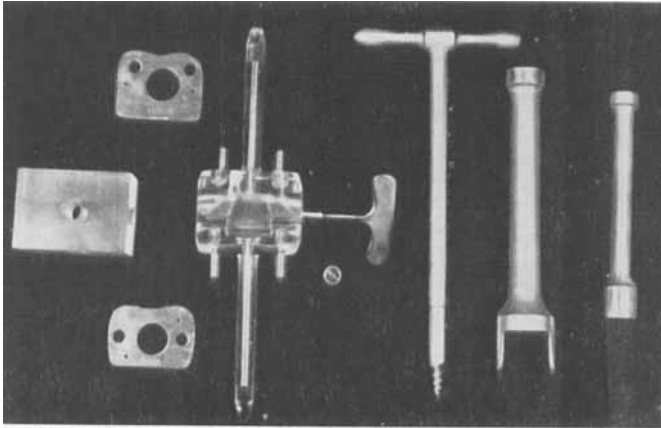
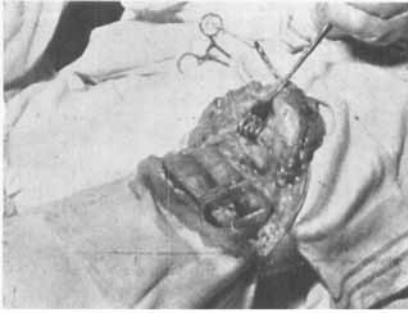
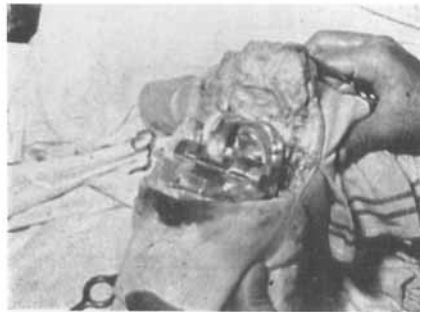


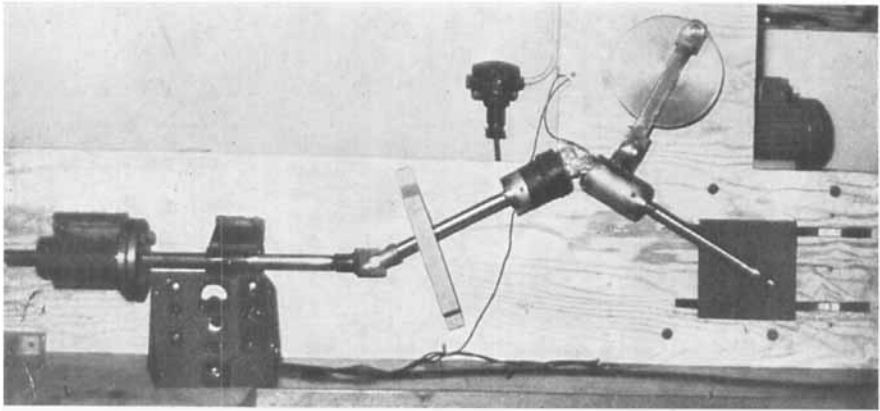
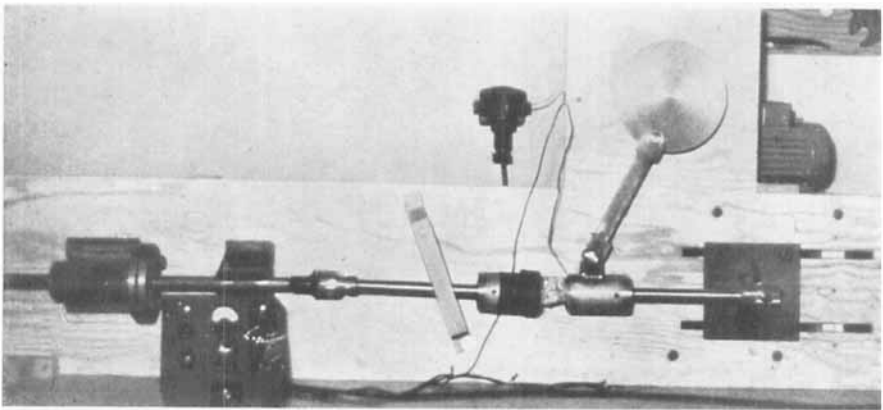
Fig. 2.

and the ligamentum patellae with its bony attachment and the patella are turned upwards so that the joint is widely exposed. The collateral ligaments are also cut if necessary. The patella is retained. The articular surfaces of the tibia and femur are sawed off level and at right angles to the longitudinal direction of the diaphysis. Approximately one centimeter is removed from the tibia and approximately three centimeters from the femur. A check is made with the measuring block to ascertain whether the correct amount of bone has been resected and that the alignment of the limb is accurate when the block rests against the two resected surfaces simultaneously. Canals are prepared for the stabilizing pins and the prosthesis parts are driven in. The two parts are joined with the steel axle and the outer tip of the axle is covered by an acrylic screw, which may be fused into position or fixed with acrylic cement. An electric grinder is used to smooth off any parts of the prosthesis that may extend too far forwards, and to retouch the patella and its sliding surface on the prosthesis, so that good congruence is obtained (fig. 5). Figure 6 shows the tibial and femoral parts of the prosthesis mounted in position and joined by the

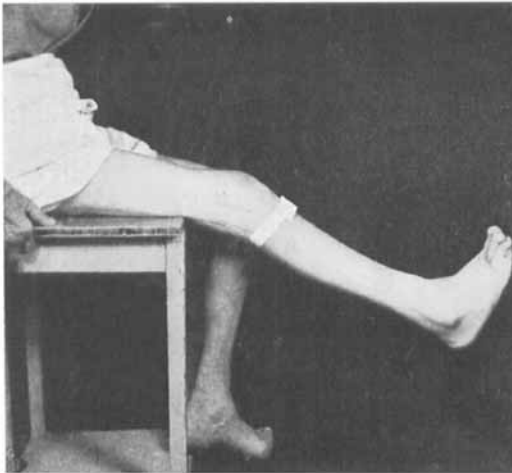
*Fig. 3.**Fig. 4.**Fig. 5.**Fig. 6.*

axle. The ligamentum patellae with its attachment is replaced if possible more distally, with two strong silk sutures through the bone. The capsule is sutured with catgut. A rubber drainage tube is inserted toward the posterior part of the joint. The skin is sutured. A plaster of Paris knee cast is applied. This is immediately cut into anterior and posterior portions. The cast is removed after about 14 days, when active exercises are commenced. After approximately four weeks the patient starts getting up and successively applying increasing weight to the leg.

In order to determine the durability of the prosthesis and the amount of wear it had sustained, a machine roughly resembling the lower extremity was constructed in the service department of the A.B. Bofors Nobelkrut in Karlskoga (fig. 7). This represented the thigh, the knee-joint with the prosthesis in position, and the lower leg. An electric motor drove the joint forward and backward in flexed and extended positions. In the extension movement the lower leg was pressed against a spring which corresponded to the body weight. At the onset

*Fig. 7 a.**Fig. 7 b.*

of the experiment the load was 90 kilograms (198 pounds). Estimating in distances walked, the machine covered 44 Swedish miles (273 English miles) at a normal walking rate. No lubrication was used. A thermotile measured the temperature attained owing to friction within the prosthesis. With a load of 90 kilograms it remained at about 30°C , and with a load of 140 kilograms about 42°C . This rise in temperature damaged neither the plastic material nor the adjacent tissues. Under the 140 kilogram load the planks on which the machine was mounted began to sag. As a result the entire system began to sway thereby applying a lateral strain to the prosthesis. The machine was permitted to continue running in order to demonstrate where the

*Fig. 8 a.**Fig. 8 b.**Fig. 8 c.**Fig. 8 d.*

prosthesis would break down under the abnormal load. Little by little the screws in the lower part of the cross-piece grew slack. When this broke loose, the swaying from side to side increased and the prosthesis broke apart at the point of attachment of one medullary pin to the central part. The machine had then run with this abnormal load for eight hours. After the experiment it was observed that there had not been any change in weight in the various parts of the prosthesis, nor any change in the respective measurements.

The first arthroplasty in which this acrylic prosthesis was em-

ployed was performed on Oct. 12, 1951. The patient was a 55 year old bookbinder (J. nr. 4992/40), with a history of polyarthritis starting at the age of 18 years. For 11 years before the operation he was unable to work because of severe changes in most of his joints. The right knee joint especially was severely affected. Ten years prior to the operation he had appreciable flexion contracture in the joint and a genu valgum deformity. He was then treated at a general hospital. At that time a tenotomy was performed on the flexor tendons at the back of the knee and a plaster cast was applied. Following this he wore a leather support for a time. During the four years immediately prior to the arthroplasty he was able to walk only with the aid of a crutch and a stick, and was unable to support his weight on the right leg (fig. 8 a). He was unable to walk more than 50 meters (55 yards) at a time.

Condition on admission: The patient was small, thin and had atrophic musculature. His sedimentation rate was 36 mm. in one hour. The right knee joint showed: genu valgum 25° , flexion contracture 35° . Flexion, active as well as passive, was 145° to 70° with pain in the extreme positions. The patella had a lateral displacement of only a few millimeters. Considerable crepitus was present. Postero-laterally there was a 10-centimeter-long operation scar.

Roentgen examination showed high grade destructive changes and a capsular chondromatosis (fig. 10). Owing to the genu valgum there was lateral subluxation of the patella. Pronounced polyarthritis changes were observed in the majority of the other joints, and not least in the feet.

Operation: An arthroplasty was performed by Professor Friberg on Oct. 12, 1951. It was carried out according to the technique described in the foregoing paragraphs, but the tuberosity of the tibia was fixed with a screw. A superficial necrosis developed at the level of the screw which was later removed. Three months after the operation the patient was able to walk without pain, without support, with his full weight on the leg and with complete stability in the joint. The genu valgum was eliminated (fig. 8 b) and the active mobility was 165° – 105° (fig. 8 c and d). On a check-up 15 months after the operation he was further improved. He had an active mobility in the joint from 175° to 80° . He was able to stand on the prosthetic side alone and flex the knee from 165° to 130° (fig. 9). The patient's patellar reflex was normal. He was able to walk outdoors for one kilometer at a time using a stick and when indoors he required no support. Figure 11 shows roentgenograms taken one year after the operation, with the joint in maximal flexion and extension.

The second patient was a 61 year old woman (J. no. 3289/50) who had a history of polyarthritis of 31 years' duration. During the two years before operation she had had severe pain in the left knee joint, with increasing stiffness.

Condition on admission: The patient had severe pain on movement of the knee joint, with the result that she performed movements very slowly and with the greatest care. She was able to walk only with slow steps about a foot apart. She had slight hydrops and pronounced



Fig. 9 a.



Fig. 9 b.

thickening of the capsule. Mobility, active as well as passive, was 150° to 100° .

Operation: The arthroplasty was performed by Walldius on Feb. 20, 1952.

At the last check-up 15 months after the operation the patient walked with brisk steps of average length, without pain, without support, with her full weight on the leg and with complete stability. Active and passive mobility was 180° to 95° .

The third patient was a 53 year old unmarried woman (J. no. 5859/49). She reported polyarthritis of 26 years' duration. She had pronounced changes in the majority of her joints, with most marked symptoms arising from both knee joints. Five months before the operation the patient had fallen and dislocated the left knee joint.

Condition on admission: The right knee joint showed ankylosis with 15° genu valgum and 10° flexion deformity. The left knee joint exhibited appreciable instability with lateral unsteadiness. In addition the skin was extremely atrophic following roentgen therapy. Active

and passive mobility were 175° to 110° . She was able to walk only with the support of two persons.

Operation: An arthroplasty of the left knee joint was performed by Walldius on April 2, 1952.

At the last check-up six months after the operation she was able to walk about as far as one kilometer at a time with a stick. Indoors she used no support. She had no pain and full stability. The active mobility in the joint was 180° to 100° . The patellar reflex was normal.

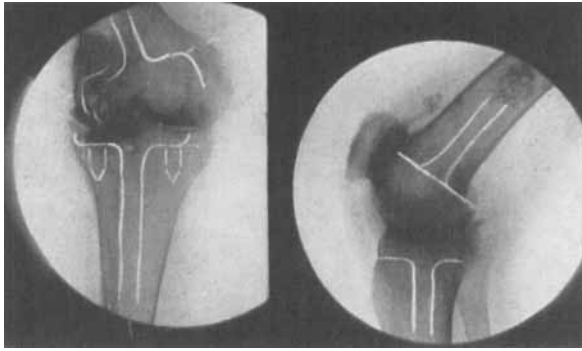


Fig. 10.

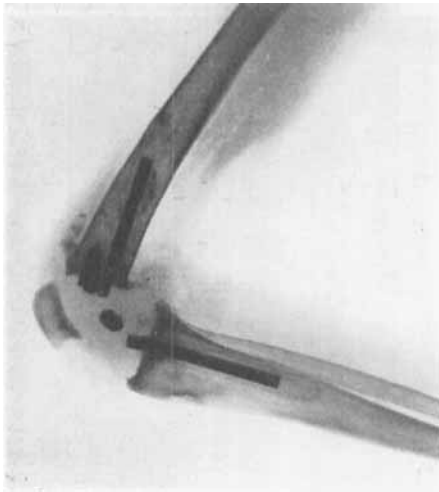
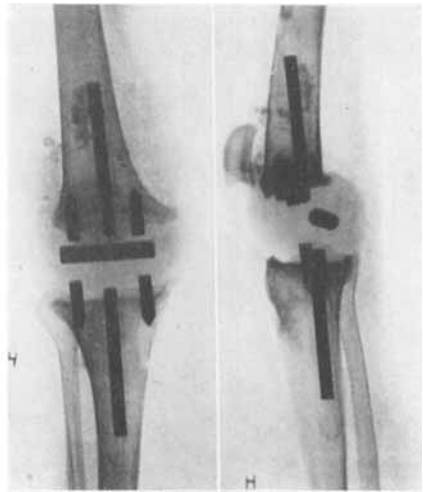
She was able to stand on the operated leg alone and flex and extend it in this position.

The fourth patient was a 34 year old unmarried woman (J. no. 2567/51). She had a polyarthritis history of 16 years' duration before the operation. For the last eight years she had been a total invalid. She sat in a wheel chair and was wholly dependent upon the assistance of one or two persons in order to get from her bed to the wheel chair or vice versa.

Condition on admission: There were pronounced destructive changes in all joints of the extremities. In both knee joints there was slight hydrops and marked capsular thickening, with moderate diffuse tenderness. The patella was immobile laterally. Both active and passive mobility were 125° to 90° in the right knee joint and 145° to 100° in the left, with pain in the extreme positions. Pronounced crepitation was observed.

Roentgen examination showed considerable reduction in the joint space and subchondral defects.

Operation: Patellar extirpation and reduction of adhesions in the *left* knee joint were performed by Walldius on June 27, 1952.

*Fig. 11 a.**Fig. 11 b.*

Operation: An arthroplasty with an acrylic prosthesis was performed on the *right* knee joint by Walldius on Aug. 6, 1952.

On examination eight and a half months after the second operation the patient was able to walk without support, but used two crutches temporarily in order to feel secure. Because of 90° extension deformities in both elbow-joints she was unable to use sticks, and if she should fall she would be unable to break the fall with her hands. In the right knee joint she had an active mobility of 180° to 90° without pain and with full stability. The patellar reflex was normal. She was able to bear her weight on the operated leg alone and to flex the knee approximately 30°. In the left knee joint, where only patellar extirpation was performed, the range was 170° to 110° but movement was painful. For this reason she uses a locking, articulated knee brace on this leg.

Four additional patients have undergone operation. All have had pronounced destruction in the joints: one owing to an old intraarticular fracture and the others owing to polyarthritis. However, their treatment is not yet complete.

It is naturally difficult to give any prognosis. The first patient was operated on one and a half years before the time of writing. This is a short period, to be sure, but as yet no deterioration has appeared. Nor has there been any in the other cases. On the other hand how will the joint look after five to ten years? The question is whether the prosthesis will gradually loosen. Since the contact surfaces are plane and in normal walking receive an evenly distributed load, there will

not be any leverage between the prosthesis and the bone. Therefore the tendency to loosen should be less than in a case where there is a more one-sided loading, e.g. as in a Judét arthroplasty of the hip joint. The possibility exists that a chondromalacia patellae may occur, if there should be a lack of congruence between the prosthesis and the patella. A patellar extirpation can then be performed at a later date. Determination of the acrylic material because of adhesions cannot reasonably take place, in as much as these would not obtain any attachment on the slippery and non-vital acrylic surface. Finally, if the plastic operation should be unsuccessful, arthrodesis is still possible, although this would result in a shortening of the leg. However, this could be offset by the use of special shoes.

The operative indications lie within the disease groups of polyarthritis, arthrosis deformans and sequelae to intra-articular traumatic damage. It is evident from the case histories that the patients selected for operation have had pronounced polyarthritic changes and have been total invalids. Since the primary results of the operation in these cases appear promising, they should be at least as good in cases where pathological soft tissue changes in the capsule, ligaments and musculature are not so pronounced as in polyarthritis. On the other hand, the operation may be of value in the treatment of patients suffering from polyarthritis with flexion contractures in both knee joints. They pass their lives in reclining and sitting positions and are frequently dependent upon a nurse or caretaker. Since their condition could scarcely be worse there is everything to gain and little to lose by operation.

SUMMARY

The writer describes a new operation method for arthroplasty of the knee joint with an acrylic prosthesis. The results of the first four operations performed are presented.

RESUME

L'auteur décrit une nouvelle méthode opératoire pour l'arthroplastie de l'articulation du genou avec prothèse acrylique. Compte-rendu des résultats des quatre premières opérations.

ZUSAMMENFASSUNG

Der Verfasser beschreibt eine neue operative Methode für die Arthroplastik des Kniegelenkes mit einer Akryl-Prothese. Die Ergebnisse der ersten vier Operationen werden vorgelegt.