

TOTAL KNEE REPLACEMENT

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tisch SD, Rovere GD: Knee arthroplasty with the use of prosthesis. Clin Orthop 94:72, 1973
us arthroplasty Clin Orthop 94:85, 1973
ntric knee arthroplasty. J Bone Joint Surg 53B:2, 1971
s of Total Knee Replacement, American Academy of
as.
R: Guepar total knee prosthesis. Clin Orthop 94:214,

L, Paul IL: Repairing the human skeleton: Materials
Tech Rev Mar/Apr 1974, p. 41
mechanics of the knee joint in relation to normal walk-
:51-61, 1970

L, Simon SR: Biomechanics of Gait, A Critical Visual
alysis Laboratory, Shriners Hospital for Crippled Chil-
co, 1975

Mechanical causes of loosening in knee joint replace-
10:387-91, 1977

GEOMETRIC AND ANAMETRIC TOTAL KNEE REPLACEMENT

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Total knee replacement to replace severely diseased knees evolved as a direct outgrowth of the successful development of total hip replacement. Each advance in the management of diseases of the hip has been followed by improvement in treatment of conditions of the knee joint.

The first primitive knee arthroplasty noted in the English medical literature was reported by Ferguson in 1861.^{1,2} This was a resection arthroplasty that resulted in a functional extremity when reported five years postoperative.

Following this early effort, several materials were used as an interposition arthroplasty in the early 1900's. Murphy³ used fascia lata and fat in 1913; Baer⁴ used chronicized pig bladder in 1918; Platt⁵ used fascia lata in 1921; Campbell⁶ used prepatellar bursa tissue in 1921; Albee⁷ used fascia lata and fat in 1928; Samson⁸ used cellophane in

1949; Brown, McGraw, and Shaw⁹ used skin in 1958, and Kuhns and Potter¹⁰ utilized sheets of nylon in 1950. The results using any of these materials were so unpredictable that during this period, arthrodesis remained the treatment of choice for managing most severely arthritic knees.

The use of metallic interposition knee arthroplasty began in the 1940's when Campbell¹¹ used a Vitallium plate and in 1942 when Smith-Petersen^{11,12} used a Vitallium model. Smith-Petersen's femoral mold was redesigned in 1953 and the new mold was reported on in 1966 by Jones et al in 1967¹³ and by Platt and Peples⁴ in 1969 with 41 percent good-to-excellent results. Later, several authors including Coventry (1965),¹⁴ Jackson et al. (1969),^{15,16} Davaas (1969),¹⁶ Ewatts et al. (1971),¹⁷ and others have supported the concept of proximal tibial osteotomy as a means of treating degenerative arthritis of the knee. MacIntosh and Hunter (1972)¹⁸ and McKeever (1960)¹⁹ have strongly advocated the use of metallic implants of various thicknesses to cover the tibial plateau.

Jones et al. (1967)¹³ reported 41 percent good or very good results using the MGH distal femoral mold; Potter reported 56 percent good or excellent results using the MacIntosh or the McKeever tibial plateau prosthesis in a series of 99 arthroplasties in 82 patients with rheumatoid arthritis.

Hinged total knee replacement first came on the scene in 1947 when Judet et al.^{20,21} designed an experimental hinged prosthesis made of acrylic. Walldius²² also reported early experience with an acrylic hinged prosthesis in 1953, but he changed from acrylic to metal hinges in 1957.²³ In 1952, Seddon used a custom made total knee to replace a distal femoral tumor but this failed. In 1954, Jackson Burrows used a similar prosthesis for a giant cell tumor of the femur. The patient was still doing well 15 years later. In 1957, MacAusland and in 1963, Young,²⁴ reported their experiences with the Walldius hinged prosthesis. Hinged total knee arthroplasty became an accepted, but infrequent form of treatment in the sixties. Walldius²⁵ reported 64 percent good results with his hinged prosthesis in which 43/64 patients had rheumatoid arthritis; and Shiers and Young^{21,26} reported 42 percent good results using the hinge prosthesis.

After careful review of all these proposed techniques, it became obvious that each had their problems and limitations. Debridement makes no attempt to restore the anatomic configuration of the articular surfaces. The interposition membrane arthroplasties neither provide stability nor do they recreate the congruity of the joint surfaces.

The tibial plateau and femoral mold prostheses are designed to treat only one-half of the joint surface problems and are, therefore, clearly unsuitable in many knees that need treatment. The various metal

hinged type prostheses were subject to a high rate of failure due to loosening, fractures of the bolt or stem, infection, peroneal nerve palsy, and skin necrosis. In view of all this accumulated knowledge on the treatment of knee disease, it became obvious that new designs had to be considered. The geometric knee for total knee arthroplasty was devised because the principle of metal to polyethylene bearing surfaces had been so well proven in the hip. The later-developed anametric total knee replacement grew out of the need to more closely reproduce the normal knee anatomy of the average knee.

DESIGN CONCEPTS

The original geometric total knee replacement was the result of a collective effort involving a committee of five orthopedic surgeons from five different medical centers working between 1969 and 1971.²⁷⁻²⁹ The intent of this combined effort was to devise a metal-to-plastic knee implant to resurface the knee and to be secured with methyl methacrylate cement.

When designing any knee implant,²⁵⁻²⁷ one should give special attention to a number of unique biomechanical features of the knee joint, especially the following:

1. The instant center of joint rotation shifts completely with flexion
2. Stability is dependent to a major degree on the integrity of the four major ligaments, the posterior capsule and the quadriceps muscle unit; these vital structures are often severely damaged by the underlying disease process
3. Axial rotary motion takes place in addition to flexion between the femur and the tibia
4. The knee joint articulates the two longest bones in the body and is subjected to tremendous angular stresses

The following outline of specific criteria reflects the combined thinking of the committee on what the exact characteristics of an ideal total knee replacement are.²⁸⁻³⁰ The specific initial criteria involved:

1. Antero-posterior, rotary, and lateral stability inherent within the prosthetic unit
2. Design of the prosthetic units so that cruciate and collateral ligaments need not be sacrificed if they are present
3. The necessity for removal of as little bone as possible, preferably less than two cm for insertion of the unit
4. Knee motion from full extension to at least 90 degrees of flexion

5. Construction from materials known to be acceptable in an intra-articular environment
6. The capability to correct varus, valgus and flexion deformities of the knee
7. The avoidance of intramedullary implantation for fixation
8. The avoidance of designs that have shown appreciable wear in previous applications

Unfortunately, these criteria had been extraordinarily difficult to meet until the geometric knee for total knee arthroplasty was designed specifically to satisfy these stringent requisites. The unit follows geometric rather than anatomical principles. The term geometric knee was chosen, therefore, because both the femoral and tibial components have bearing surfaces whose contours are segments of a sphere. The factors influencing the decision to use spherical surfaces are: (1) surface finish of both components could be perfected to very rigid standards on spherical surfaces, whereas surface finishing of multi-axial surfaces was considerably more difficult; (2) wide surface contact between the components is maintained through at least 90 degrees of motion; (3) the interlocking of two spherical surfaces gives greater stability in extension than is present in the normal human knee; and (4) although stability in flexion may be sacrificed somewhat with spherical surfaces, the requirements for stability in flexion are not nearly as significant functionally as are the requirements for stability at or near full extension.

The geometric total knee has a biocondylar Vitallium femoral component (Fig. 1). The two femoral weight-bearing surfaces are spherical and are joined by an anterior crossbar. The flexing radius of the femoral condyles is 23.8 mm, with the medial and lateral condyles of identical dimensions. The overall width of the standard implant is 66.5 mm. Smaller and larger sizes are available.

The matching tibial unit is a single interlocked piece of high density polyethylene, which is designed to replace both tibial plateaus (Fig. 2). The undersurface of the tibial prosthesis has three "fins" for locking it into cement. Furthermore, the undersurface of the polyethylene is cross-hatched to provide additional surface contact with cement. Chromecobalt wires are slotted into the undersurfaces of the tibial implant for x-ray evaluation of position and alignment.

The radius of curvature of the tibial bearing surfaces is 24.6 mm or 0.8 mm larger than the radius of the femoral bearing surfaces. The difference allows approximately ten degrees of axial rotation between the femoral and tibial components.

In early models, tibial components were fabricated with two alignment markers seated in open slots on the undersurface of the polyethylene

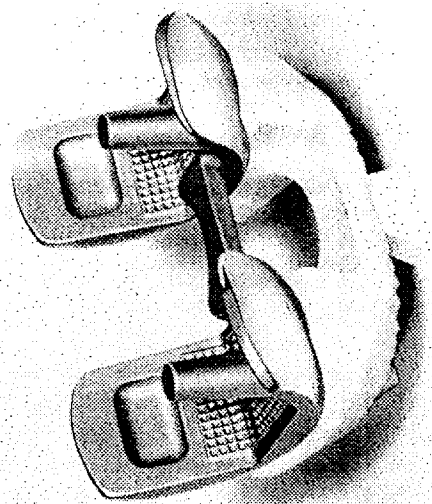


Figure 1. Geometric total knee.

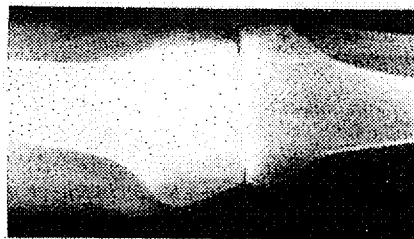


Figure 2. Pre-operative x-ray.

lene tibial implant. The rare occurrence of posterior migration of an alignment wire led to modification of the wires and the slots in which they were seated. The alignment wires now have 90 degree bend and are held firmly between the tibial polyethylene and methacrylate cement, rendering migration virtually impossible. Figures 2 and 3 are preoperative and postoperative x-rays of a patient who underwent geometric total knee replacement.

The geometric design has served as an excellent mode of total knee replacement since its inception in 1969. Although the details of the results of using this form of arthroplasty will be considered subsequently in this chapter, one salient feature which has lead the same original group of clinical investigators to an anametric (anamorphic) design concept has been that approximately 15 percent of the geometric patients have continued to complain of patellofemoral pain. Engineering and machining techniques have progressed so that it is now possible to develop a multi-axial unit with excellent contours and surface finishes. The anametric total knee unit solved the problems of patellofemoral joint pain and limited motion by reconstructing the average human distal femoral condylar contours to include the patellar and trochlear region of the femur.

The anametric total knee has a bicondylar chrome-cobalt femoral component (Fig. 4). There is a flange which measures 35 mm that covers the prepared trochlear region of the femur. The flange has a 70 degree angled cut proximally so that it goes from 12 mm on its medial border to 35 mm laterally thus necessitating the need for a right and left femoral prosthetic design. The flange is also tapered proximally to allow for a smooth transition from anterior femoral cortex to the flange. The femoral condyle is a composite of 6 circles to provide multi-axial movement. The overall width of the standard femoral prosthesis is 57 mm. Smaller or larger sizes are available.

The AP diameter is 57 mm. The transverse diameter of each metal prosthetic condyle is 15 mm. There is a single fixation peg centered under each femoral condyle. Additional fixation is afforded by the cross-hatched design on the undersurface of the flange and by negative indentations under the posterior femoral condyles (Fig. 4).

The matching tibial component is a single interlocked piece of high density polyethylene, which is designed to replace both tibial plateaus. The two tibial plateau surfaces are linked by an anterior crossbar. An anterior eminence of high density polyethylene on the tibial crossbar gives considerable resistance to medial-lateral translation. The undersurface of the tibial prosthesis has three "fins" for locking it into cement. Furthermore, the undersurface of the polyethylene is crosshatched to provide additional surface contact with cement. There are two "L"-shaped Vitallium wires that are slotted into the undersurface of the

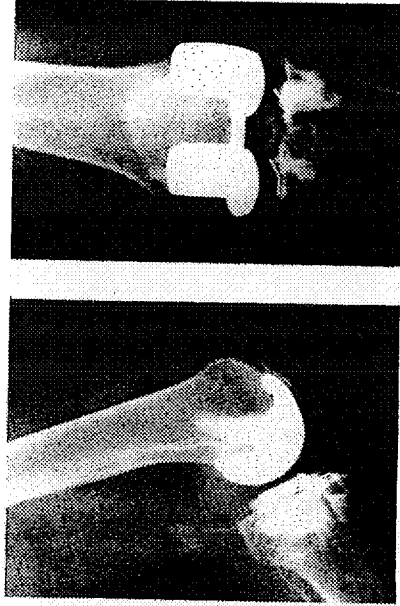


Figure 3. Post-operative x-ray.

tibial unit for x-ray evaluation of position and alignment. The standard component is 11 mm high with the polyethylene thickness measuring 8 mm in the area undergoing maximum weight-bearing compression by the femoral condyles. Recently, a metal backed tibial component has been made available.

A patellar replacement made of ultra-high molecular weight poly-

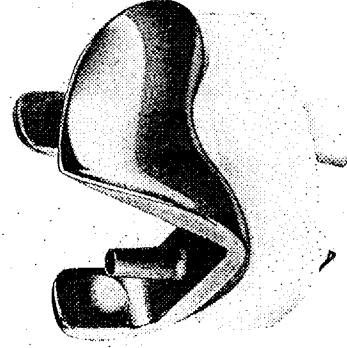


Figure 4. Anametric total knee.

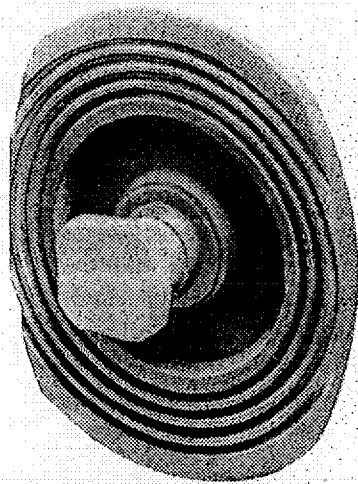


Figure 5. Patellar replacement implant.

ethylene (Fig. 5) is available for the Anametric total knee replacement in case of severe patellar disease. This implant is dome-shaped to conform with the surface of the femoral component and has a single fixation stud which measures 8 mm in depth and is cemented in the patella after

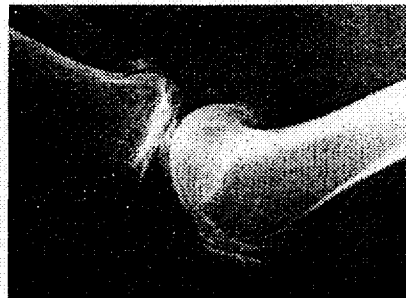
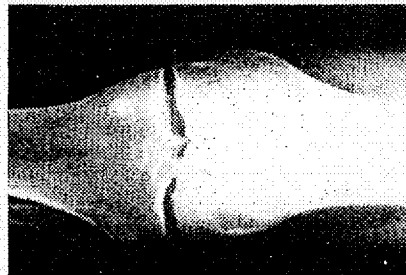


Figure 6. Pre-operative x-ray.



Figure 7. Post-operative anametric replacement.

removal of the diseased articular surface. There are multiple circular grooves in the undersurface of the prosthesis to enhance fixation.

Figures 6 and 7 show preoperative and postoperative x-rays of a patient who underwent an Anametric total knee replacement.

SUMMARY OF RATIONALE OF ANAMETRIC DESIGN FEATURES

1. Provides anatomic function in prosthetic replacement of the articulating surfaces of the knee (Fig. 4)
2. Curvatures of medial and lateral condyles of femoral components are dissimilar and are essentially anatomic
3. The medial condyle is canted to help promote rotation-derotation movements
4. Patellar flange offers an articulating surface for either a natural patella or a patellar prosthesis (Fig. 5)
5. Tibial component has an anterior eminence for medial-lateral stability (Fig. 4)
6. Retains cruciate ligaments

FAILURES OF THE CONSERVATIVE APPROACH

Those patients who have undergone a full course of conservative treatment as has been suggested, and in spite of it are still quite disabled by knee pain, should be considered for total knee replacement. If there is

no patellofemoral arthritis, then either geometric or anametric prosthetic units can be used. When there is significant patellofemoral arthritis, the anametric total knee is indicated. When a choice is to be made between arthrodesis and total knee replacement, the following conditions would favor total knee replacement: bilateral knee disease; concomitant hip disease; back pain; situations in which the contralateral knee has been arthrodesed for any reason; and in a patient with systematic arthritis whose disease is likely to be progressive in the future (rheumatoid arthritis). Once rheumatoid arthritis has passed beyond the synovial phase and significant joint damage is recognizable by roentgenogram, total knee arthroplasty should be considered.

INDICATIONS FOR TOTAL KNEE REPLACEMENT

One should attempt total knee replacement only after a complete course of conservative therapeutic modalities has been established and has failed. The treatment plan should include any or all of the following as they apply: weight loss, anti-inflammatory agents, ambulatory aids, diagnostic arthrography and/or arthroscopy, Magnuson debridement, high-tibial osteotomy, or even unicondylar replacement.

CONTRAINDICATIONS FOR GEOMETRIC AND ANAMETRIC TOTAL KNEE REPLACEMENTS

The following circumstances are direct contraindications to total joint replacement of the knee: prior joint sepsis; a fused knee; quadriceps paralysis; poor skin coverage; neuropathic joints; and gross instability. The presence of poor dentition, urinary tract obstruction, sepsis anywhere in the body, and concomitant ipsilateral hip pain are conditions which should be remedied before any total joint surgery is performed.

GEOMETRIC TOTAL KNEE ARTHROPLASTY TECHNIQUE*

Approach

Step 1. The knee is approached by a long, medial parapatellar incision beginning four to six inches above the superior pole of the patella, curving gently around its medial border and ending one inch distal to the

* Adapted from Murray, W. R.: Technique for geometric total knee arthroplasty. Rutherford NJ, Howmedica Surgical Techniques, 1973.

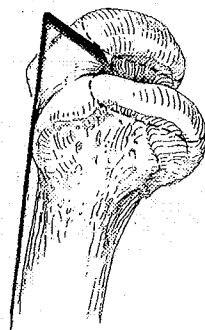


Figure 8. Placing of femoral cutting guide.

tibial tubercle. The approach is made under tourniquet control. Quadriceps mechanism, joint capsule, and synovium are incised on the same line. An anterior synovectomy is done if there is considerable hypertrophic proliferative synovium. The knee is flexed to 90 degrees with the patella turned 180 degrees on its long axis, thereby, exposing the joint and distal femur.

Step II. (Fig. 8) The femoral cutting guide is inserted in the midline, deep to the suprapatellar pouch. The initial transverse femoral osteotomies are made with a power or hand saw parallel with the guide which is approximately 30 degrees to the long axis of the femur.

Figure 9 shows the appearance of the femur after this initial osteotomy with the distal-most portions of the medial and lateral femoral condyles removed.

Step III. (Fig. 10) The femoral cutting jig is then tapped in place with the central guide post in the midline. The downward projection of the central guide post must not extend anterior to a line projected along the anterior femoral cortex. Drill holes are then passed through the drill hole guides into the distal femur to assist in stabilizing the jig in place (Fig. 10).

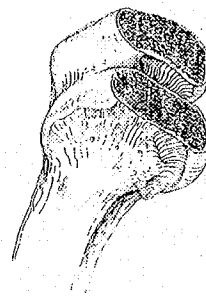


Figure 9. Appearance of femur after cutting of distal condyles.

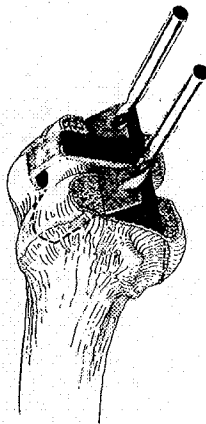


Figure 10. Drill holes passed through drill hole guides.

The oblique, distal femoral osteotomies are then made with a power saw on planes parallel with the jig (Fig. 11). A final anterior transverse femoral osteotomy is made on a plane parallel with the downward projection of the central guide post (Fig. 11).

It is essential that the most anterior femoral cut not be anterior to the anterior cortex of the femur, for if it is, there is danger that the patella will "hang up" on this osteotomy at 90 degrees flexion. If the osteotomies are made too far posteriorly, difficulty may be encountered in getting full extension of the knee after insertion of the prosthesis.

Step IV. The femoral jig is removed (Fig. 12) and intercondylar bone removed to receive the bridge of the prosthesis. The area of bone removal is marked by the four holes left from the prongs of the femoral jig (Fig. 12). Figure 13 shows the appearance of the femur after removal of intercondylar bone to accommodate the bridge of the prosthesis.

Step V. The dummy prosthesis is then temporarily inserted and checked for proper fit. Any bony projections preventing satisfactory seating of the prosthesis are then removed (Fig. 14.)

Step VI. (Fig. 15) The dummy prosthesis is removed, the knee flexed to 90 degrees and the tibial jig tapped into place in the distal femur. The tibial jig is used to assist in preparing the proximal tibial lazy "L" osteotomies. The depth of the osteotomies is determined by the most distal projection of the prongs of the tibial jig. The anteroposterior intercondylar cuts are placed just to the middle of the most midline downward projection of the jig. Figure 14 shows the osteotomies outlined. The osteotomies are performed with a power reciprocating saw and

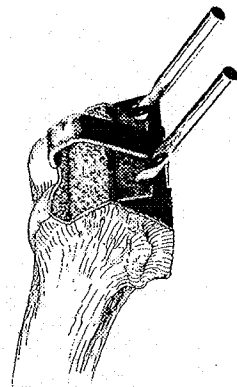


Figure 11. Drill holes made by markers left by jig.

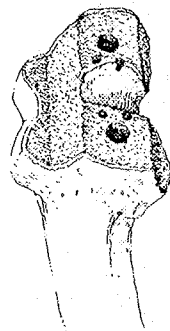


Figure 12. Femur after removal of intercondylar bone.

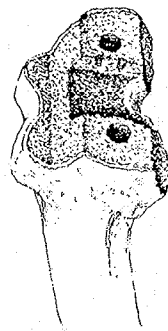


Figure 13. Alternative view of femur after removal of intercondylar bone.



Figure 14. Removal of abnormal bony projections.

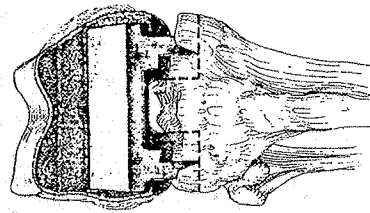


Figure 15. Placing trial jig into distal femur.

completed with an osteotome. The anterior one-half inch to three-quarters inch of intercondylar bone anterior to the cruciate ligament attachment is then removed on the same plane as the lazy "L" osteotomies (Fig. 16). It is necessary to remove this bone to accommodate the bridge of the tibial component.

The tibial prosthesis is then placed on the cut surface of the proximal tibia and the areas of bone which must be removed to receive the

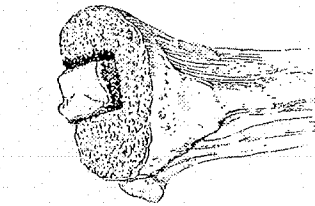


Figure 16. Removal of bone anterior to cruciate ligaments.

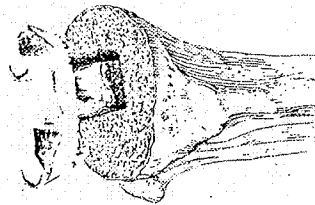


Figure 17. Placement of tibial prosthesis.

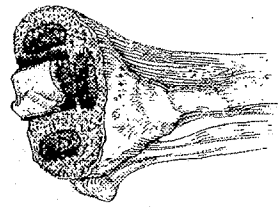


Figure 18. Proximal tibia prior to insertion of tibial prosthesis.

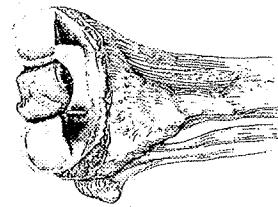


Figure 19. Tibial prosthesis temporarily inserted.

three downward fin-like projections on the under-surface of the prosthesis are marked (Fig. 17). These slots or troughs are then made with either a gouge or the power saw.

Figure 18 shows the appearance of the proximal tibia after removal of bone for reception of the prosthesis.

Figure 19 shows the tibial prosthesis temporarily inserted. There should be maximum contact between the under-surface of the prosthesis and the cut surfaces of the proximal tibia.

Step VII. The tibial component is removed, the femoral component inserted and the tibial component reinserted. A trial range of motion and check for stability and alignment is then made. If there is varus or valgus deformity, bone may be removed from the medial or lateral tibial plateaus to restore normal alignment. If there is incomplete extension, it may be necessary to remove bone from the proximal tibia or the distal femur to allow more room for the prosthesis.

Figure 20 shows the prosthesis in place in flexion and Figure 21 is a lateral view in full extension.

Step VIII. Both components are then removed, the wound packed and the tourniquet deflated. Bleeding is controlled at this time. If patelloplasty is indicated it is performed after tourniquet deflation, however, it is usually not necessary. If there are hypertrophic margins on the patella which would impinge against the femur or the prosthesis, they should be removed. Patelectomy is not recommended in association

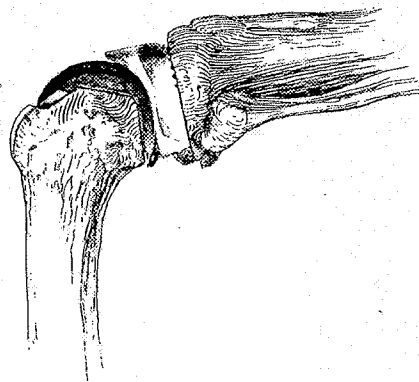


Figure 20. Prosthesis in place, knee in flexion.

with geometric knee arthroplasty and has rarely been performed. The wound is then thoroughly irrigated with a Kanomycin solution containing one gram Kanomycin in 500 cc of saline. At the time of tourniquet deflation, intravenous antibiotics are given. Two grams of Keflin as a single dose, and four grams to be run in during the remainder of the case are placed in the intravenous fluid. After control of bleeding, the extremity is elevated, wrapped with an Esmarch bandage from toes to tourniquet and the tourniquet reinflated to 450 mm of Mercury. The tourniquet should remain inflated until after application of the post-operative dressing.



Figure 21. Tourniquet deflated and wound packed.

Step IX. The femoral and tibial components are reinserted and once again checked for range of motion, stability and alignment. When these are satisfactory, the components are removed and the first mix of methyl methacrylate is made which is then impacted into the prepared distal femur and the recesses of the femoral prosthesis. The femoral prosthesis is then seated into the prepared bed, held securely in place and excess cement is removed from the margins of the prosthesis.

The tibial component is then once again temporarily inserted and a check made to be sure that addition of cement to the femur did not produce sufficient lengthening to prevent full extension.

Step X. The tibial component is removed and a second mix of methyl methacrylate is firmly impacted into the prepared tibial and recesses on the undersurface of the tibial prosthesis. The tibial prosthesis is then inserted and the knee is carried into full extension while holding the prosthesis in place. The knee is then flexed to 90 degrees and excess cement is removed from the posterior compartments. The knee is then fully extended and maintained in full extension while the cement is setting. During this time, excess cement is removed from around the margins of the tibial prosthesis. When the cement has set, the wound is thoroughly irrigated, all fragments of cement are removed and the wound is closed in layers over Snyder Hemovac drains. After closure of the capsule and quadriceps mechanism, the knee is flexed to be sure there is no undue tension on the suture line.

Step XI. After skin closure, a sterile, bulky, compression dressing is applied from toes to tourniquet. The tourniquet is then deflated and the dressing carried as high as possible on the thigh. The leg is then immobilized in plaster.

THE ANAMETRIC TOTAL KNEE PROSTHESIS*

The knee is exposed through a median parapatellar approach which has already been described. Once the exposure is obtained, the knee is flexed to 90 degrees and a one-fourth inch drill hole is placed in the distal femur just superior to the jig # 1 (femoral shaper jig) is inserted

* Adapted from Coventry MK et al: Anametric total knee surgical technique. Rutherford NJ, Howmedica Surgical Techniques, 1977

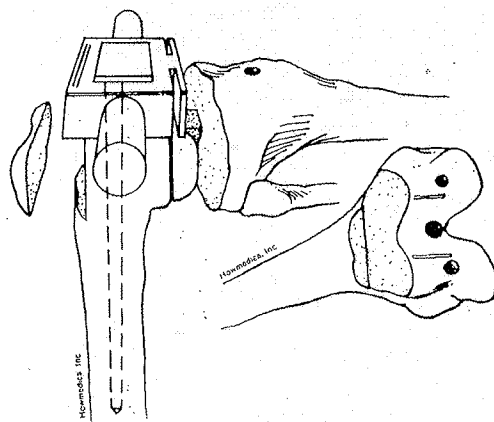


Figure 22. Proper osteotomies anterior and posterior are made.

in the previously prepared drill hole (Fig. 22). As the jig is inserted into the distal femur it is tapped into place with a mallet. The appropriate anterior and posterior osteotomies are then made through the outlined slots in the jig using either a reciprocating saw or a thin osteotome. The femoral shaper is then removed and the remaining portion of the osteotomy is completed under visual control. The two vertical indentations on the distal femur are noted and these two vertical slots are connected with an osteotome. The holes for the femoral fixation pins are drilled with three-eighths inch drill bit. The position of these holes will have been marked by the femoral shaper on each distal femoral condyle.

The jig #2 (Tibial cutter jig) is inserted in the same one-fourth inch drill hole in the femur (Fig. 23). The knee is now flexed to a right angle and distracted distally. The distal portion of this jig is then brought into alignment with the portion of the tibia using the long axis of the instrument as an axial alignment guide. After obtaining the proper alignment the tibial fixation pin is hammered into the proximal tibia to hold the distracted position. The tibia is now cut through the appropriate

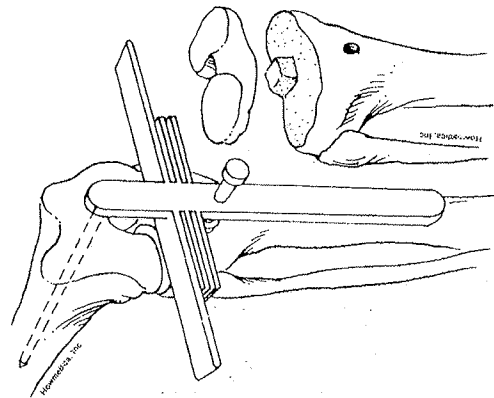


Figure 23. Tibial cutter in place for cutting of proximal tibia.

slot as outlined on the jig. A horseshoe-shaped piece is removed from the proximal tibia taking care not to destroy the insertion of the cruciate ligaments. The jig is then removed and the remaining portion of the osteotomy is completed under visual control.

The jig #3 (femoral cutter jig) is then placed in the inner space created by the two osteotomies (Fig. 24). The knee is then extended and proper axial alignment is obtained by aligning the tibia to the long handle of the instrument. With the knee in full extension and a distal distraction force on the handle of the jig, a transverse osteotomy is made in the distal femur perpendicular to the long axis of the femur. This osteotomy is accomplished with a reciprocating saw or a narrow osteotome. The knee is now flexed to 90 degrees with the same instrument in place. Dye is used to mark the appropriate slots in the proximal tibia. The instrument is now removed and the slots are cut with a saw or thin osteotome.

The jig #4 (long alignment jig) is then placed into the osteo-

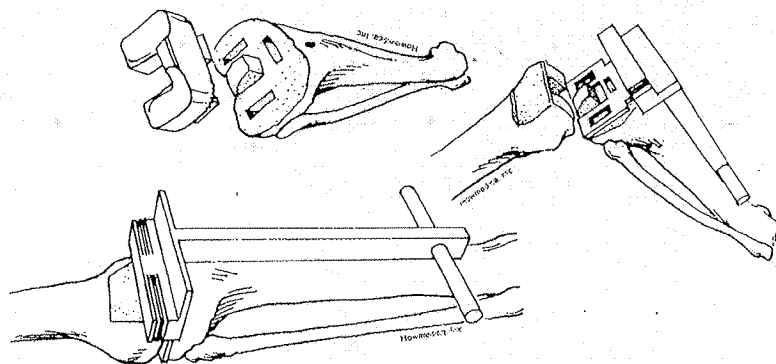


Figure 24. Transverse osteotomy of distal femur.

tomized joint space and the overall alignment is checked (Fig. 25). This can be done either with the thin or the thick jig in place depending upon the desired size of the tibial implant. Minor adjustments can be made at this time for overall alignment.

Replacement of the patellar articular surface is considered optional. A patellar implant is available and can be implanted into a three-eighths

inch drill hole in the middle of the articular side of the hemisected patella. Surgical Simplex P Bone Cement is used to secure the implant which is held in place with firm digital pressure.

The wound is now irrigated repeatedly with antibiotic irrigating solution. The trial tibial and trial femoral implants are then inserted and the knee is taken through an arc of motion to check its alignment and stability. Once satisfied that this is adequate, both trial implants are removed and the prepared surfaces are carefully cleaned and dried. One package of Surgical Simplex P Bone Cement is then mixed and placed into the dried, prepared tibial bed. The tibial implant is then inserted with the tibia held manually with the knee in a position of 90 degrees of flexion. Excess cement is removed and tibial cement is allowed to cure completely. The femoral implant is then placed in its bed and a trial reduction is completed. The femoral implant is removed and its prepared bed is carefully cleaned and dried. One package of Surgical Simplex P Bone Cement is then prepared and placed into the prepared femoral bed. The femoral implant is then placed into position and excess cement is cleared from around the perimeter of the implant. The knee is then fully extended to allow a last check on the overall alignment.

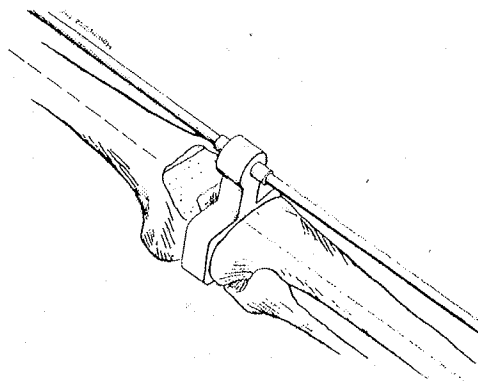


Figure 25. Checking of overall alignment.

ment of the implants. It is important that the knee be fully extended when implanting the femoral implant, but it is not advised that the knee be extended against pressure when implanting the tibial implant. Excess cement is then removed and the extremity is held in full extension until the cement is completely cured.

The knee is again flexed and irrigated with copious amounts of antibiotic solution. All osseous and acrylic debris are carefully removed. The knee is then placed in full extension and the wound is closed in the usual fashion. Suction drainage is recommended. Sterile dressings are applied and a long leg cast is applied with the knee in full extension. The cast is ordinarily bi-valved in the Operating Room or in the Recovery Room.

REFERENCES

1. Ferguson M: Excision of the knee joint. Recovery with a false joint and a useful Limb. *Med Times GA2*: 1:601, 1861
2. Apley AG: Arthroplasty of the knee. In: *Modern Trends in Orthopedics*. London, Butterworth E. Comp. Ltd. 1972
3. Murphy JB: Arthroplasty. *Ann Surg* 57:593, 1914
4. Baer WS: Arthroplasty with the aid of animal membrane. *Amer J Orthop Surg* 16: 171, 1918
5. Platt G and Pepler E: Mold arthroplasty of the knee. A ten year follow-up study. *J Bone Joint Surg* 41B:76-87, 1959
6. Campbell WE: Arthroplasty of the knee. Report of cases. *Amer J Orth Surg* 19: 430, 1921
7. Albee FH: Original features in arthroplasty of the knee with improved prognosis. *SC&O* 47: 312, 1928
8. Samson JE: Arthroplasty of the knee joint. *J Bone Joint Surg* 31B:50, 1949
9. Brown JE, McGraw WH, Shaw, DT: Use of cuts as an interposing membrane in arthroplasty of the knee. *J Bone Joint Surg* 40A:10030, 1958
10. Kuluns JG and Porter TA: Nylon arthroplasty of the knee joint in chronic arthritis. *SC&O* 91:851, 1950
11. Campbell WC: Interposition of vitallium plates in arthroplasties of the knee. Preliminary Report. *Am J Surg* 47:639, 1940
12. Jones WN, AuFranc OE and Kermond WL: Mold arthroplasty of the knee. *J Bone Joint Surg* 49A:1022, 1967
13. Coventry MB: Osteotomy of the upper portion of the tibia for degenerative arthritis of the knee. *J Bone Joint Surg* 47A:984-990, 1965
14. Jackson JP, Waugh W, Green, JP: High tibial osteotomy for osteoarthritis of the knee. *J Bone Joint Surg* 51B:88-94, 1969
15. Jackson JP, Waugh W: Tibial osteotomy for osteoarthritis of the knee. *J Bone Joint Surg* 43B:746-751, 1961
16. Devas MB: High tibial osteotomy for arthritis of the knee. A method suitable for the elderly. *J Bone Joint Surg* 51B:85-98, 1969
17. Evans CM, DeHaven K, Nelson CL: Proximal tibial osteotomy for degenerative arthritis of the knee. *OCNA* 2:231-243, 1971
18. Macintosh DL and Hunter GA: The use of the hemi-arthroplasty prosthesis for advanced osteoarthritis and rheumatoid arthritis of the knee. *J Bone Joint Surg* 54B: 244-255, 1972
19. McKeever DE: Tibial plateau prosthesis. *Clin Ortho* 18:86, 1960
20. Judet J, Judet R and Crepin G RIGAUDO: Easis de Prothese Osteoarticulaire. *Presse Med* 52:302, 1947
21. Judet J, Judet R, LaGrange J, Dunover J: In Misen KI, Livingston O (eds): *Resection-Reconstruction of the Hip. Arthroplasty with an acrylic prosthesis*. London, E&S, 1954
22. Walldius B: Arthroplasty of the knee joint using an acrylic prosthesis. *ACTA Orthop Scand* 23:121, 1953
23. Walldius B: Arthroplasty of the knee using endoprosthesis. *ACTA Orthop Scand Supp* 24, 1957
24. Walldius B: Arthroplasty of the knee using an endoprosthesis. *ACTA Orthop Scand* 30: 137-148, 1960
25. Coventry MB, Finerman GA, Riley LH, Turner RH, Upshaw JE: A new geometric knee for total knee replacement. *Clin Ortho* 83: 157, March-April, 1972
26. Coventry MB, Upshaw JE, Riley LH, Finerman, GAM, Turner RH: Geometric total knee arthroplasty II. Patient data and complications. *Clin Ortho Rel Res* No. 94, 177, July-August, 1973
27. Turner RH: Geometric total knee replacement. AAOS, instructional course lectures
28. Coventry MB, Bryan RS: Technical pitfalls in the polycentric and geometric total knee arthroplasties. Paper read at the joint meeting of the Institution of Mechanical Engineers and the British Orthopedic Association Conference on Total Knee Replacement, London, Sept. 16-18, 1974
29. Insall John N, Ranawat Chitranjan S, Aglietti Paolo, Shive J: A Comparison of four Models of total knee replacement prostheses. *J Bone Joint Surg* Vol 58-A, No. 6, 754, Sept. 1976
30. Kettelkamp DB, Nasca R: Biomechanics and knee replacement arthroplasty. *Clin Ortho* 94: 8-14, 1973
31. Potter JA, Weinfeld MS and Thomas WH: Arthroplasty of the knee in rheumatoid arthritis and osteoarthritis. *J Bone Joint Surg* 54A: 1-24, 1972
32. Putti V: Arthroplasty. *Amer J Ortho Surg* 19:421, 1921
33. Shiers LG: Arthroplasty of the knee. Interim report of a new method. *J Bone Joint Surg* 42B:31-39, 1960
34. Shiers LG: Arthroplasty of the knee. Interim report of a new method. *J Bone Joint Surg* 42B:31-39, 1968
35. Wilde AH, Collins, HR, Evans CM, Greenwald AS, DeHaven KE, Bergfeld JA: Report on the geometric knee prosthesis. *Conr Surg* Vol. 6, p. 37, Jan. 1975
36. Young HH: Use of a hinged vitallium prosthesis for arthroplasty of the knee. A preliminary report. *J Bone Joint Surg* 45A:1627-1612, 1963