INTRODUCTION

The purpose of this paper is to compile a complete overview of hip replacements. It will include numerous aspects including: history, frequency, industry, costs, causes, techniques, products, success, failure, and the future of hip replacements. Primarily the paper will focus on the practical applications rather than medical techniques.

Hip replacement surgery has helped thousands of people regain a productive and enjoyable lifestyle. Although hip surgery has not always been the sophisticated science it is today. In fact one of the first complete attempts at hip arthroplasty occurred in 1890 when a physician, Dr. Sluck, replaced the head of a patient’s femur with an ivory ball. (Mraz, p.88) Since this first crude surgery medical and technological advances have dramatically increased the success rates of hip surgery.

There will be over 188,000 complete hip replacements performed this year in the United States, and the rate is increasing rapidly (Biomet, P.15). Consequently, growth within the orthopedic industry is phenomenal. This growth is fueled by the industries commitment to the research and development of new products and procedures in order to further improve the implantation process.

MATERIALS FOR PROSTHESIS

Some sixty years after the first attempted hip arthroplasty, Austin Moore made one of the most important advances in hip prosthesis. He properly assumed that an artificial femoral head with a slightly curved stem could be anchored in the intermedullary section or marrow, of the femur to give more mechanical support to the head (Mraz, p.89). Various modifications of his original design are still in use today. Once the problem of the general shape of implant was solved, yet another issue needed to be addressed.
What materials would best be suited for human hip implantation? During the “primitive” days of hip prosthesis stainless steel was appealing although it lacked sufficient strength, and many broke after implantation. As a result, engineers worked on better methods of casting and forging sturdier cobalt-chrome alloys. Titanium alloys are also used in hip implants. Some engineers believe titanium is superior to cobalt-chrome alloys because its stiffness is closer to that of bone. Titanium is also prescribed for patients hypersensitive to chromium.

Obviously, metal on metal could never replace the near frictionless ball and socket joint of the hip. Therefore, in 1961 high density polyethylene was combined with titanium to fabricate a complete hip joint replacing teflon which wore poorly and proved reactive in the human body. Polyethylene allows proper lubrication in acetabular components, provides excellent weight-bearing properties, and is biocompatible. Despite some studies showing polyethylene liners decreased in thickness by 1 mm a year, it remains the material of choice in modern hip replacements (Brand, P. 173). Some engineers are now adding carbon fibers to the polyethylene to increase its wearing properties.

High-performance plastic composite may lead to a device to replace metal-hip components. A rigid metal stem can, in some patients, cause long-term problems. If bone tissue is not used and stressed, it tends to decrease in size and strength. A rigid rod down the middle of the bone can shield the bone from stress. This transmits loads from walking and climbing stairs down the metal rod. As a result, the stress substantially bypasses the bone, leading to bone resorption. With time, the bone around the implant may weaken (Zimmer, P. 32). The composite prosthesis design should allow enough strength to meet expected loads, but have enough flexibility to transfer the load to the material bone.
INDICATIONS FOR TOTAL HIP REPLACEMENT

Do to the major risks of a surgery of type, total hip replacement should be limited to patients with substantial pain or marked functional disabilities. Most commonly these disabilities are caused by advanced osteoarthritis and rheumatoid arthritis. There are however less common problems of the hip which may require surgery including: Paget's disease, ankylosing spondylitis, avascular necrosis and epiphyseal dysplasia. In addition, surgery should only be performed if nonsteroidal antiinflammatory medications, weight reduction, limitation of vigorous activities, or periodic use of cane has not provided acceptable relief (Brand, p.59). Patients over the age of 60 are the best candidates for this surgery, because both longevity and demand on the prosthesis is reduced. An operation of this sort is surely nothing rush into, especially when considering the $10,000 operating cost and ten day hospital stay.

CEMENT VS. PRESS FIT

There are only two widely accepted methods for securing hip replacements in place, polymethyl methacrylate cement (pmma) and press-fitting. Currently, there is a debate among surgeons and medical experts regarding which method is best and under which situation. Today over half of the components inserted in the United States are of the porous cementless type (Mraz, p.90).

Surgeons performing cemented total hips replacements can expect success rates of over 90%. Patients of cemented replacements can begin putting weight on their new hip after only short postoperative recovery period. There is also less pain associated with cemented hip replacements. Conversely, recipients of cementless prosthesis could experience thigh pain for up to a year post operatively.

The results that modern cemented implants enjoy can be attributed to advances
made in bone preparation cement mixing, and the prosthetic itself. Macrotexturing of the prosthetic adds precise grooves and ridges designed to increase bonding with the cement and to better distribute loads. New methods of cleaning and drying the femoral cavity increase the bond between the bone and the cement. Vacuum mixing has been found to ensure the bone cement has a smooth uniform, texture with a minimum of trapped air. Cement also compensates for any unexpected error while forming the femoral cavity in which the prosthesis will be seated.

Unfortunately, cemented hip implants do harvest some disadvantages. These problems are long term and often do not surface for 10 to 15 years. Cemented implant techniques requires significantly more bone tissue removal than cementless techniques. The proponents of cementless prosthetics point out that leaving more bone tissue in tact allows the bone to function more normally. The Pmma layer, they argue, inhibits further bone growth and might actually cause bone tissue to die. This can lead to loosening of the device. Up to 50% of the patients who received cemented devices 10 to 15 years ago are experiencing such loosening (Mark, p. 536).

If loosening of the prosthesis occurs revisionary surgery is needed. This forces the surgeon to take out the old prosthetic and cement and then prepare the femur for another implant, thus causing even more bone removal. When revisionary surgery in a cementless device is called for, loss of bone tissue is not as great.

Medical experts hope press-fitting implants will promote bone growth (or ingrowth), allowing the patients to more fully recover, and eliminate the need for revisionary surgery. Patients under the age of 65 usually receive press-fit implants, and patients over 65 almost always receive cemented implants.

The decision weather to use cement or press-fit implants is always made by the surgeon. Factors such as age, weight, sex, and health of the patient are taken into account along with the surgeon’s own experience and preference. In general, age is the deciding factor.
COMPLICATIONS

As with any surgery of this magnitude, hip replacement may breed several complications. The most prevalent complications include the loosening of one or more components, nerve damage from surgery, dislocation of the hip, fracture of the femur, and deep wound infection. The results of primary total hip replacement are good or excellent for most of the patients, whereas about 5 percent have serious complications, most self-resolving or correctable (Brand, p.136).

Over time the components may fail to remain fixed to the skeleton. The predominant failures are the fragmentation of the methyl methacrylate (bone cement) and its associated bone lysis, and the wearing out of the high-density polyethylene (the weight bearing material) and the bone lysis associated with its particles. These specific loosening lead to surgical revision. Unfortunately, revisions have a dramatically worse prognosis than the primary operations, with up to one third of the components becoming loose again.

Generally the other complications do not create significant problems, and can be rectified with minimal treatment and time. Although a high incidence of deep-wound infection, up to 13 percent in the 1970's, became a severe complication associated with these massive implants in the early years of total hip replacement surgery. Since then it has effectively been curtailed with an array of approaches, varying from more intensive application of conventional aseptic techniques and the routine use of prophylactic antibiotic agents to the use of "hi-tech" laminar-airflow operating room enclosures, which assure a sterile environment (Brand, p.128).

No extensive surgery can assure that no complications will arise, but we can learn valuable lessons from the ones that do. By properly learning from these adverse events we may be able to deter them from happening during future procedures. Eventually, surgical complications form hip replacements will become almost
nonexistent.

**REHABILITATION**

Rehabilitation after the ordinary total hip replacement is lengthy but not unusually demanding. Although, boney ingrowth usually requires a longer period of protected weight-bearing. Patients generally use two crutches for 6 to 12 weeks and then make a gradual transition over a period of 1 to 2 months to walking well without crutches or a cane. Most patients require at least three to five months to regain full strength and energy.

Immediately after surgery patients must begin working on range of motion (ROM). Today weight bearing is stressed as soon as possible after cemented procedures. This not only builds leg strength and ROM, but it also prevents further bone resorption. Recipients of total hip arthroplasties are also instructed to do exercises to increase strength of hip flexors, knee extensors, hip abductors, and the quadriceps.

Gains in strength, ROM, and activity level are unique to every different patient, and success rates can very dramatically. Some patients may even be able to tolerate such activities as doubles tennis and cycling while others may hardly be able to walk without a cane. Even with very good surgical results physicians ask most recipients to refrain from running and jogging (Nash, p.180).

In summary, the results of total hip replacement during the past ten years show a high rate of success, and presumably the most recent improvements will extend this success for substantially longer periods. Although a controversy of which method, cemented or press-fitting, is best and under which circumstances still exists. The most significant problem is related to the longevity of the prosthesis and implantation techniques. Total hip replacement can result in dramatic relief of pain, good or
excellent restoration of function, and relatively few complications considering the magnitude of the surgery. Nevertheless, to date even the most sophisticated prosthesis with the best techniques can never replace the "God-given" original hip joint.
TOTAL HIP REPLACEMENT PROCEDURES UNITED STATES

PROcedures (Thousands)

YEAR


135 155 170 188 200

BIOMET ESTIMATES
References


3. Design News: Doctors/Robots Team up to Implant: P. 34-35, August 1, 1988


