The Classic

Cartilaginous-cup Arthroplasty in Ununited Fractures of the Neck of the Femur

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Abstract This Classic Article is a reprint of the original work by J. R. Moore, Cartilaginous-Cup Arthroplasty in Ununited Fractures of the Neck of the Femur. An accompanying biographical sketch of J.R. Moore is available at DOI [10.1007/s11999-011-1976-x](https://doi.org/10.1007/s11999-011-1976-x). The Classic Article is ©1948 and is reprinted with permission from The Journal of Bone and Joint Surgery from Moore JR. Cartilaginous-cup arthroplasty in ununited fractures of the neck of the femur. *J Bone Joint Surg Am.* 1948;30:313–330.

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Ununited fractures of the neck of the femur have been less frequent since the revival of internal fixation of acute fractures of the femoral neck, in 1931, by Smith-Petersen and his associates. In a recent review of 300 fractures of the femoral neck, Boyd and George report union in 86.5 per cent, and non-union in 13.5 per cent. However, ununited fractures of the neck of the femur are a greater problem today, since the revival of internal fixation, due to the fact that the head of the femur and the trochanteric area are often irreparably damaged by the internal-fixation elements themselves. It is not unusual to encounter large defects in the trochanteric area and in the head of the femur, and in many instances in the cartilage of the head and the acetabulum, which have resulted from nails, screws, or various types of pins. The employment of the bone graft in ununited fractures of the neck of the femur, as advocated by Albee and others, which was frequently used in the late 1920s and the early 1930s, is usually contra-indicated, principally because of the structural defects already referred to. Aseptic necrosis of the head continues to persist with slight, if any, reduction in its frequency, in spite of internal fixation. Absorption of the neck of the femur (both the shaft and the head fragment) is often more pronounced

than formerly, due either to failure to recognize the non-union early or to persistent retention of the internal-fixation apparatus in the hope that, by a miracle, union may occur.

All of these factors play an extremely important part in the selection of the procedure to be employed in the treatment of ununited fractures of the femoral neck. The writer divides ununited fractures of the neck of the femur into three classes:

Class I: Non-union with a viable head and well-preserved neck fragments.

Class II: Non-union with a viable head and complete, or nearly complete, absorption of one or both neck fragments.

Class III: Non-union with absorption of the neck fragments and a devitalized head.

The bone graft, recommended by Albee, or the bone graft combined with internal pin fixation, recommended by Gallie, and the osteotomies suggested by Pauwels, Lead better, Dickson, Schanz, and McMurray, are especially suited for cases in Class I. The reconstruction operations of Brackett, Luck, and Magnuson, and similar procedures, are particularly indicated for fractures in Class II. The reconstruction procedures advocated by Whitman, Albee, Colonna, Lorenz, Smith-Petersen, Wilson, and others may

be employed in the fractures of Class I, but seem particularly indicated in Class II or Class III, where loss of the neck and a “dead” head are present. All of these operative procedures are well known, and time and space do not permit a detailed description of the technique of the operations or a discussion of their relative merits.

The cartilaginous-cup arthroplasty was devised by the writer in 1938, and should be properly regarded as a modification of the Brackett operation. Wagner, in 1929, advocated removing the head of the femur, reaming out the head, and fitting it to the neck of the femur, thus restricting its use to those cases in which the distal fragment of the neck persisted.

Technique

Briefly, the cartilaginous-cup arthroplasty consists in removing the femoral head and reaming out the osseous portion until only a cartilaginous cup with a very thin layer of bone (one-eighth of an inch or less in thickness) remains. The cup then readily transmits light (Fig. 4B). A small section of the trochanter is elevated and reflected with its attachment to the gluteus medius. The end of the femur is then carefully rounded off with a cup reamer and the

cartilaginous cup is fitted to it. The femur with its cartilaginous cup is then returned to the acetabulum, and the greater trochanter is reattached to the lateral aspect of the shaft, two or three inches below the cup level. (Figures 1, 2, 3, 4, 5 and 6, inclusive, are illustrative of the technique.) The wound is carefully closed in layers, beginning with the capsule and following with the vastus lateralis and gluteus medius layer, then the fascia lata, the subcutaneous tissue, and the skin. A double hip spica, extending from the ankle to the nipple line on the side being operated upon and from the knee to the nipple line on the other side, is applied. The extremity operated upon is in maximum abduction, usually from 60 to 80 degrees, with the patella pointing straight up. A minimum of 60 degrees of abduction is essential. Occasionally an adductor tenotomy is required to obtain the desired abduction.

Certain points should be emphasized in carrying out this procedure. Complete hemostasis, clamping and tying all vessels to prevent free bleeding (except from bony areas), is essential. The cup must be fitted snugly. It should be placed accurately on the end of the femur, neither in valgus nor in varus, and with neither anterior nor posterior tilting. Its position should be maintained by wide abduction; this is accomplished by abducting the femur until firm resistance is met. A double spica is essential to complete the

Fig. 1 The approach to the hip used in the cartilaginous-cup arthroplasty (not original).

Fig. 2 Sketch of a sagittal section through the hip, illustrating removal of the head.

Fig. 3 Preparation of the trochanteric area of the femur with reamer.

Fig. 4 Illustrates the preparation of the head, the light test, and the fitting of the head on the femur.

immobilization. The foot on the side operated upon need not be included. The trochanter with its gluteal attachments must be reattached in order to ensure abduction power. It should be reattached securely, preferably with a screw, in order that early union of the trochanter and the shaft may be obtained. Closure must be done with extreme care to avoid hematoma. It is very important to ream the femoral head out thoroughly before the proximal end of the femur is rounded off, to prevent a small femoral fragment. The cup must fit very tightly; otherwise it will slip off (Case 7).

Postoperative Care

Movement of the ankle, foot, and knee on the side not enclosed in the cast is begun after recovery from the anaesthesia (spinal anaesthesia is employed in all cases), and is carried out hourly during waking hours. Deep breathing, likewise, is done at hourly intervals. The patient is turned every two hours during the day and every four hours during the night. On the twenty-eighth day the back half of the plaster, on the side on which the knee is enclosed in the cast, is cut and knee exercises are done at

Fig. 5 Shows the cartilaginous cup properly placed on the end of the femur and inserted within the acetabulum. The fragment of the trochanter is attached to the femur with a Vitallium screw. (Note that the shaft of the femur is in wide abduction.)

hourly intervals until flexion of 90 degrees or better is obtained. This usually requires one or two weeks. On the forty-second day (six weeks), the thigh which was not operated upon is released. The hip spica on the side operated upon is removed at the beginning of the eighth week, and balanced traction is applied in the line of abduction. The extremity is gradually brought down to approach the neutral position. The patella must be straight up so as to avoid any external-rotation deformity. Active flexion, extension, and rotation exercises are employed during the traction period. Weight-bearing is permitted at the end of the tenth week.

By the end of the sixth month the patient usually has approximately 80 degrees of flexion, 30 degrees of abduction, 5 to 10 degrees of adduction, and 180 degrees of extension. This motion increases gradually up to one year. In case of pain in the hip or the knee on the side which has been operated upon, or a tendency to external rotation, the patient is confined to bed with a five-pound to ten-pound weight and pulley traction, until the discomfort has disappeared. A moderate abduction deformity occasionally persists as long as six months. Three centimeters of shortening may occur, depending upon the structure of the upper end of the femur. This must be rounded off until a

Fig. 6 The greater trochanter has been attached to the shaft of the femur. The vastus lateralis is approximated and sewed to the soft parts overlying the trochanter and to the muscle sheath of the gluteus medius. (This is similar to the technique of Colonna.)

healthy bone surface for contact with the head is encountered, thus causing the shortening. Shortening of less than two centimeters is not compensated for by an elevation of the heel, as the tilt of the pelvis compensates for the loss of the neck angle and maintains the acetabulum in a favorably tilted position, thus offering the best assurance of stability in this type of procedure.

Results

The cartilaginous-cup arthroplasty has been performed in nineteen cases in Class II and Class III, from 1938 until June 1947. Eleven of the nineteen cases have been followed from one to nine years.

The majority of the patients were women, ranging in age from forty-four to seventy-seven years. Nine of the cases are considered to show excellent results. M. S. (Case 4) is considered to have had a fair result, in spite of the slight pain and the continued use of a cane, because he is happy and contented, and leads a normal life. Y. W. (Case 7) is regarded as a poor result, even though pain is very slight when a cane is employed. The patient works daily and earns her own living. Shortening averaged one to three centimeters, the majority of patients having two centimeters or less. The characteristic findings in early and late cases are illustrated in Figs. 7A through 10C.

Fig. 7A–C (A) J. Unlaminated fracture of the neck of the femur (January 24, 1946). (B, C) Anteroposterior and lateral views of cartilaginous cup after fifteen months (May 5, 1947).

Fig. 8 Anteroposterior and lateral views of cartilaginous cup, five months after operation.

The majority of the patients complained of mild stiffness when they arose in the morning or after prolonged sitting. This disappeared after activity and, although regarded skeptically as an early sign of degenerative arthritis, it has offered no problem to date in any of the patients in the group.

Complications

Among the nineteen cases reviewed, there were three deaths. One patient, P. G. H., died twenty-one days after operation, and a pulmonary embolism was found at postmortem examination. A second patient, S. T., died six weeks after operation, of a cerebral accident. The third patient, A. M., died nine years after a cartilaginous-cup arthroplasty, of carcinomatosis. High-power and low-power microscopic sections of cartilage, taken from the head of the femur in this case, are shown in Fig. 10D, E. A fourth patient, A. McC., has multiple sclerosis and has been confined to bed and to a walker since the second year after operation. There have been no operative deaths. In Y. W. (Case 7) the cartilaginous cup slipped off during the first three weeks, due to a poorly fitting head and lack of adequate abduction. This patient has a painful hip and degenerative arthritis, with a very thin joint line.

Discussion

The cartilaginous-cup arthroplasty, first performed in 1938, differs from the Brackett operation, primarily, in that the head of the femur is converted fundamentally into a cartilaginous cup. The procedure was first performed with a good deal of trepidation, due primarily to the fact that the consensus of the investigators was that hyaline cartilage would not survive transplantation. A reasonable questioning of this impression was permissible because of the amazing restoration of the hip to practically normal motion, with a negative Trendelenburg sign and the absence of limp, and the appearance of a good joint line. The continuance of excellent joint motion and the absence of limp seemed to justify repetition of the procedure. This patient died in 1947, nine years after the operation, and a section of the cartilage from the head of the femur was obtained (Fig. 10-D and 10-E). The pathologist's report¹ is as follows:

"A section, removed from the weight-bearing portion of the head of the femur, is covered with a layer of hyaline cartilage, measuring five millimeters in thickness. The hyaline matrix is homogeneous and appears to be normal in quality. There is a normal distribution of the lacunae throughout this fragment

¹ Made by E. E. Aegerter, M.D., Professor of Pathology, Temple University Medical School, Philadelphia, Pennsylvania.

Fig. 9A–C (A) E. W. Ununited fracture of the neck of the femur (December 19, 1944). (B, C) Anteroposterior and lateral views of cartilaginous cup, twenty-five months after operation (April 29, 1947). This is one of the early cases, and an attempt was made to sew the trochanter to the underlying soft parts. Note marked improvement in this regard in the more recent cases, as shown in Figs. 7A–C, and 8A, B.

Fig. 10A–E (A) A. M. Ununited fracture of the neck of the femur (January 5, 1938). (B, C) Anteroposterior and lateral views of cartilaginous cup (July 26, 1946). In this early cartilaginous-cup arthroplasty, the trochanter was poorly attached (sewed in position). The end result was excellent (see Tables 1, 2, and 3 and D, E). Description of microscopic findings by K. K. Aegerter, M.D.: “One section was removed from the weight-bearing portion of the head of the femur. The articular surface of this bone is covered with a layer of cartilage, measuring approximately five millimeters in thickness. The hyaline matrix is homogeneous and appears to be normal in quality. There is a normal distribution of lacunae throughout this fragment of cartilage, and the cells within the lacunae appear to be normal. Directly beneath this cartilage is adult bone. There is no recognizable epiphyseal line and no evidence of new-bone formation. Between the rather coarse spicules are a few marrow cells, interspersed between considerable amounts of fat. Diagnosis: normal hyaline articular cartilage.”

Fig. 10A–E continued

Fig. 11A–B (A) A cephalic view of a cartilaginous cup, three weeks old. (Patient died of pulmonary embolism.) The cartilage is blood-stained. It is firmly attached and could not be removed by vigorous twisting. (B) A lateral view of the same cartilaginous cup. Note the blending of the cartilage with bone.

of cartilage, and the cells within the lacunae appear to be normal. Directly beneath this cartilage is normal adult bone. A section taken from the non-weight-bearing portion of the femoral head shows a layer of cartilage which is indistinguishable from that described above. Sections from the acetabular rim show the usual fibrillar cartilage with attachment of adult bony tissue. Diagnosis: normal hyaline cartilage”

A second patient, P. G. H., died six weeks after operation. The head and neck of the femur (Fig. 12A) were obtained for study. From the description of the microscopic findings (Fig. 12B–D), it will be noted that the superficial cartilage appears dead, while the deep layers of cartilage are alive.

Table 1. Follow-up studies after operation

Case	Patient	Sex	Age	Postoperative period (Years)	Presence of pain
1	A.M.	Female	63	9	None
2	A.F.	Female	72	7	None
3	A.R.	Female	72	7	None
4	M.S.	Male	63	6	Slight
5	A.McC.	Female	49	3	None
6	S.S.	Male	51	3	None
7	Y.W.	Female	53	3	Pain present
8	E.W.	Female	44	2	None
9	E.R.	Female	77	1	None
10	A.J.	Female	44	1	None
11	S.O.S.	Female	69	1	None

Table 2. Range of motion one year after operation

Case	Extension-flexion (degrees)	Internal rotation-external rotation (degrees)	Abduction-adduction (degrees)
1	190–110	30–30	45–45
2	180–90	10–10	30–15
3	180–90	30–30	45–45
4	180–90	30–10	20–10
5	180–80	30–10	15–30
6	180–90	20–20	30–20
7	195–110	10–30	45–30
8	190–110	30–30	30–30
9	180–60	10–45	30–0
10	180–90	30–10	20–10
11	180–90	15–30	30–20

Fig. 12A–D (A) Shows a six-week-old cartilaginous cup, attached to shaft. This was so firmly attached that manual manipulation could not pull it loose. (B–D) Description of microscopic findings by E. E. Aegerter, M.D.: “Sections from the surface of the head of this femur in the weight-bearing area show it to be covered by a layer of cartilage. The outer two-thirds of this tissue shows no evidence of living chondroblasts, but in the inner third lacunae are present and one can find viable cells. This suggests that the outer two-thirds had undergone cell death, but that the inner third has been preserved. Along the inner surface of this cartilaginous layer the bony spicules conform to the contours of the cartilage. ... At one side of the section there is a considerable amount of fibrous tissue and provisional bone, which appears to be arising from the under-cartilaginous layer. One might conclude that this process has developed secondary to the implantation of the cartilage. Diagnosis: viable cartilage.”

Fig. 12A–D continued

Furthermore, “along the inner surface of this cartilaginous layer the bony spicules conform to the contours of the cartilage. This would suggest that some osteogenesis has caused an arrangement of the bone lamellae which is most efficient for stresses in this area. At one side there is a considerable amount of fibrous tissue and provisional bone, which appears to be arising from the under-cartilaginous layer. One might conclude that this process has developed secondary to the implantation of the cartilage.”

Figure 11A, B represent a cartilaginous cup, three weeks old, taken from a patient who died of pulmonary embolism. The large defect present in the head was caused by the nail used in the internal fixation. The head was securely attached and could not be pulled off by manual efforts. Unfortunately, the microscopic sections were lost before they were read. The early bony attachment of the cartilage to the head in this case and in that of P. G. H. (Fig. 12A–D) is the basis for the relatively early

mobilization in the after-care. There is undoubtedly a long gap between the specimens observed nine years and six weeks, respectively, after operation, but it is quite probable that the older case may have had similar development.

The fact that normal hyaline cartilage was found in these cases does not prove, of course, that all of the other patients reported in this series have hyaline-cartilage regeneration. However, the clinical and roentgenographic findings strongly suggest the possibility that they are following a like course.

Lyndon Peer, in an article published in 1938, stated that Paul Bert, about 1865, was probably the first to transplant hyaline cartilage. Bert concluded that cartilage grafts retain their viability. Fischer, in 1882, reached the conclusion that cartilage grafts would survive if transplanted with perichondrium. Loeb, in 1926, transplanted xiphoid cartilage with perichondrium in the same guinea pig (autografts) and

in different guinea pigs (homografts). The autograft survived, with practically no reaction about the graft. The homograft survived, but with a lymphocytic reaction which usually reached its peak at the end of twenty-one days. Mannheim and Zypkin, in 1926, performed fifty experiments with autografts of hyaline cartilage, and concluded that the cartilage retained its specific structures in all cases and that autcartilaginous grafts formed good material for plastic repair. König, in 1896, was the first to use cartilaginous transplants in human beings. He employed cartilaginous grafts in the repair of laryngeal and tracheal cartilage defects. Von Mangoldt, in 1899, successfully transplanted costal cartilage to the nose. Most of the pioneer work in hyaline-cartilage transplantation has been performed by the otolaryngological and plastic surgeons. Davis, in 1917, and Gillies, in 1920, emphasized particularly the viability of hyaline-cartilage autogenous grafts and the practical value of these grafts to surgery. Lyndon Peer, from whose work the historical review is largely quoted, presented, in 1945, microscopic sections taken from a twenty-year-old hyaline-cartilage graft (Fig. 13), which had been employed by John Staige Davis in the repair of a saddle nose. Slight buckling had necessitated partial excision; hence a specimen of the twenty-year-old transplanted cartilage was obtained. It proved to be normal hyaline cartilage. This work and that of Fisher, Carter, Loeb and Siebert, Logan, Hills, O'Connor, Falconer, and others point rather conclusively to the value of autografts of hyaline cartilage.

Sherman and Phemister, in 1947, published a paper on the pathology of ununited fractures of the neck of the femur and concluded that, if the blood supply of the head is cut off, the head dies and the articular cartilage becomes necrotic. The cartilage remains unaltered until the blood

Fig. 13 Low-power microscopic section of a twenty-year-old autogenous rib-cartilage graft (used by John Staige Davis to repair a saddle depression in the nose). Graft became distorted and one-third of the transplant was removed twenty years later by Dr. Lyndon A. Peer. Note normal cartilage in old graft. (Reproduced, by permission of the American Medical Association, from *Archives of Otolaryngology*, 42: 386, 1945.)

Table 3. Clinical findings

Case	Trendelenburg test	Presence of limp	Amount of shortening (Centimeters)	Use of brace, crutches, or cane	X-ray evidence of degenerative arthritis	Condition of head
1	Negative	None	1	None	None	Live
2	Negative	None	2	None	Plus-minus	Dead
3	Negative	None	1	None	None	Live
4	Negative	Slight	1.5	Cane	None	Dead
5	Negative	None	1.4	Walker*	None	Live
6	Negative	None	3	None	None	Dead
7	Positive	Marked	2	Cane	Plus	Dead
8	Negative	None	2	None	None	Live
9	Negative	Slight	2	None	None	Dead
10	Negative	None	2	None	None	Live
11	Negative	None	1.5	None	None	Dead

* Multiple sclerosis was present in this case.

supply reaches it, and is then replaced by either an imperfect type of fibrocartilage or by bone. This excellent piece of work casts considerable doubt upon the value of the cartilaginous-cup arthroplasty. However, the historical data as well as the clinical and roentgenographic findings reported in this article, particularly the findings in the nine-year-old cartilaginous cup in Case 1 (A. M.), point to the contrary. In the eleven cases reported in this series, the head was completely removed from the acetabulum in each case. In two instances there was slight bleeding; in the other nine, no bleeding occurred. Unfortunately, no bone sections or cartilage sections were studied at the time of the cup arthroplasty, so that there is no microscopic evidence as to which head was dead and which was viable. Six cases showed roentgenographic evidence of a dead head; the remainder, viable heads (Table 3). The complete removal of the head certainly deprived the cartilage of all blood supply.

It is hoped by the writer that this presentation will stimulate thought on hyaline-cartilage autografts. Their possible application to smaller joints, particularly those of the hand and foot, seems practical. The writer has under observation at this time a number of old congenital club feet upon which reconstructions have been performed through the usual approach of a triple arthrodesis. The cartilaginous surfaces were reapplied after the desired bony reconstruction was done. Movement in these joints, instead of fixation, has been obtained. The results to date in several cases (after one year of follow-up) have been striking. This material will be analyzed and reported after adequate time for proper analysis has elapsed.

Homografts have been utilized by the plastic surgeons, and cartilage banks have been established for a long time. Perhaps cartilage banks will be a part of the orthopaedic surgeon's armamentarium in the near future.

Conclusions

The cartilaginous-cup arthroplasty has been proposed as another method for handling ununited fractures of the neck of the femur, particularly those in Classes II and III. The method is admittedly a modification of the Brackett procedure and is similar anatomically to the methods described by Wagner; Venable, Stuck, and Beach; and others. Its originality, if there be any, is based primarily upon the utilization of the hyaline cartilage of the head of the femur as an autograft transplant. The results in nine cases are considered excellent, and two are poor.

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Appendix

Discussion

DR. JOSEPH A. FREIBERG, CINCINNATI, OHIO: I was fortunate in seeing Dr. Moore's first case, a nine-year result, last fall. Those of us who saw this woman were really amazed at the excellent restoration of function. Because of my impression of this case, and on the basis of what Dr. Moore told us, I decided to carry out the procedure in the next case that presented itself. I have done the operation in two cases. Unfortunately, neither one was an ideal patient for a reconstruction operation, but I am satisfied with the results. Before I show lantern slides of these patients, I want to mention one or two facts.

First, Dr. Moore did not state that, when you have the head in your hand and are reaming it out with the burr, the head has a tendency to get away from you. This happened to me on one occasion, and I could not be persuaded to put it back. I finished this operation as a Whitman reconstruction. This hip is progressing at about the same rate as though an arthroplasty had been performed.

The second criticism is the difficulty of putting the cartilaginous cup back on the neck at the original angle. If this is not done, the hip-joint relations are permanently disturbed. The cartilage cup should be replaced as accurately as possible. In two of Dr. Moore's cases, one four months and the other five months after operation, there is limitation of extension. Neither one of these was an ideal case. In the moving picture which Dr. Moore has showed, there appeared also to be some limitation in extension, as in the last case.

Discussion

I wish to show the slides of my cases: This man, aged fifty-two, had had a left hemiplegia in 1944 and a fracture of the femur, treated elsewhere with traction, which resulted in non-union. He came in because of the non-union. He had a contracture of the knee of about 15 degrees, as well as some flexion contracture of the hip. From the postoperative roentgenogram, it appears that the head is not so well placed on the neck as it might be. This is a point which Dr. Moore brought out. In the lateral view the head has not slipped. The amazing thing is the firmness with which the cup was fitted at the time of operation. We did not have any difficulty in keeping it from being displaced. This man is shown four months after his operation. He is exceptionally

well pleased with the result. He walks on crutches, with limited weight-bearing. He has now 70 degrees of motion, but he still has some flexion contracture and limitation of extension of the hip to 15 degrees. Clinically, he appears to have an excellent result.

This second man, aged fifty-five, had a fracture of the neck of the femur. He was treated elsewhere, and non-union resulted. The head appeared to be viable. He had a full-thickness tibial graft and a Smith-Petersen nail reconstruction, done in January 1947. He complained of pain. It was not an ideal case for reconstruction. This roentgenogram was made in June 1947, five months after operation. There is one screw in the shaft. The patient has slight limitation of motion. He is putting some weight on the leg, with crutches. He now has 60 degrees of flexion in the hip.

I do not believe that the end results in my cases are as good as those in Dr. Moore's cases, but I am satisfied with them so far.

DR. PAUL C. COLONNA, PHILADELPHIA, PENNSYLVANIA: Although I have not had any personal experience with this operation, the results shown here are very impressive in the treatment of selected cases of non-union of the neck of the femur. Technical difficulties may occur in reaming out some of these femoral heads, however.

The technique described by Dr. Moore presupposes that one is dealing with viable articular cartilage. Unfortunately, many of these loose heads present marked evidence of damage which has been produced by misplaced pins and nails,—not infrequently cartilaginous degeneration or areas of fibrillation. In addition, certain cases present ischaemic or avascular necrosis of the entire loose head. In these instances, it is difficult to say whether any portion of the head fragment should be used. In those cases in which the head fragments cannot be salvaged, other types of reconstruction operation are desirable.

Certain cases present narrowing of the joint space, indicating cartilage destruction. At times there is arthritis, and these cases are best treated by arthrodesis.

However, this still leaves a number of old ununited fractures of the hip with a viable head and a normal joint space, for which this operation may be ideally suited.

This operation, which might be called a modification of the Brackett operation, could have a far wider application than the author has described,—for instance, the utilization of the articular cartilage to produce an arthroplasty. If it is possible to restore function by using the joint cartilage over the head of the femur, why cannot joint cartilage be used in other joints? Will it be possible to restore function by preserving the articular cartilage of many joints by the use of cartilage banks, as we are doing today with bone banks, utilizing both heterogeneous and autogenous grafts?

I would like to compliment Dr. Moore on finding another method for treating non-union and, more

important, for using the principle he has illustrated in the restoration of joint function. This may be the answer to many of our problems in the reconstruction surgery of joints.

DR. I. WILLIAM NACHLAS, BALTIMORE, MARYLAND: It has been the concept of arthroplasty that one good articular surface is all that you need to get good motion. Are the beautiful end results that we saw in these illustrations the result of saving that cartilaginous cup, or are they the results of the superb technique that Dr. Moore has used?

DR. M. N. SMITH-PETERSEN, BOSTON, MASSACHUSETTS: I have had no experience with this procedure. I think that the principle of reconstruction may be a little different from what Dr. Moore thinks it is. He showed some beautiful slides of a "new head". I question whether the "cartilaginous cup" actually survives as an articular surface. In my opinion, the cartilaginous cup surrounded by a blood clot is exposed to the acetabulum, which acts as a mold. The blood clot undergoes metaplasia and is gradually transformed into hyaline cartilage. This, then, is new hyaline cartilage, and the photomicrographs will probably show the cartilage cells running parallel to the joint surface rather than perpendicular, as they do in normal hyaline cartilage.

I believe, then, that the principle is really that of mold arthroplasty.

DR. JOHN R. MOORE (closing): The use of homografts of hyaline cartilage is not new. They have been employed by the plastic surgeons and the rhinolaryngologists for many years. The possible application of homografts of hyaline cartilage to orthopaedic surgery is primarily the purpose of this presentation. Cartilage banks may be part of the armamentarium of the orthopaedic surgeon in the future.

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