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McKeever Metallic Hemiarthroplasty of the Knee in Unicompartmental Degenerative Arthritis

LONG-TERM CLINICAL FOLLOW-UP AND CURRENT INDICATIONS

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ABSTRACT: Forty patients with forty-four unicompartmental McKeever metallic uncemented hemiarthroplasties were followed for five to thirteen years (average, eight years). Thirty-nine knees had a medial and five, a lateral arthroplasty. The age at surgery ranged from thirty-two to eighty-two years (average, sixty-seven years). At the final follow-up, 70 per cent of the knees were rated as good or excellent. Seventy-nine per cent of the knees in patients who were less than sixty-five years old at the time of surgery were in these categories. Six knees (14 per cent) had required revision to either a unicompartmental or a bicompartamental total knee replacement. The average preoperative and postoperative knee flexion did not change, but knees with initially poor motion improved. The average preoperative flexion contracture of 10 degrees improved postoperatively to 5 degrees. Complications were rare and no cases of infection, peroneal palsy, or clinically detectable phlebitis occurred. Obesity did not seem to adversely affect the outcome. This study indicated that the McKeever unicompartmental metallic hemiarthroplasty can provide an attractive alternative in the treatment of unicompartmental degenerative arthritis when proximal tibial osteotomy is contraindicated or has failed or when the patient is too young, heavy, or active to consider total knee replacement.

The surgical options that currently are available for the treatment of advanced unicompartmental osteoarthritis of the knee include tibial osteotomy, metallic hemiarthroplasty, and metal-to-plastic unicompartmental, bicompartamental, or tricompartmental knee replacement. If tibial osteotomy is contraindicated or has failed, most surgeons do not consider metallic hemiarthroplasty but proceed directly to metal-to-plastic knee replacement.

In the late 1950's, McKeever introduced a metallic hemiarthroplasty to resurface the tibial plateau. He reported good initial results in thirty-nine of forty knees. MacIntosh designed a similar interpositional hemiarthroplasty and reported good initial results in seventy-two of 103 knees with

a minimum six-month follow-up^{5,6}. Potter et al. followed nineteen osteoarthritic knees that had either a McKeever or a MacIntosh prosthesis for an average of three years (range, one to nine years) and noted good to excellent results in seventeen. Despite these early encouraging reports, metallic hemiarthroplasty never became popular, possibly because of the advent of metal-to-plastic cemented total knee replacement. However, as the rate of loosening of cemented prosthetic components increases with both time and higher stresses across the bone-cement interface, younger, heavier, and more active patients risk a higher failure rate than do older, lighter, and less active patients. Bone stock is compromised by the insertion of the total knee components and by the effects of loosening, which makes revision surgery difficult. The revised knee arthroplasty is then in turn subjected to the same risks of failure as the initial knee arthroplasty. "Bridges have been burned", and the opportunity to take advantage of subsequent technological advances with the second operation may have been compromised.

For this reason, we believe that metallic hemiarthroplasty should still be considered in a select group of patients before proceeding to total knee replacement. The purpose of this report is to review our long-term results with McKeever arthroplasty in unicompartmental degenerative arthritis and to suggest which patients may be candidates.

Materials and Methods

At the Robert Breck Brigham Hospital (now Brigham and Women's Hospital), unicompartmental McKeever arthroplasty was performed on fifty-one patients (fifty-five knees) with degenerative arthritis between January 1968 and January 1976 by one of six staff surgeons. Eleven patients were lost to follow-up before the five-year examination could be performed. Two had died within two years after surgery, one had insufficient data to be included in the study, and eight were lost to follow-up within the first three years. This left forty patients (forty-four knees) who had been followed for five to thirteen years (average, eight years). Thirty-nine knees had had a medial and five, a lateral arthroplasty. Thirty-two of the knees were in thirty women and twelve, in ten men. The age at the time of surgery ranged from thirty-two to eighty-two years (average, sixty-seven years). Prior operative procedures had been performed on the ipsilateral knee in four patients, and consisted of

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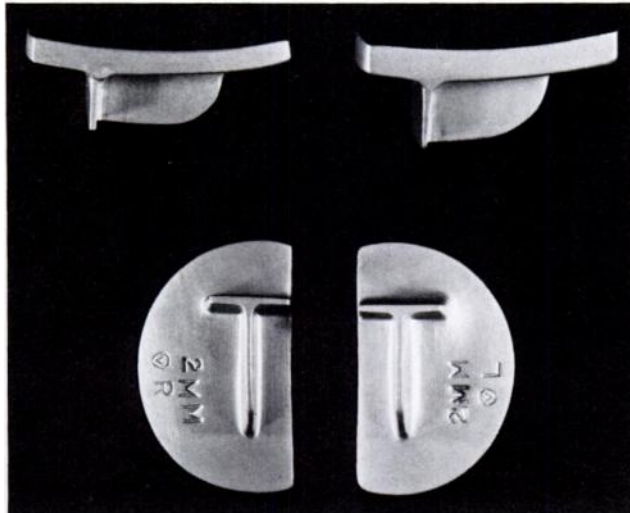


FIG. 1

The McKeever metallic prostheses. They are available in thicknesses ranging from two to fifteen millimeters.

three medial meniscectomies and one proximal tibial osteotomy. In two knees there had been a prior fracture of the tibial plateau. In nine knees the meniscus in the contralateral compartment was found at surgery to be torn and was removed. Eleven patients subsequently had had surgery on the contralateral knee. Four of them had had a contralateral unicompartamental McKeever arthroplasty; four, a unicompartamental metal-to-plastic knee replacement; two, a bicompartamental total knee replacement; and one, a proximal tibial osteotomy.

McKeever Vitallium prostheses were used in this series. Their shape roughly simulates that of a tibial plateau, with a slightly concave and a highly polished superior surface (Fig. 1). The inferior surface has a T-shaped fin that is inserted into a corresponding T-shaped slot made in the tibial plateau for fixation. The transverse limb of the T is anterior, for ease of insertion. The prostheses are designed as right and left mirror-images. A right prosthesis resurfaces either the right lateral or the left medial tibial plateau and a left prosthesis resurfaces either the left lateral or the right medial plateau. Varying thicknesses of the prostheses are available, ranging from two to fifteen millimeters. Three and four-millimeter prostheses were used in twenty-seven (61 per cent) of the knees in this series.

Operative Technique

We prefer a slightly median vertical parapatellar incision to expose the joint, such as is used for unicompartamental total joint replacement¹⁰. The details of the surgical approach and the technique for insertion of the prosthesis have been previously described⁸. An oscillating saw or burr is used to remove any irregularity on the opposing femoral condyle and to shape the tibial plateau so as to achieve maximum surface contact with the tibial prosthesis. It is not necessary to remove all remnants of articular cartilage, but only what is needed to properly shape the tibial plateau. Intercondylar osteophytes should be removed to relieve any

impingement with the tibial spine. All peripheral osteophytes that press against the collateral ligaments and capsule on the concave side of the knee deformity should be removed to assist passive correction of the deformity¹⁰. The correct thickness of the prosthesis is that which fills the joint space in the arthritic compartment but which is not so tight that it causes subluxation of the tibia on the femur or excessive pressure on the contralateral compartment. As a rule, the correct prosthesis in the medial compartment should allow the medial joint space to be opened approximately one millimeter when a valgus stress is applied with the knee in full extension. The knee must also be tested in flexion, as ex-

TABLE I*
KNEE ARTHROPLASTY EVALUATION

	Demerit Points
Pain	
None; no limitation of activity	0
Occasionally with prolonged walking; no limitation of usual activity	1
After walking short distances; some limitation of usual activity	3
Sufficient to require narcotics for relief; marked limitation of activity	6
At rest; patient incapacitated	7
Knee motion	
80 degrees or more	0
60 to 80 degrees	1
30 to 60 degrees	3
Less than 30 degrees	6
Flexion contracture	
None to 5 degrees	0
5 to 15 degrees	1
15 to 30 degrees	2
30 to 45 degrees	4
More than 45 degrees	6
Varus or valgus deformity	
Less than 10 degrees	0
10 to 20 degrees	2
20 to 30 degrees	3
More than 30 degrees	4
Medial-lateral instability	
Less than 10 degrees	0
10 to 20 degrees	2
More than 20 degrees	4
Quadriceps power	
Normal to good	0
Good minus to fair plus	1
Fair	2
Poor	4
No motion	6
Support	
None	0
Occasionally uses cane	1
Uses cane all the time	2
Uses crutches	4
Final rating	
Excellent	0 to 2
Good	3 to 6
Fair	7 to 10
Poor	11 +

* Reproduced from Potter, T. A.; Weinfeld, M. S.; and Thomas, W. H.: Arthroplasty of the Knee in Rheumatoid Arthritis and Osteoarthritis. A Follow-up Study after Implantation of the McKeever and MacIntosh Prostheses. *J. Bone and Joint Surg.*, 54-A: 12, Jan. 1972.

cessive tightness will cause the prosthesis to lift up anteriorly as the femoral condyle rolls posteriorly on the prosthesis during flexion. If this does occur, it can usually be prevented by resecting a little more of the posterior femoral condyle or by contouring the bone of the tibial plateau so that it slopes downward posteriorly 10 or 15 degrees rather than sloping upward.

Postoperative Regimen

Postoperatively, the knee is immobilized in full extension with a knee-immobilizer. Quadriceps-setting exercises are initiated on the first postoperative day and active flexion in the side-lying position is begun on the second day. Active knee flexion over the side of the bed is begun after the patient has achieved 45 degrees of active side-lying flexion. Walking is begun on the third or fourth postoperative day using the knee-immobilizer and two crutches. Thirty to 50 per cent weight-bearing is allowed. The splint is discontinued after the patient is able to actively raise the leg with the knee fully extended. When sufficient active flexion has been gained, a stationary bicycle is used for fifteen minutes twice a day. If the patient fails to regain the flexion that was achieved at the end of the operative procedure within two weeks after surgery, manipulation under general anesthesia is performed. Seven (16 per cent) of the forty-four knees in this series required manipulation.

Two crutches are used for a minimum of six weeks. At that time, external support is decreased, as tolerated, to the use of one cane outdoors and no support indoors. By twelve weeks postoperatively, the continued use of any support depends on the patient's progress. Recovery after a McKeever arthroplasty can be expected to be longer than that after a cemented total knee arthroplasty. Some soreness in the resurfaced compartment usually persists for six to nine months, but gradually improves with time. This is often accompanied by an effusion. Support with a cane or crutch is continued as long as either pain or swelling is present.

Results

We examined all but three of the patients (four knees) who had retained the McKeever prosthesis at the time of the latest follow-up. For these three patients the last examination had been done within eighteen months by the operating surgeon, but they had moved away, and data on pain and functional status were obtained from these patients by telephone. Preoperative data and intermediate results were obtained from their records and confirmed by the patient.

The over-all results were classified as excellent, good, fair, or poor according to the demerit system used by Potter et al. (Table I). In essence, an excellent knee had no pain and normal function. A good knee had mild, trivial pain related to activities and little or no functional limitation. A fair knee had satisfactory pain relief but moderate functional limitation, and a poor knee had an unsatisfactory level of function.

The results at one year, three years, five years, and the

latest follow-up (five to thirteen years) are shown in Table II. At one year, thirty-eight (86 per cent) of the forty-four knees were in the good or excellent category, but this had gradually diminished to thirty-one (70 per cent) at the final follow-up evaluation. Three knees (7 per cent) had a poor result at the one-year evaluation, and this number gradually increased to seven knees (16 per cent) at the time of the final follow-up.

TABLE II
EVOLUTION OF RESULTS (IN PER CENT) AFTER
McKEEVER ARTHROPLASTY IN FORTY-FOUR KNEES

Result	At 1 Yr.	At 3 Yrs.	At 5 Yrs.	At >5 to 13 Yrs.*
Excellent	7	7	7	7
Good	79	72	68	63
Fair	7	14	14	14
Poor	7	7	11	16
Revised	5	5	7	14

* Average, eight years.

Six knees (14 per cent) required revision because of inadequate relief of pain. Three knees were revised to a unicompartmental total knee replacement and three, to a bicompartmental total knee replacement. All of them were graded as good or excellent when last seen. The revision was accomplished without difficulty, as the McKeever prosthesis did not compromise the bone stock of the tibial plateau. Two revisions were done within the first postoperative year and one each was done at four and a half, five, seven, and ten years.

Pain relief: All of the patients had had significant pain on weight-bearing before surgery. In patients who had had preoperative pain at night, this was relieved by the end of the first postoperative year and did not recur except in the patients who required revision. The three knees that had been rated as excellent and had had no pain at the one-year follow-up continued to be pain-free at the final follow-up. Eight of the thirty-five knees that were rated as good at one year had no pain regardless of activity. The remaining twenty-seven knees had some mild discomfort after strenuous activity, but no limitation of function.

Range of motion: Preoperative flexion of the knee averaged 110 degrees (range, 70 to 135 degrees). The flexion at final follow-up also averaged 110 degrees (range, 85 to 135 degrees). The average preoperative flexion contracture was 10 degrees (range, zero to 40 degrees), while the average flexion contracture at final follow-up was reduced to 5 degrees (range, zero to 20 degrees).

Results in younger patients: As we thought that the McKeever arthroplasty might have particular advantages in younger patients, we singled out, for special study, thirteen patients (fourteen knees) who were less than sixty-five years old at the time of surgery. The average age of these patients was fifty-four years (range, thirty-two to sixty-four years). Five years after surgery, thirteen of the fourteen knees were rated good or excellent. At five to twelve years of follow-

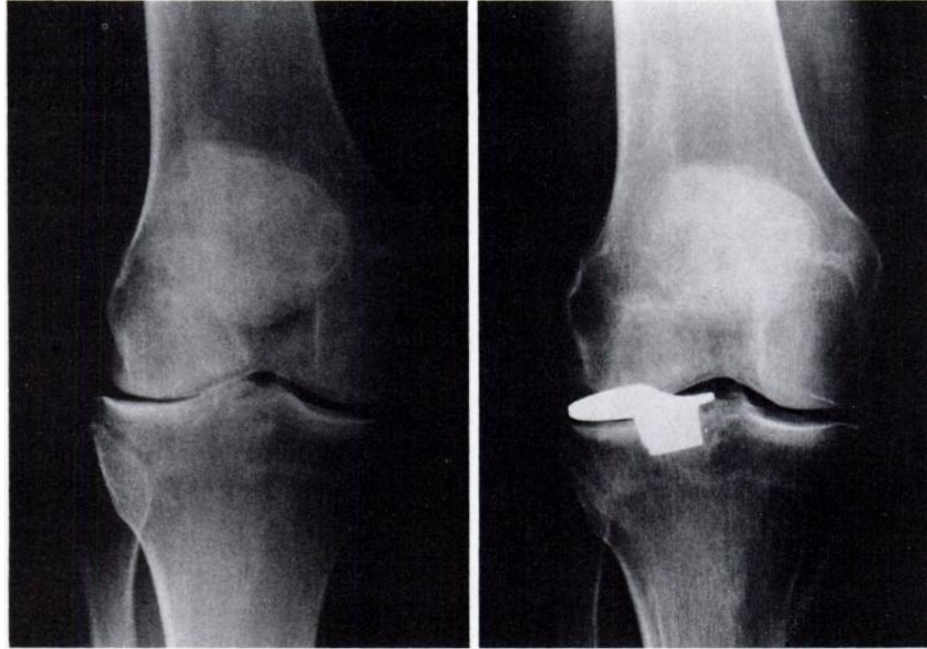


FIG. 2-A

FIG. 2-B

Fig. 2-A: Preoperative radiograph of a knee with osteoarthritis involving the lateral compartment. The patient was fifty-eight years old and worked daily in the winter as a downhill-skiing instructor.

Fig. 2-B: Radiograph made three years after arthroplasty. Eburnated bone on the lateral condyle of the femur was drilled at the time of surgery. Minimum bone stock was sacrificed. The knee had a full range of motion, good stability, no effusion, and no pain. The patient returned to downhill skiing with no difficulty.

up (average, eight years) eleven knees (79 per cent) were still in the good or excellent category, one knee was rated fair, and two knees had been revised.

Complications: There were few perioperative complications and no infections. In one patient the surgical drain was retained, and repeat surgery was necessary to remove it. One patient had a large intra-articular hematoma that gradually resolved and did not compromise the result, and one patient had a superficial wound hematoma that drained spontaneously, with no effect on wound-healing. There were no clinically manifested cases of thrombophlebitis.

Discussion

We are strong advocates of proximal tibial osteotomy as the procedure of choice in the younger, heavy, or active patient with medial unicompartmental degenerative arthritis. The McKeever interpositional arthroplasty, however, can provide an attractive surgical alternative in a knee with unicompartmental degenerative arthritis when proximal tibial osteotomy is contraindicated or has failed and the patient is too young, too heavy, or too active to consider total knee replacement.

In our opinion, the relative contraindications to osteotomy include active flexion of the knee of less than 90 degrees, a flexion contracture of more than 15 degrees, intercondylar osteophyte impingement as shown on a tunnel radiograph, the presence of pain at rest, a history of phlebothrombosis or venous stasis disease in that extremity, or signs of internal derangement (especially episodes of locking). Early degenerative changes in the contralateral joint compartment shown on a standing plain radiograph (pe-

ripheral osteophytes, subchondral sclerosis, mild joint-space narrowing, or chondrocalcinosis) or a bone scan showing increased uptake in the opposite compartment are also contraindications.

It is more difficult to define what we mean by "too young, too heavy, or too active to consider total knee replacement", as so many factors must be considered for each individual patient. For example, we would not consider a twelve-year-old bedridden patient with juvenile rheumatoid arthritis who weighs forty kilograms to be too young for total knee replacement⁹, but we might think that a fifty-five-year-old laborer weighing 120 kilograms is too heavy and too active for the procedure.

The McKeever arthroplasty has some distinct advantages over tibial osteotomy, as a torn meniscal fragment and bone impingement can be removed at the time of surgery. After such débridement and the release of intra-articular adhesions, it is possible to gain both flexion and extension in patients who have significant preoperative limitation of motion. As we have not found postoperative immobilization to be necessary after a McKeever arthroplasty, the chance of venous thrombosis is diminished. Also, both knees can be operated on during the same hospitalization, significantly diminishing recovery time in a patient with bilateral involvement. The potential problem of delayed union or non-union of an osteotomy is avoided, and the incidence of peroneal palsy is less^{2,4,11}.

In patients who already have early degenerative changes in the contralateral joint compartment of the same knee, the McKeever arthroplasty has an additional advantage over osteotomy. Slight overcorrection of the preoper-

ative varus or valgus deformity, which is the goal of osteotomy, transfers extra weight-bearing forces to the contralateral compartment with early involvement. In the knee with preoperative varus alignment that has advanced medial-compartment disease but only early lateral-compartment disease, the correctly chosen width of McKeever prosthesis can adjust the postoperative alignment to neutral or only a few degrees of valgus angulation. This permits the resurfaced medial compartment to share substantial weight-bearing forces while protecting the opposite compartment from overload. It is permissible to allow the patient to engage in vigorous physical activity as tolerated. Finally, at an average of eight years of follow-up, the results in our patients were equal to or better than those that have been reported for osteotomy^{1-4,11}.

A McKeever arthroplasty cannot be expected to produce an initial result that is comparable with that after cemented unicompartmental or bicompartamental total knee replacement. All of the patients in this series who had a cemented total knee replacement in the opposite knee or who eventually had a conversion to a total knee replacement preferred the total knee arthroplasty. However, the McKeever arthroplasty has several advantages over unicompartmental or bicompartamental total knee replacement in selected patients. As bone cement is not required, the po-

tential adverse effects on bone of late cement failure are eliminated. The minimum resection of bone stock results in little or no compromise of any later salvage procedure. The patients can resume vigorous physical activity as tolerated, allowing their potential return to a strenuous occupation or avocation (Figs. 2-A and 2-B).

Two categories of patients benefit from these advantages: the obese and the young. The obese patient is at greater risk of component loosening — the heavier the patient, the higher are the stresses that are generated across the bone-cement interface. However, obesity did not appear to adversely affect the outcome of the McKeever arthroplasty in our series and is, perhaps, a relative indication for the procedure. We have obtained good results with three years of follow-up in patients who were as heavy as 170 kilograms.

Youth is a relative contraindication to any prosthetic joint replacement. The McKeever arthroplasty, however, can be used to maintain a good functional knee during the years prior to a probably inevitable total knee replacement. Bone stock is preserved, and the delay will enable the patient to have the advantage of the latest joint-replacement technology.

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