INDICATIONS, TECHNIQUES AND RESULTS OF TOTAL HIP REPLACEMENT IN THE UNITED STATES

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SUMMARY

Sir John Charnley ushered in the era of total hip replacement over 50 years ago. His innovations of polymethylmethacrylate fixation of implants, polyethylene/metal bearing surfaces, standardized instrumentation, and clean air operating rooms revolutionized previous attempts to replace arthritic hips. In the United States, Charnley's principles and implants were adopted, investigated, and modified as they have been in most countries. His basic concepts and techniques remain valid, however, and total hip replacement is widely regarded as one of the most successful procedures in orthopaedic surgery. Over 400,000 hip replacements are now performed annually in the United States.

Key words: Hip replacement, total hip, arthroplasty, femoral implants.

INDICATIONS FOR TOTAL HIP REPLACEMENT

The accepted indications for total hip replacement changed and expanded over the years. An operation intended as a salvage procedure in elderly, low demand patients has evolved to being the preferred surgery for a wide variety of pathological conditions of the hip. The primary indication for THR remains endstage osteoarthritis. With our aging population in the United States suffering from an epidemic of obesity (recent estimates that one third of the American population is obese with a body mass index of greater than 30), the prevalence of primary osteoarthritis has markedly increased. When nonoperative care, including weight reduction, activity modification, ambulatory aides, and nonsteroidal anti-inflammatory medications, fail to relieve the pain and disability of endstage osteoarthritis, total hip replacement offers a highly predictable treatment.

Inflammatory arthritis, principally from rheumatoid disease, historically has been another common indication of THR. Since the introduction of disease modifying anti-rheumatic medications several decades ago, however, the prevalence of advanced rheumatic destruction of the hip joint has decreased. Post-traumatic arthritis following fractures and/or dislocations of the acetabulum and proximal femur remain a frequent indication for THR.

Osteonecrosis with segmental collapse of the femoral head is an all too common indication for total hip replacement. With the widespread use of corticosteroids for numerous medical conditions, the high rate of alcoholism in the general population, and the increasing number of HIV patients on highly active antiretroviral medications, the incidence of osteonecrosis has increased in the United States as well as in many other industrialized countries.

Displaced fractures of the femoral neck in patients older than 60 years have become another common indication for THR. Several large retrospective studies as well as randomized clinical trials demonstrate that THR provides better functional outcomes and fewer complications compared to traditional techniques of internal fixation or hemiarthroplasty for displaced femoral neck fractures.

Less frequent indications for THR include primary or metastatic tumors of the hip joint and the residua of post-infectious arthritis.

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TECHNIQUES IN TOTAL HIP REPLACEMENT

The surgical technique in total hip replacement evolved over the last 50 years. While traditional Charnley cemented components remain popular in the United Kingdom and much of Europe, most surgeons in the United States currently use noncemented implants only. More importantly, the types of bearing surfaces changed dramatically, especially in the last 10-20 years.

ACETABULAR COMPONENTS

All orthopaedic centers now utilize strictly non-cemented acetabular cups (1). Indeed, most young orthopaedic surgeons do not know how to implant cemented acetabular cups in index arthroplasties. Noncemented hemispherical cups differ in design with variable microporous or plasma spray surfaces for osteointegration of new bone. Immediate fixation can be provided by spikes, fins, or screws on the cup. Whenever technically feasible, solid cups without screw holes are preferred so as to lessen the liner wear and diminish the effective joint space for spread of osteolysis.

Cup positioning is critical for a stable prosthesis. Ideally, cup anteversion should be from 10 to 30 degrees, and cup inclination from 40 to 50 degrees off the horizontal. Outliers from these preferred positions may predispose to dislocation and/or increased polyethylene wear. Accurate cup positioning may be achieved using body surface landmarks, intraoperative landmarks (e.g., the transverse acetabular ligament) or computer navigation.

In the last five years, trabecular metal coated cups have gained popularity in both primary and revision arthroplasties. The tantalum microporous dimensions of trabecular metal provide both an ideal roughened surface for immediate stability with trabecular bone as well as pore dimensions for rapid osteointegration of the implant.

FEMORAL COMPONENTS

Femoral implants have undergone a similar evolution in design over the last 20 years. While cemented femoral stems are occasionally used (hybrid arthroplasty), noncemented stems now constitute around 80-90% of the market (2). Most modern noncemented femoral stems share a common generic design including

1) Titanium metal composition with its favorable elastic modulus,
2) A double or triple wedge configuration allowing for both immediate fit and fill of the medullary canal and minimal early subsidence for stability,
3) A straight, collarless design,
4) Multiple available sizes,
5) Modularity for use in patients with significant proximal femoral deformity,
6) Proximally, circumferentially coated surfaces with micropores between 100 and 600 microns,
7) Precise instrumentation for insertion through small incisions,
8) Variable offset necks for precise restoration of the abductor moment arm, and
9) Optional hydroxyapatite coating of the porous surface for enhanced osteointegration. Despite these widely-used, common design features, numerous other stem designs are marketed in the United States.

BEARING SURFACES

The primary long-term mode of failure of THR historically has been abrasive polyethylene wear resulting in osteolysis and subsequent component loosening (figure 1). Technological advances have led to the introduction of three potential solutions to this clinical problem.

First, highly cross linked polyethylene was first clinically used approximately 10-15 years ago (3). Both in laboratory testing and early clinical experience, its abrasive wear properties are 5-10 times better than conventional polyethylene. This biomechanical improvement along with changes in the sterilization, packaging, and storage of the polyethylene markedly enhances its longevity. Multiple recent, well documented studies of metal or ceramic on highly cross linked polyethylene demonstrate at an average of 10 years negligible wear and no osteolysis, even in highly active younger patients (3).

Second, metal on metal (MOM) bearing surfaces were reintroduced in Europe and then the United States for both resurfacing arthroplasty and conventional THR. In theory, the MOM surface creates less volumetric wear and thus, less osteolysis compared to metal on polyethylene. After initial favorable results in the United States, it use explanded to the point where 5 years ago, 35% of all bearing surfaces used were MOM. At that point, however, multiple arthroplasty registries and individual clinical trials reported higher failure rates with MOM surfaces both in resurfacings and primary THR using large diameter heads (4,5). A new complication of metallosis with adverse local tissue reactions (ALTR) and high metal ion

FIGURE 1. BILATERAL TOTAL HIP REPLACEMENT

Figure 1. Twenty year followup pelvis radiograph in a 65 year old female with bilateral total hip replacements for moderate acetabular dysplasia and osteoarthritis. Her functional status bilaterally is excellent though the radiographs demonstrate moderate linear wear of her conventional polyethylene liners.