FROM THE ORTHOPAEDIC HOSPITAL, DEPARTMENT II, COPENHAGEN
CHIEF: SVEN KIÆR, M.D.

HIP ARTHROPLASTY WITH ACRYLIC PROSTHESIS[1]

By

SVEN KIÆR

Dissatisfied with our arthroplasty operations on the hip (Murphy-Putti) and removal of the femoral head (Girdlestone), we went on in 1948 to consider other treatments. Our choice lay between Smith-Petersen's cup-plasty and alloplasty with a fixed prosthesis. As the published results and other information available to us on the Smith-Petersen results were not uniform, we elected to try alloplasty using acrylic prosthesis (Hudach 1946, Judet brothers 1947–1949). Professor Krogh-Poulsen, Dr. Jansen and Dr. Henrichsen undertook the experimental investigation into tissue to acryl and into the possibility of fixing acrylic prosthesis with cement.

For the first 6 patients individual acrylic prostheses were made from moulds. They were fixed with acrylic cement to the modelled neck of the femur. We abandoned this operation as the standard method, however, because it is unnecessarily troublesome and requires two hip operations at an interval of eight to ten days. Instead, we adopted the method described by the Judet brothers, with certain technical modifications.

We submit our preliminary results and observations at this early stage because our results correspond well with those of Judet and therefore constitute a numerical supplement to the small acryliplasty material so far published. The results obtained by Judet and Merle-d'Aubigné and at this hospital have been so good that it would be of value if others would try the method.

TECHNIQUE

45 hips were operated on by the Judet method. For 15 we used a Hueter's incision, and for 30 a Gibson's incision which we find provides a better and gentler

1 Paper read before the fifth congress of S.I.C.O.T., Stockholm, May 1951.

approach to the joint. The capsule was completely excised in 30 cases and left in position in 15 cases even in the presence of severe changes. In most cases the hip was mobilised three or four days after the operation. All cases were given energetic after-treatment with exercises. The prone position has been found particularly effective in counteracting joint contracture. As a general rule the patient is allowed to bear weight on the hip from the sixth week, and the average period of hospitalization has been eight weeks. The cases are re-examined every three months.

The acrylic prostheses were originally made by Drapier, Paris, but most of them have been made in our own workshops. We have also designed special models for cases where the neck of the femur is very short.

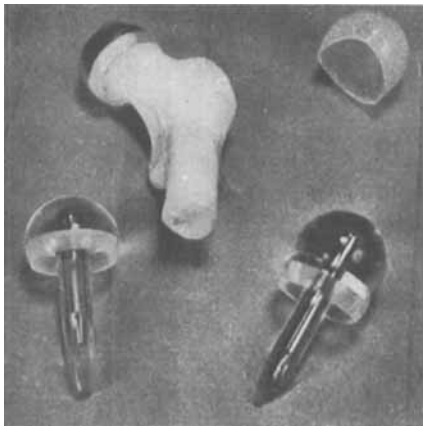


Fig. 1.
Samples of prostheses.

CLASSIFICATION

At the International Congress in Amsterdam, 1948, Merle d'Aubigné suggested the introduction of a numerical system for evaluating the function of hips before and after arthroplasty. It is of course important to be able to make a rational comparison of the function of the hip before and after a plastic operation, and the principle of Merle d'Aubigné suggested the introduction of a numerical system for evaluating the function of hips before and after arthroplasty. It is of course important to be able to make a rational comparison of the function of the hip before and after a plastic operation, and the principle of Merle d'Aubigné's idea was to select the three elements characterizing the function of a hip: pain, mobility and gait, and grade them according to quality. The different grades of qualities vere designated and each was given a score from 0–the worst–to 6, the best. Pain, mobility and gait were so graded that the results of various methods could be compared fairly well.

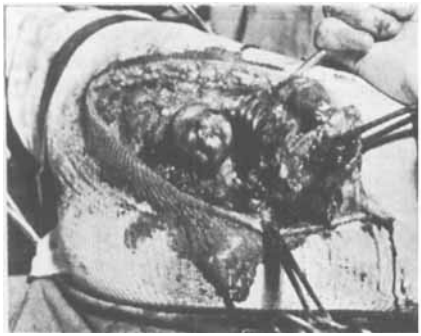
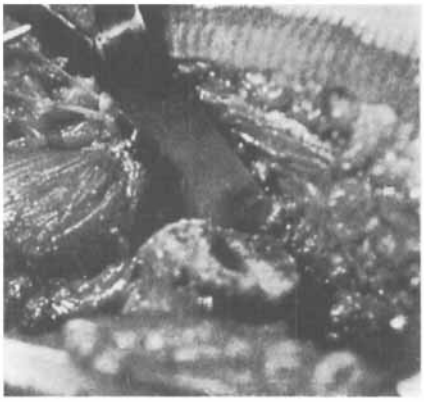


Fig. 2 a, b.

a) Gibson incision.

b) The acrylic head fixed with acrylic cement to the shaped femoral head.



Figs. 3 a, b, c.

Judet's prosthesis is fixed on the femoral neck.

a) The neck stump is shaped and hollowed out for the prosthesis.

b) The acrylic prosthesis in position before knocking into place.

c) The prosthesis is firmly fixed.

NUMERICAL CLASSIFICATION

In assessing the result obtained after operation, changes in pain and gait, not mobility, are considered the dominating factors.

Points for pain and gait, whether gain or loss, are multiplied by 2, while points for mobility are not altered.

The sum of the points indicates the result.

Example I:

	Pain	Gait	Mobility
pre-operative	3	4	1
post-operative	6	5	4
Gain	3×2	+1×2	+3 = 11 (result)

Example II:

	Pain	Gait	Mobility
pre-operative	3	4	3
post-operative	5	2	3
	2×2	−2×2	0 = 0 (result)

Results:

Excellent ..... ≧ + 12 (max. 36)
Good ..... + 12 — + 8
Moderate ..... + 8 — + 2
Bad ..... ≦ 0

It is impossible to compare together the results of cases in which the pre-operative picture is unknown, and the results in old and young patients are given solely on the basis of the final results. For the patient, the all-important consideration is how much his condition is improved. The Merle d'Aubigné method therefore represents a distinct

TABLE I

Numerical evaluation of hip condition.

Points	Pain	Gait	Mobility
0	very severe, continuous	impossible	ankylosis in wrong position
2	very severe, preventing sleep	only with crutches	clinical ankylosis with slight or no wrong position
2	severe when walking all work inhibited	only with 2 sticks	flexion 180–140 (abduct. 0 or slightly wrong position)
3	severe but tolerable, work inhibited	1 hr. with stick, very difficult without stick	flexion 180–120
4	only after walking, subsides after rest	1 stick for some time. Limited without stick	flexion 180–100 (can lace shoes)
5	insignificant or fluctuating, does not inhibit work	slight limp without stick	flexion 180–90 abduction 25
6	complete painlessness	normal	flexion > 90 abduction > 25

advance, although of course, the awarding of points for the various degrees of pain, gait and mobility is not perfect, and the calculation, which is rough, is open to criticism. All the same, if these values are taken with all due reserve and understanding, they give us a better assessment than a division into "excellent", "moderate" and "bad", based on the ordinary assessment. With the Merle-dAubigné method the results of a particular case can be expressed in a single figure.

The criteria for the classification of the three characteristics are given in Table I, and the number of points awarded each condition is shown in the left margin.

Since pain and gait are more important for the function of the joint than mobility, their points are doubled. The improvement in mobility therefore merely appears as a single element in the points total. Example I. shows such a calculation. The total points are then grouped as: "excellent" (12 or more), "good" (12–8 points), "moderate" (8–2 points), "bad" (0). The maximum 'good' result is 36 points. The conditions of course have deteriorated (Example II).

RESULTS

During the period 2nd April 1949 to 28th November 1950, we performed arthroplasty on 51 hips (50 patients, 1 operated bilaterally). (Up to date, 16th March 1951, we have performed altogether 79 arthroplasties).

Age: 10 patients were aged between 30 and 40 years, 30 between 40 and 60 years, 9 between 60 and 70 years, and one 17 years.

The observation period was from 3 to 5 months in 15 cases, 6 to 11 months in 20 cases, and 12 to 21 months in 16 cases.

The most common *indication* for the operation was bilateral osteoarthrosis with severe disabling pain in one hip. In 21 cases there was osteoarthrosis, in 18 there was arthrosis secondary to congenital changes in the hip, congenital luxation and congenital subluxation. In 4 cases arthrosis was a sequel to epiphysiolysis, infantile coxitis (1) and coxa plana (1). In a separate group we have placed 3 cases of necrosis of the head after fracture of the neck of the femur and 2 cases of pseudarthrosis colli femoris.

The diagnoses are shown in Table II. The various results after arthroplasty in 50 cases are indicated in points. The results were excellent in 40 and bad in 3. I shall revert to these three, but it will be expedient to mention here that the bad results were caused by faulty technique; in two the moulded prosthesis was unsatisfactory and in

TABLE II
Diagnosis.

	No. of pts.	Excellent	Good	Moderate	Bad
Osteoarthrosis	21	17	2	1	1 a
Arthrosis (cong. luxat.-subluxat.)	18	14	2	1	1 b
Arthrosis (coxa plana)	1	1			
Arthrosis (epiphysiolysis)	4	2		1	1 c
Arthrosis (coxit. infantil.)	1	1			
Ps. colli femoris	2	2			
Necrosis capit. femoris (fract. colli. fem.)	3	3			
	50	40	4	3	3

a. Moulded prosthesis failed, prosthesis removed.
b. „ „ „ „ „
c. Judet prosthesis failed, stem broken.

TABLE III
Hip arthroplasty.

Result	Moulded prosthesis	Judet Hueter		Judet Gibson		Acrylic cap.
Excellent (12 points)	3	12	87 %	24	93 %	1
Good (12–8 points		1		3		
Moderate (8–2 points)	1	1		2		
Bad (0)	2 a-b	1 c				

a. Moulded prosthesis failed, prosthesis removed.
b. „ „ „ „ „
c. Judet prosthesis failed, stem broken.

one the stem of Judet's prosthesis broke while being introduced; this was not discovered until several months after the operation.

Table III shows the results following the various types of arthroplasty. *The moulded prosthesis* gave the poorest results: two plastic prostheses were bad, three were excellent and one was moderately good. *Judet's acryloplasty* and *Hueter's incision* gave 87 per cent satisfactory results, only one result was bad–again owing to faulty technique. *Judet's operation* and *Gibson's incision* gave 95 per cent satisfactory results.

The clinical evaluation of the results may of course need revision after longer observation, but we can already say that in every case so far the longer we have observed the patient, the better has been the result.

TABLE IV
Hip arthroplasty (acryl).

		Hip function: mean		
		Pain	Mobility	Gait
Arthrosis (42 cases)				
3 cases excluded, faulty technique	pre	1·4	2·8	2·9
	post	5·7	4·5	4·7
Ps. colli femoris (necrosis capit. femg.). 5 cases	pre	1·6	3·2	2·2
	post	6	5·4	5·2

The changes in the three components (pain, gait and mobility) after operation are important, particularly as regards the significant factor of pain. In 42 cases of arthrosis (Table IV) the pain has been greatly reduced, from 1.4 to 5.7. It is not difficult to assess the pain before arthroplasty, but there may be difficulty after it, because it is not uncommon for the patients, especially arthrosis patients, to have definite muscular pain and sometimes vague pain in the hip or knee (reflex). Pain due to muscular changes and not affecting the function of the joint is not included in the assessment; the other two types are. When the origin of the pain is in doubt it is included. In the 5 patients with pseudoarthrosis colli femoris and necrosis of the femoral head the improvement has been very satisfactory; all are free from pain. I shall revert to this later.

There has been some discussion as to the effect of removal of the capsule on the pain and the mobility. The articular capsule was preserved in 15 cases and removed in 29; no difference was found in the post-operative relief of pain—nor does there seem to be much difference in the mobility (Table V), though we have the impression that mobilization of the joint is more rapid when the capsule has been removed.

From the technical aspect it was of interest to find out whether there were complications in those cases where it was necessary to fill

TABLE V
Arthroplasty (Judet).

				Pain	Mobility
Joint capsule retained cases	15	15	pre	1·4	3·3
			post	5·8	5
Joint capsule removed cases	29	29	pre	1·5	2·6
			post	5·9	4·4

out the prosthesis with cement; in six instances it was necessary to fill up with cement because either the prosthesis did not fit on the end of the bone, or there were considerable defects in the bone. There were no complications in any instance. Six moulded prostheses were fixed with cement, and of these the fixation was faulty in one case, due to infection.

When we first began, using Judet's arthroplasty and Hueter's incision, more cases developed a slight thrombosis in the lower extremity than is usually seen after hip operations, and we presumed that the pressure of the elevators on the vein might be injurious. Accordingly, we considered that one of the advantages of adopting Gibson's incision would be fewer cases of thrombosis. With our present material we cannot say whether this is so, because out of the 15 cases in which we operated with Hueter's incision, 13 were put into a plaster cast after the operation and 5 of them had thrombosis, while of 2 patients without the plaster cast one had thrombosis. Of 29 patients operated on with Gibson's incision without being immobilized with plaster, 1 had a thrombosis, 1 operated on with a Gibson's incision and immobilized in plaster had no thrombosis. Thus we cannot prove that Gibson's incision is better in this respect, but our impression is that we work better, and are less severe on vessels, veins and muscles, and in particular have good access to the capsule and the joint. We therefore think it justifiable to recommend this incision.

There have been no deaths or dangerous complications. The patient is not seriously affected, old people tolerate it well.

UNSATISFACTORY CASES

No. 15: 36/49. Woman aged 56 years–diabetes, adiposity, arthrosis coxae dex. Moulded prosthesis. Operation in two stages, 7/5/49 and 31/5/49.

The diabetes was difficult to control and the electrolyte balance gave trouble. Thrombosis occurred and there was low grade infection in the operation scar.

On 31/10/50 we removed the prosthesis, which was loose. The stem was covered with granulation tissue. Microscopy showed simple inflammation. There were a few trabeculae chiefly newly-formed. On 7/12/50 she was walking painlessly in a Thomas splint. Her general condition was good. The hip was painless but showed poor stability.

No. 17: 10839/44. Midwife, 44 years old. Arthrosis coxae bilateralis, more pronounced on right side. 5/11/46 resection arthroplastica coxae dxt. (decapitatio). 2/4 and 30/4/49 arthroplasty with moulded prosthesis in two phases. The prosthesis was fixed as in Whitemann's operation; plaster cast for four weeks.

20/6/49 right hip reluxated during movement.

21/6/49 shelf-plasty a.m. Lance. Patient discharged, no pain, walking nicely on two sticks.

27/9/50. Pain in right hip on weight-bearing. Radiography showed good position. Complaints due to muscular insufficiency; perhaps joint pain. Readmission advised, but the patient cannot afford the time from her work as a midwife.

No. 21: 6229/38. Man 37 years old. Arthrosis coxae. Epiphyseolysis seq. Adipositas. 25/2/50 arthroplasty, Hueter's incision. Judet's prosthesis. No complications. Nine weeks after operation no pain when walking with sticks.

16/10/50, prosthesis has moved to varus position, increasing pain. 15/2/51 reoperated, prosthesis loose, stem broken just distal to the metal pin. Femoral neck useless for fixation of new prosthesis, so the new prosthesis was placed as a Whitemann's operation and the trochanter mobilized distally. 16/3/51, the hip joint now excellent.

No. 29: 6349/49. Woman, 55 years old. Arthrosis coxae sin. Adipositas. Moulded prosthesis. Operation in two phases, 30/8 and 6/9/49. On 7/10/49 severe thrombosis in left leg. 8/12/49 after subluxation while walking, the hip was reduced.

19/1/50, slight discharge from the old drainage site persists. The whole leg is swollen. 7/3/50, prosthesis subluxated, was removed; it was firmly fixed to the bone and had to be chiselled off. Acetabulum full of granulation tissue.

2/10/50, long convalescence, only now able to move about with a splint, but no pain. The ultimate result as after decapitation caput fem. (Girdlestone).

DISCUSSION

Is it advisable to publish our material at this early stage, when only 16 cases have been observed for as long as 12 to 21 months? I think it is, because our experience agrees with Judet's results and we have not seen complications other than those described by him. The complications were of a technical nature: in one instance the pin of the prosthesis snapped when being knocked into position; the reason was faulty drilling, the drill having slipped on the hard ridge of cortical bone just below the trochanter major. Like Judet, who has observed his patients for more than three years, we have not seen loosening of the prosthesis nor bone atrophy under or around the prosthesis nor slipping of the prosthesis. These are three important points, and I consider that if during the course of two years an alloplastic material has not changed its position or affected the bone, it is justifiable to assume (as after osteosynthesis with vitallium or V. 2 A plates) that the condition is stationary. We can support this opinion from our experiments on rapidly growing pigs.

We have modified Judet's technique on one or two points. In the first place, we consider it better to have the patient on his side and operate through a Gibson's incision which is extremely convenient to work with and gives free access to the joint so that one can proceed quickly and gently without injuring vessels, nerves or muscles. In the second place, if one has to deal with a badly formed neck–short, soft

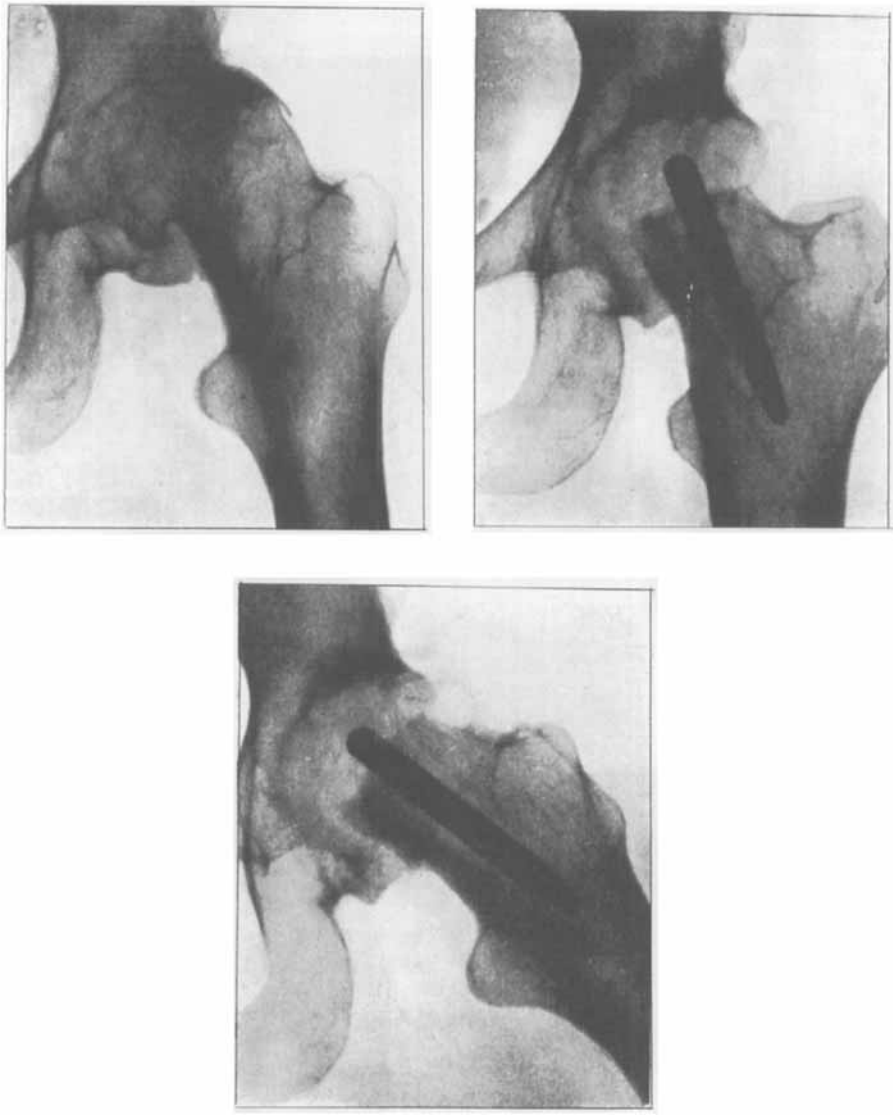


Fig. 4 a, b, c.
Woman, aged 60 years. Arthrosis coxae bilateralis. Arthroplasty (Judet). Followed for 16 months. Excellent result. (17 points).

or fragile, as it is often the case in arthrosis or pseudoarthrosis colli femoris, it is of advantage (as with a dentist when building up a tooth under a crown) to use cement[1]: the cement is non-irritant and fixes the prothesis firmly to the bone. We consider the use of cement for

[1] Chemische Fabrik, Schönenwerd, (S. O.), Schweitz.

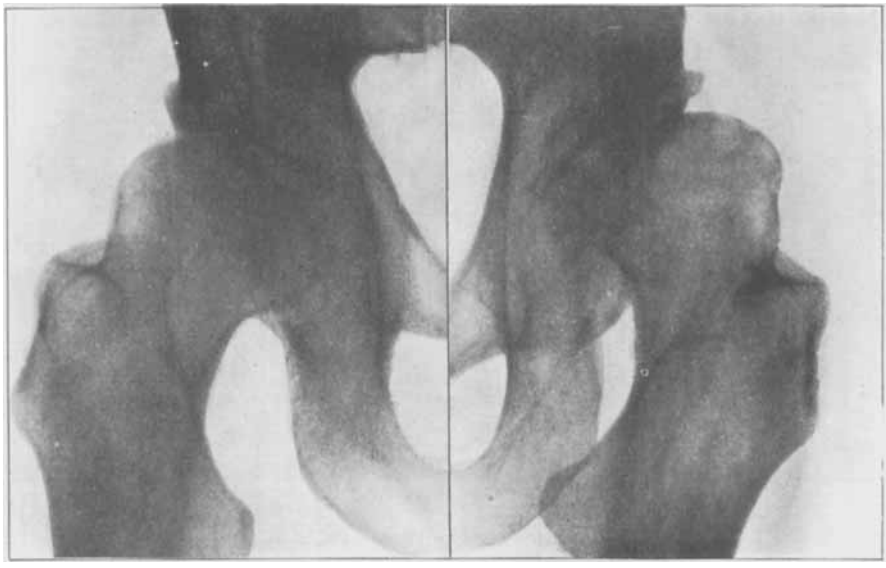


Fig. 5 a.

Fig. 5 b.

Woman aged 39 years. Arthrosis coxae bilateralis. Subluxation of the hip. Arthroplasty (Judet). Followed for 15 months. Excellent result (16 points).

fixing the prosthesis to be a technical improvement; one which, incidentally, we can employ for all types of acrylic prosthesis.

Our experience indicates that one should mobilize the limb early; except in cases where there has been a reconstructive operation of the Whitman type or arthroplasty of the hip with deepening of the

Fig. 6.
The bone growth round the acrylic stem.

acetabulum it is advisable to leave the hip in plaster for fourteen days and then mobilize it. The trouble to be overcome is often an adduction contracture, and if this is not readily remedied by mobilization after the prosthesis is in position, the hip should be fixed in plaster in maximum abduction and medial rotation. The actual operation is not difficult if the technique is well practised and the instruments are suitable.

The immediate result of arthroplasty is characterized by the fact that practically all patients are relieved of pain after the operation, or at least notice such definite improvement that they are satisfied.

It is interesting to observe how many bilateral arthroses improve after an operation on only the worse of the two hips. One must be cautious about saying that the alleviation of the pain is lasting, but there is much to indicate that it will be a long time before the pain recurs. Judet, who has had three years of observation, has not seen it recur. I should like to draw a parallel with our experience of drilling

of the hip; of the patients who lost all pain (50 per cent of 150 patients) about 95 per cent were still free from pain even after five years. In our arthroplasty we either remove or denervate the capsule and make both a radical drilling into the neck of the femur and a resection of the head. The head is in contrast to the acetabulum an important factor in the pain mechanism of the hip joint. By comparison of such drillings with arthroplasty, it seems justifiable to believe that the freedom from pain will be long-lasting. There may be disappointments, of course, but we should not wait and observe our small group of patients for ten years before extending the use of the operation when theoretical considerations lead us to this conclusion that the freedom from pain will be long-lasting. Further relief from pain for two or three years is of great benefit even if the pain should return later. It should not be forgotten that the patients are often of considerable age, so that every year lived in ease is a gain.

As regards gait and mobility, the improvement is not so great though far better than we are accustomed to see after arthroplasty. In a large number of cases the gait is quite good; and in most cases the mobility is sufficient for the patient to sit, dress, pull on stockings and shoes and place the foot on a stool or chair. These are things of practical importance and ease the daily life.

It is worth noting, however, that in the younger patients and those in whom there are no severe capsular changes, or where the disease has not been of long duration (e.g. necrosis of the femoral head, pseudoarthrosis colli femoris or subluxatio coxae with secondary arthrosis in young patients who have not suffered long) the results are splendid, and I should not be surprised if experience showed that the treatment of fracture of the femoral neck in cases where conservative treatment is not possible should become surgical with the implantation of an acrylic prosthesis.

If one looks for factors which argue against this form of arthroplasty, one finds uncertainty concerning the organism's tolerance of the alloplastic material, and also uncertainty whether the prosthesis will remain in position or get worn off. It must, however, be stressed that the technical equipment must be in order and everything must be performed in a workmanlike manner so that the tissues are damaged as little as possible and the operation is no more dangerous than large hip operations generally. I consider that the major indication for arthroplasty, using an acrylic prosthesis, is a painful hip affection. The best results may be expected when the operation is performed for necrosis of the femoral head and pseudoarthrosis colli femoris.

SUMMARY

1) In the period April 1949 to November 1950, 51 arthroplasty operations with fixed acrylic prostheses were performed on the hips of 50 patients.
2) *Indication:*
   Hip pain and functional disablement.
   Arthrosis (45 patients).
   Fract. colli femoris (2 patients).
   Necrosis capit. femoris (3 patients).
3) *Operation technique:*
   a) Individual acrylic prostheses (6 patients) after moulding; prosthesis fixed with cement. Abandoned as standard operation.
   b) Standard acrylic prosthesis (Judet model) 44. Hueter's incision 15, replaced by Gibson's incision 29.
4) Results classified according to Merle-d'Aubigné (Amsterdam 1948).
   Total results (50 patients):
   Excellent 40,
   Good 4,
   Moderate 3,
   Bad 3.

RESUME

1) Dans la période d'avril 1949 à novembre 1950, il a été procédé à 51 opérations arthroplastiques avec prothèses acryliques fixes de la hanche chez 50 malades.
2) *Indications:* douleurs dans la hanche et incapacité fonctionnelle.
   Arthrose (45 malades).
   Fracture du col fémoral (2 malades).
   Nécrose de la tête fémorale (3 malades).
3) *Technique de l'opération:*
   a) prothèse acrylique individuelle (6 malades) après moulage; prothèse fixée au ciment.
   b) prothèse acrylique standard (modèle Judet): 44: incision Hueter 15, mise en place par incision Gibson 29.
4) *Resultats* classés selon Marle-d'Aubigné (Amsterdam 1948).
   Excellents 40,
   Bons 4,
   Passables 3,
   Mauvais 3.

ZUSAMMENFASSUNG

1) In dem Zeitraume April 1949 bis November 1950 wurden 51 Hüftgelenksplastiken mit fixierten Akrylprothesen an 50 Patienten ausgeführt.
2) *Indikation:*
   Hüftschmerzen und Invalidität.
   Arthrose (45 Patienten).
   Schenkelhalsbruch (2 Patienten).
   Necrosis capitis femoris (3 Patienten).
3) *Technik der Operation:*
   a) Individuelle Akrylprothese nach Abguss (6 Patienten), Prothese fixiert mit Zement.
   b) Normierte Akrylprothese (Judet Modell) 44 Patienten. Hueters Inzision 15, erstattet mit Gibsons Inzision in 29 Fällen.
4) *Ergebnisse* beurteilt nach Merle-D'Aubigné (Amsterdam 1948).
   Gesamtergebnisse (50 Patienten):
   Ausgezeichnet 40,
   Gut 4,
   Mittelmässig 3,
   Schlecht 3.