Maturitas 75 (2013) 221–226

Contents lists available at SciVerse ScienceDirect

Maturitas

journal homepage: www.elsevier.com/locate/maturitas

Review

Hip replacement: Landmark surgery in modern medical history

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ARTICLE INFO

Article history:
Received 16 April 2013
Accepted 21 April 2013

Keywords:
Total hip replacement
Osteoarthritis
Hip replacement

ABSTRACT

Total hip replacement (THR) is most often performed to treat end-stage symptomatic osteoarthritis. Patients typically present with increasing pain, restricted mobility and stiffness. In this procedure, the femoral head and part of the femoral neck are excised. The acetabulum is enlarged and an acetabular cup is inserted. The femoral head is replaced by a femoral component, the stem of which is inserted into the medullary canal of the femur. The components can be either cemented in place or press-fit (cementless). The THR concept was popularised by Sir John Charnley in the 1960s and although, over half a century of development has resulted in incremental improvements, the procedure is not dramatically different from the one he described. However, over the last two decades there have been significant changes in the types of bearing surfaces used. Metal on polyethylene continues to be the workhorse for the majority of cases. In the young and active, bearing surfaces with low wear rate are increasingly used. Since the early 1960s, THR has played an important role in alleviating pain and restoring mobility to millions of people. The cost-effectiveness of THR in treating advanced osteoarthritis makes it one of the most successful of all surgical interventions.

Contents

1. Introduction

The hip joint is a synovial ball and socket joint where stability is provided by the close-fit of the spherical femoral head with the cup-shaped acetabulum. The joint's stability is further enhanced by the joint capsule and ligaments which are reinforced by large muscle groups [1]. The hip joint supports a load exceeding three times body weight during level walking [2].

Total hip replacement (THR) is most often carried out to treat symptomatic end-stage primary osteoarthritis. Other indications include osteonecrosis (2%), femoral neck fracture (2%) and developmental dysplasia of the hip (2%) [3]. Rheumatoid arthritis, which formed a significant proportion of the early series of THR, now accounts for less than 1% [4] This is due to the remarkable success of medical treatments for rheumatoid disease.

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http://dx.doi.org/10.1016/j.maturitas.2013.04.011

The aim of this review is to discuss the role of THR in the management of hip pathology and in particular osteoarthritis. Included are summaries of the procedure, the different types of THR and outcomes associated with this surgery. In addition, the early development of THR and future perspectives are briefly discussed.

2. Osteoarthritis

Joint pathology, consistent with osteoarthritis, has been identified in Saxon [5], Mediaeval [5] and Roman [6] populations found on archaeological excavations in Britain. Osteoarthritis (OA) is not a single disease or process, but rather the clinical and pathological outcome of a range of disorders characterised by structural, and eventually symptomatic, failure of one or more synovial joints [7]. It is estimated that as many as 40% of people aged 65 and over have symptomatic OA of the knee or hip [8,9].

Pain is the predominant symptom of OA. The progression of pain within OA of the hip is variable; patients often describe pain that varies over time rather than a continuous deterioration [1,10]. The advanced stage of OA is characterised by severe pain that disrupts sleep. Ambulation becomes markedly diminished, and the use of analgesics is increased. Individuals will have limitations that impair their ability to perform activities of daily living (ADLs), such as walking, bathing, dressing, use of the toilet, and performing household chores [11]. On radiographs, the joint space is obliterated, with sclerosis, osteophytes and subchondral cyst formation [1]. The most common sites of pain are the groin, the anterior and lateral thigh, the buttock and the knee [12]. Occasionally, knee pain predominates, and misdiagnosis and investigation of the knee may delay diagnosis and treatment.

Although the causes of OA are not completely understood, biomechanical stresses affecting the articular cartilage and subchondral bone, biochemical changes in the articular cartilage and synovial membrane, and genetic factors are all important in its pathogenesis [11].

More than 50 modalities of non-pharmacological, pharmacological and surgical therapy for knee and hip OA are described in the medical literature [13]. Surgical interventions that are alternatives to THR include administration of intra-articular steroid and local anaesthetic, soft tissue releases, acetabular/femoral osteotomy, arthrodesis and arthroscopy. The aim of these procedures is to relieve pain and delay or halt further degenerative changes, negating the need for THR or delaying the age at which there is no other option [12].

3. Total hip replacement

3.1. Development

The development of THR is seen as a landmark in twentieth-century surgery. Philip Wiles of the Middlesex Hospital in London is credited with developing and carrying out the first THR in 1938 [14]. In the period between 1920 and 1950 Wiles was one of a number of people, in Europe and the US, contributing to the gradual evolution in surgical procedure and implant design of THR. During this period, materials that varied from stainless steel and cobalt–chrome alloys to rubber, glass, plastic and even ivory were trialled by different groups [15]. The use of polymethyl methacrylate bone cement for fixation of total hip prostheses was popularised by Charnley in the late 1950s. The work carried out in the UK by Charnley and colleagues is responsible for much of our understanding of modern THR. They revolutionised management of the arthritic hip with the introduction of "low friction arthroplasty" using high-density polyethylene as a bearing material [16]. While early metal-on-metal hip replacements showed promising early results [17], they were ultimately abandoned in the 1970's due to the popularity of Charnley's design. THR is a now very common procedure; in 2011 in England and Wales, 71,672 primary hip replacement procedures were carried out [4].

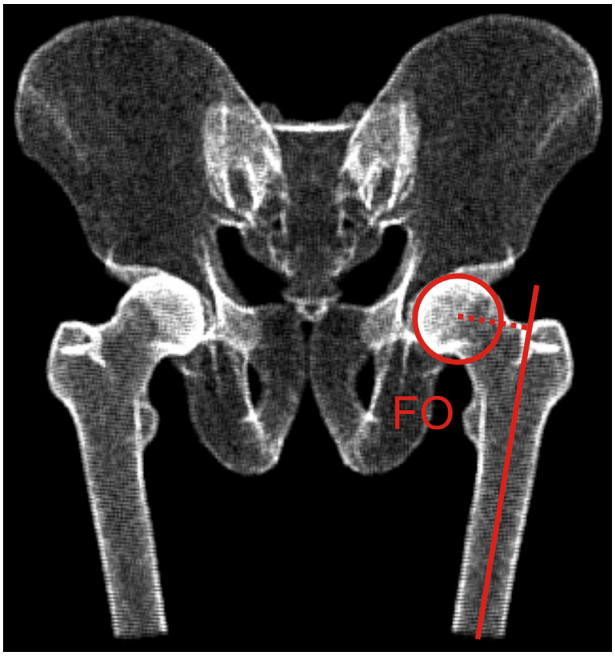

Fig. 1. Synthetic anterioposterior X-ray showing the femoral offset (FO) measured in preoperative planning.

3.2. THR types and procedure

Many designs of THR prosthesis exist on the market, with every manufacturer marketing different versions of popular designs. Despite this variety, the surgical procedure varies little. The femoral neck is resected just below the femoral head, and the acetabular cartilage is removed using sequential reaming. The medullary canal of the femur is prepared using broaches, and the femoral stem and acetabular 'cup' are inserted.

The aim of the surgeon during THR is to restore, as best as possible, the pre-disease anatomy in order to restore the pre-disease biomechanics. If successful, this results in improved abductor muscle strength, a greater range of movement (ROM) and a reduced risk of post-operative complications such as limp, dislocation and wear-related implant failure [18]. Important factors include the restoration of pre-disease leg length and offset (Fig. 1), and recreation of normal orientation of the femoral stem and cup (inclination and version, Fig. 2). Length and offset are normally estimated by comparison with the other hip (this can be challenging if the other hip is osteoarthritic or dysplastic), with the use of templates on pre-operative radiographs, and by estimation of the tension of the peri-articular tissues intra-operatively. Whilst early designs of THR were 'monobloc', with a one-piece femoral stem and head, modern designs are modular, with a range of heads which can be attached once the stem has been inserted, which facilitates fine adjustment of leg length and offset.

Inclination and version vary between patients, and a balance must be struck between restoring the patient's native anatomy and creating a stable articulation; in practice, inclination and version are defined using a combination of patient anatomy and accepted 'normal' values. Lewinnek et al. identified from radiological measurements a 'safe zone' of 40° (±10°) inclination and 15° (±10°)