Total hip replacement in young adults

Thesis

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Abstract

Total hip replacement is very effective procedure to relieve the pain and disability in young active patients.

This study reports our initial experience of THR in young patients below 30 years old regarding the functional outcome and complications.

Twenty-eight patients (30 hips) were included in the study their age ranged between 18-26 years old. All were Cairo University students.

The follow up ranged between (6-24) months. The clinical evaluation of the cases in the study depends on Harris hip score.

This study showed the excellent results of cementless alumina ceramic on ceramic THR in young active patients due to its superior wear character.

The future of ceramic on ceramic THR appears to be extremely promising in young active patients.

Key words:

-Total hip replacement

-Harris hip score

-Ceramic on ceramic

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AML	Anatomic medullary lacking
AVN	Avascular necrosis
BHR	Bir mingham hip resurfacing
Ca HAP	Calcium hydroxyl appatite
CAS	Computer assisted surgery
CBC	Complete blood count
COC	Ceramic on ceramic
COXP	Ceramic on cross linked polyethelene
CRP	C-reactive protien
DDH	Developmental dysplasia of the hip
DVT	Deep venous thrombosis
ESR	Erythrocyte sedimentation rate
HA	Hydroxyappatite
HDPE	High density polyethelene
HHC	High hip centre
HHS	Harris hip score
LFA	Low friction arthroplasty
Lt.	Left
MOM	Metal on metal
MOP	Metalon polyethelene
PE	Polyethelene
Rh.Ar.	Rheumatoid arthritis
Rt.	Right
Sys.Lup.	Systemic lupus erythromatosis
TAL	Transverse acetabular ligament
THA	Total hip arthroplasty
UHMWPE	Ultra high molecular weight polyethelene

Introduction

Total hip arthroplasty is one of the most successful and cost-effective surgical interventions in medicine ***(Malchau etal, 2000)*** and is the most effective treatment for osteoarthritis of the hip joint. On the basis of this success, total hip replacement is being performed on increasingly younger and more active patients. However, there are at least two problems that a young or active patient faces with regard to the prosthetic joint. First, the use of the implant is more intense in proportion to their physical activities Second, the patient's life expectancy is longer and the potential total number of loading cycles is increased proportionally ***(Schmalzried etal, 2000)***.

Improvements in manufacturing processes have led to the near elimination of catastrophic component fracture resulting from corrosive and noncorrosive fatigue. Consequently, from the overall successful outcome of primary THA, a dramatic reduction in the conservative application of these surgical procedures has resulted in a growing application of THA in younger and more active individuals***(Silva etal, 2002)***.

The primary concern of patients with longer life expectancies and of patients who are younger and more active is the longevity of their THA. Annual reports of the Swedish Hip Arthroplasty Registry ***(Eskelinen etal, 2006)*** consistently document among patient-related risk factors young age (i.e., younger than 50 years) substantially reduces the survival of all types of primary THAs. The Maurice E. Muller Research Center in Orthopaedic Surgery at the University of Bern reported the risk of aseptic stem loosening increases by 1.8% for each year of age reduction at the time of index surgery ***(Munger etal, 2006)***.

High activity level is highlighted worldwide as the major factor affecting prosthetic reconstruction durability as a result of conventional polyethylene (PE) wear. Even in a center of excellence, cemented fixation of the THA using low friction arthroplasty (LFA), considered worldwide as a gold standard, cannot achieve a long-lasting outcome. In patients younger than 30 the best results have been reported with the Kerboull cemented hip, providing 85.4% ± 5% survival at 20 years ***(Ziaee etal, 2007)***.

At worst, in patients younger than 30 years of age, the Wrightington survival were 76% at 20 years and none of the cups with a wear rate greater than 0.2 mm per year survived 25 years ***(Vervest etal, 2005)***. However, activity level varies considerably between patients of the same age class (body mass index, type of work, sports, and leisure activities) ***(Milosev etal, 2006)*** Moreover, younger candidates for THA are not normally active as a result of the etiology of their disease (eg: juvenile arthritis, avascular necrosis, or developmental dysplasia of the hip) ***(Kerboull etal, 2004)***. Obviously, cemented fixation of low-friction torque metal-on-PE THA in younger active patients does not achieve the goal of longevity. Most studies hypothesized cementless fixation and hard-on-hard bearings could improve THA survival in a highly active patient population***(Kerboull etal, 2004)***.

Historical overview

Total hip joint replacement is an orthopaedic success story enabling hundreds of thousands of people to live fuller, more active lives.

Using metal alloys, high-grade plastics and polymeric materials orthopaedic Surgeons can replace a painful dysfunctional joint with a highly functional long lasting prosthesis.

Over the past half-century there have been many advances in the design, construction and implantation of artificial hip joints resulting in a high percentage of successful long term outcomes.

The earliest recorded attempts at hip replacement which were carried out in Germany used ivory to replace the femoral head (the ball on the femur) Ivory may have been used because it was cheaper than metal at that time and also was thought to have good biomechanical properties including biological bonding of ivory with the human tissues nearby ***(Gluck, l890)***.

In 1940 at Johns Hopkins hospital, Dr. Austin T. Moore (1899-1963) an American surgeon reported and performed the first metallic hip replacement surgery. The original prosthesis he designed was a proximal femoral replacement with a large fixed head made of Cobalt chrome alloy vitallium. It was about a foot in length and it bolted to the resected end of the femoral shaft. A later version of Dr. Moore's prosthesis the so-called Austin Moore developed in Columbia was introduced in 1952 is still in use today ***(Moore, 1957)***.

Like modern hip implants it is inserted into the medullary canal of the femur. It depends on bone growth through a hole in the stem for long term attachment.

In the 1950s Dr. Charnley reported and performed a replacement joint known as the Low Friction Arthroplasty with a small diameter prosthetic head lubricated with synovial fluid. The small femoral head (7/8" (22.2 mm) was chosen for Dr. Charnley's belief that it would have lower friction against the acetabular component and thus wear out the acetabulum more slowly. Unfortunately, the smaller head dislocated more easily.

Alternative designs with larger heads such as the Mueller prosthesis were proposed. Stability was improved but acetabular wear and subsequent failure rates were increased with these designs ***(Charnley, 1960)***.

The Teflon acetabular components of Dr. Charnley's early designs failed within a year or two of implantation. This prompted a search for a more suitable material. A German salesman showed a polyethylene gear sample to Dr. Charnley's machinist, sparking the idea to use this material for the acetabular component. The Ultra High Molecular Weight Polyethylene or UHMWPE acetabular component was introduced in 1962. By Dr. Charnley's and others major contribution was to use polymethylmethacrylate (PMMA) bone cement to attach the two components to the bone ***(Charnley , 1964***).

For over two decades, the Charnley Low Friction Arthroplasty, and derivative designs were the most used systems in the world. It formed the basis for all modern hip implants. The Exeter hip stem was developed in the United Kingdom during the same time as the Charnley device. This is also a cemented device, but with a slightly different stems geometry. Both designs have shown excellent long-term durability when properly placed and are still wisely used in slightly modified versions. Early implant designs had the potential to loosen from their attachment to the bones, becoming painful typically ten to twelve years after placement. In addition to the devices loosening, erosion of the bone around the implant was seen on x-rays ***(Charnley, 1970***).

Initially surgeons believed this was caused by an abnormal reaction in response to the cement holding the implant in place. That belief prompted a search for an alternative method to attach the implants. The Austin Moore device had a small hole in the stem into which bone graft was placed before implanting the stem. It was hoped bone would then grow through the window over time and hold the stem in position. Success was unpredictable and the fixation not very robust.

In the early 1980s, surgeons in the United States applied a coating of small beads to the Austin Moore device and implanted it without cement. The beads were constructed so that gaps between beads matched the size or the pores in native bone. Over time, bone cells from the patient would grow into these spaces and fix the stem in position. The stem was modified slightly to fit more tightly into the femoral canal, resulting in the Anatomic Medullary Locking (AML) stem design ***(Spector, 1987)***.
With time, other forms of stem surface treatment and stem geometry have been developed and improved. Initial hip designs were made of a one-piece femoral component and a one-piece acetabular component.

Current designs have a femoral stem and separate head piece. Using an independent head allows the surgeon to adjust leg length (some heads seat more or less onto the stem) and to select from various materials from which the head is formed. A modern acetabulum component is also made up of two parts: a metal shell with a coating for bone attachment and a separate liner. First the shell is placed. Its position can be adjusted, unlike the original cemented cup design which is fixed in place once the cement sets***(Bateman, 1990)***. When proper positioning of the meal shell is obtained, the surgeon may select a liner made from various materials. To combat loosening caused by polyethylene wear debris, hip manufacturers developed improved and novel materials for the acetabular liners. Ceramic heads mated with regular polyethylene liners or a ceramic liner was the first significant alternative metal liners to mate with a metal head were also developed. At the same time these designs were being developed, the problems that caused polyethylene wear were determined and manufacturing of this material improved ***(Bateman, 1990)***.

Highly-cross linked UHMWPE was introduced in the late 1990s. The most recent data comparing the various bearing surfaces has shown no clinically significant differences in their performance. Performance data after 20 or 30 years may be needed to demonstrate significant differences in the devices. All newer materials allow use of larger diameter femoral heads. Use of larger heads significantly decreases the chance of the hip dislocation, which remains the greatest complication of the surgery. To date, when currently available implants are used, there is no demonstrable difference in performance of cemented versus uncemented stems, and no significant difference in the clinical performance of the various methods of surface treatment of uncemented devices. Uncemented stems are selected for patients with good quality bone that can resist the forces needed to drive the stem in tightly. Cemented devices are typically selected for patients with poor quality bone who are at risk of fracture during stem insertion. Cemented stems are less expensive due to lower manufacturing cost, but require good surgical technique to place them correctly. Uncemented stems can cause pain with activity in up to 20% of patients during the first year after placement as the bone adapts to the device. This is rarely seen with cemented stems ***(Boden et al., 2006).***

Anatomy

The hip is a ball and socket joint in which stability is obtained by the bony configuration combined with a complex system of muscles and ligaments around the joint *(Fig 1)*.
The femoral head diameter averages about 46mm. Two critical angular relationships of the femoral neck with the shaft include the neck shaft angle which averages 130 degrees and the femoral anteversion angle which averages 12degrees ***(D'Ambrosia, 1986)***.

Femoral neck version is the angle of the femoral neck with the intercondylar plane. The hip joint contribution to lower limb length is the vertical distance from the femoral head centre to the lesser trochanter. Femoral offset is the horizontal distance from the midline of the longitudinal axis of the femur and the centre of rotation of the femoral head) **(Kapandji, 1970).**

Femoral head diameter is normally at least 1.2 times the neck diameter. Anterior impingement may result with lesser ratios. Acetabular anteversion is the amount of forward flexion of the acetabulum as measured from lateral to medial with reference to the sagittal plane and averages about 15 degrees ***(Williams and Williams, 1985)***.
The acetabular abduction angle is the relationship of the line extending from the anteromedial and super lateral extents of the acetabulum with the horizontal. The acetabulum averages 15 degrees of anteversion and 45 degrees of abduction) ***(Sariali etal, 2009)***.