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The operation of the century almost half-century later. Report of eleven total hip replacements survived 40 years and more

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ABSTRACT

Background Total hip replacement (THR) is one of the most successful orthopaedic procedures. However, the main concern of the longevity of the prosthesis during lifelong still exists. The purpose of the present study was to report, as far as we know, for the first time in the literature the longest-term results of THR.

Methods From 164 consecutive THRs that were performed by one surgeon (GH) between 1974 and 1980 with the first-generation technique and implants introduced by John Charnley, 11 in nine patients survived 40 years and more. The surgeon who performed the operations followed these patients consistently since then.

Results At the final follow-up of the 11 hips that survived without revision for 40 years and more (mean, 42; range, 40-46), the mean patients' age was 85 years (range, 67-98). Clinically, all patients had significantly improved Merle d'Aubigné and Postel score, as modified by Charnley, in comparison with the respective pre-operative ones ($p < 0.001$).

Conclusion To our knowledge this is the first report in the literature presenting survival of a method of THR for almost half of a century. The presentation of 11 THRs survived without revision for 40 to 46 years in combination with the previously mentioned in the literature successful outcomes of the first modern THR, the Charnley's low friction arthoplasty, overpassing 30 years indicates that THR can be last lifelong for a middle-aged patient.

KEYWORDS: long-term survival, survival of total hip arthroplasty, survival of total hip replacement, low friction arthroplasty, survival over 40 years

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Introduction

Total hip replacement (THR) is one of the most successful orthopaedic procedures. It relieves patients from pain, and improves walking ability and the overall quality of life. Even patients who underwent one or more revisions had enjoyed pain relief and function improvement for a reasonable period of time [1]. However, the main concerns of the longevity of the prosthesis and the necessity of one or more reoperations during lifelong still exist.

Almost 60 years ago, the pioneer of modern THR, John Charnley [2], when he introduced his new method stated: "Neither surgeons nor engineers will ever make an artificial hip joint which will last 30 years". He died in 1982 unaware that his revolutionary method of low friction arthroplasty (LFA) will survive almost half a century and become the gold standard for comparison with the newer methods of THR.

Newer methods and implants of THR promise even better results, although there is not yet a universal agreement as to which is the best for our patients and have the longest survival prospects. This is of particular interest as there is constantly increasing elderly population, obesity, and other risk factors for OA, which are common causes leading to THR [3, 4]. The demands for THR will increase more than 4% every year between 2017 and 2024, and the cost of a primary THR will grow from US$ 6.8 billions in 2017 to US$ 9.1 billions in 2024 [5].

The purpose of the present study was to present a series of THRs survived 40 years and more and to report, as far as we know, for the first time in the literature the longest-term results of THR, an operation that seems to have been correctly characterized the operation of the century by Learmonth et al [6].

Methods

Between 1974 and 1980, 164 consecutive LFAs were performed by the senior author (Professor GH) at the Orthopaedic Department of National and Kapodistrian University of Athens, KAT Hospital. Eleven THRs in nine patients were survived 40 to 46 years (Fig. 1 and 2).

Standard Charnley technique and implants (Thackray; now DePuy, Leeds, United Kingdom), by osteotomising the greater trochanter were used in all cases [7]. The scalloped edge (non-flanged) was used in 10 hips, and the offset bore socket with a 35 mm outer diameter in one. In one hip the cotyloplasty technique was used [8, 9]. A monoblock polished femoral component with a 22.225 mm head was used in all cases. Flat-back-design stems with sharp-corners were used in 8 hips and round-back in 3 hips. The first generation cementing technique was used in all cases [10]. Prophylactic antibiotics were not given in 7 THRs performed since December 1977.

Patients were entered in our registry and reviewed clinically and radiologically at three months and one year postoperatively and at one- to three-year intervals thereafter during their lifetime. Clinical evaluation included the Merle d'Aubigné and Postel score, as modified by Charnley [11].

Statistical analysis. The analyses were performed using SPSS 24 statistical software (IBM Corp., Armonk, New York). Improvements in clinical outcome were assessed using Wilcoxon's signed-rank test. A p-value < 0.05 was considered statistically significant.

Results

The mean patients' age at the index operation was 43 years (range, 25 to 55; standard deviation (SD) 11.21). Patients were one male and 8 females. There were five left and six right hips. The primary diagnosis of these hips was congenital hip disease (CHD) in seven (five low dislocation and two high dislocation) according to Hartofilakidis classification system [8], eccentric OA in three hips, and inflammatory arthritis due to ankylosing spondylitis in one hip. Two patients had both of their hips survived for 40 years and more, while other six patients had THR of the contralateral hip survived for a mean of 27 years (range, 19 to 32; SD 5.19). Only one of the latter cases needed to be revised because of stem breakage.

At the final follow-up of the 11 hips that survived 40 years and more (mean, 42; range, 40 to 46; SD

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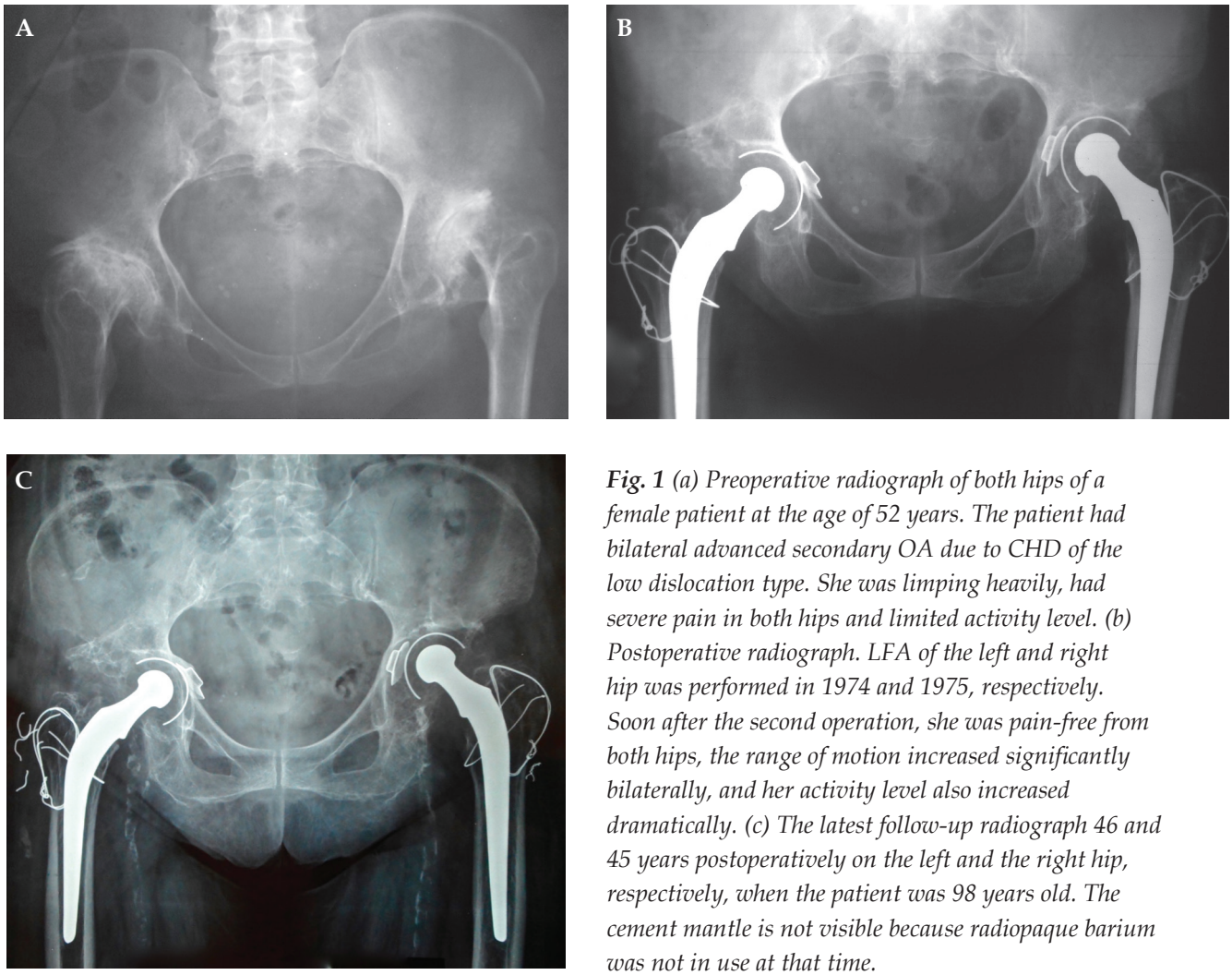

Fig. 1 *(a) Preoperative radiograph of both hips of a female patient at the age of 52 years. The patient had bilateral advanced secondary OA due to CHD of the low dislocation type. She was limping heavily, had severe pain in both hips and limited activity level. (b) Postoperative radiograph. LFA of the left and right hip was performed in 1974 and 1975, respectively. Soon after the second operation, she was pain-free from both hips, the range of motion increased significantly bilaterally, and her activity level also increased dramatically. (c) The latest follow-up radiograph 46 and 45 years postoperatively on the left and the right hip, respectively, when the patient was 98 years old. The cement mantle is not visible because radiopaque barium was not in use at that time.*

2.18), the mean patients' age was 86 years (range, 67 to 99; SD 12.45). At the preparation of the study, all of the patients were living, except one who died at the age of 95 years for a reason unrelated to the problem of the hips. Clinically, despite function (walking ability) had declined with age, all patients had significantly improved Merle d'Aubigné and Postel score, as modified by Charnley, in comparison with the respective pre-operative ones ($p < 0.001$).

Discussion

John Charnley introduced his revolutionary method of LFA that dominated the field of THR for many decades, and became the foundation stone for the contemporary prostheses during the following years. John Charnley introduced not only a successful combination of hard on soft bearing surfaces (metal on ultra-high molecular weight polyethylene), and the use of cement for fixation of the implants, but also established principles still remain of interest for orthopaedic surgeons. He is considered as the father of THR, and his method as the gold standard and a benchmark for comparison with other implants and techniques of THR that have been developed later [12].

The main principles of LFA included the use of transtrochanteric approach, the fixation of the implants with polymethacrylate (PMMA) also called acrylic or bone cement, and the use of small diameter 22.225 mm femoral head. The osteotomy of the greater trochanter and its relocation more distally at the lateral surface of the femur improves

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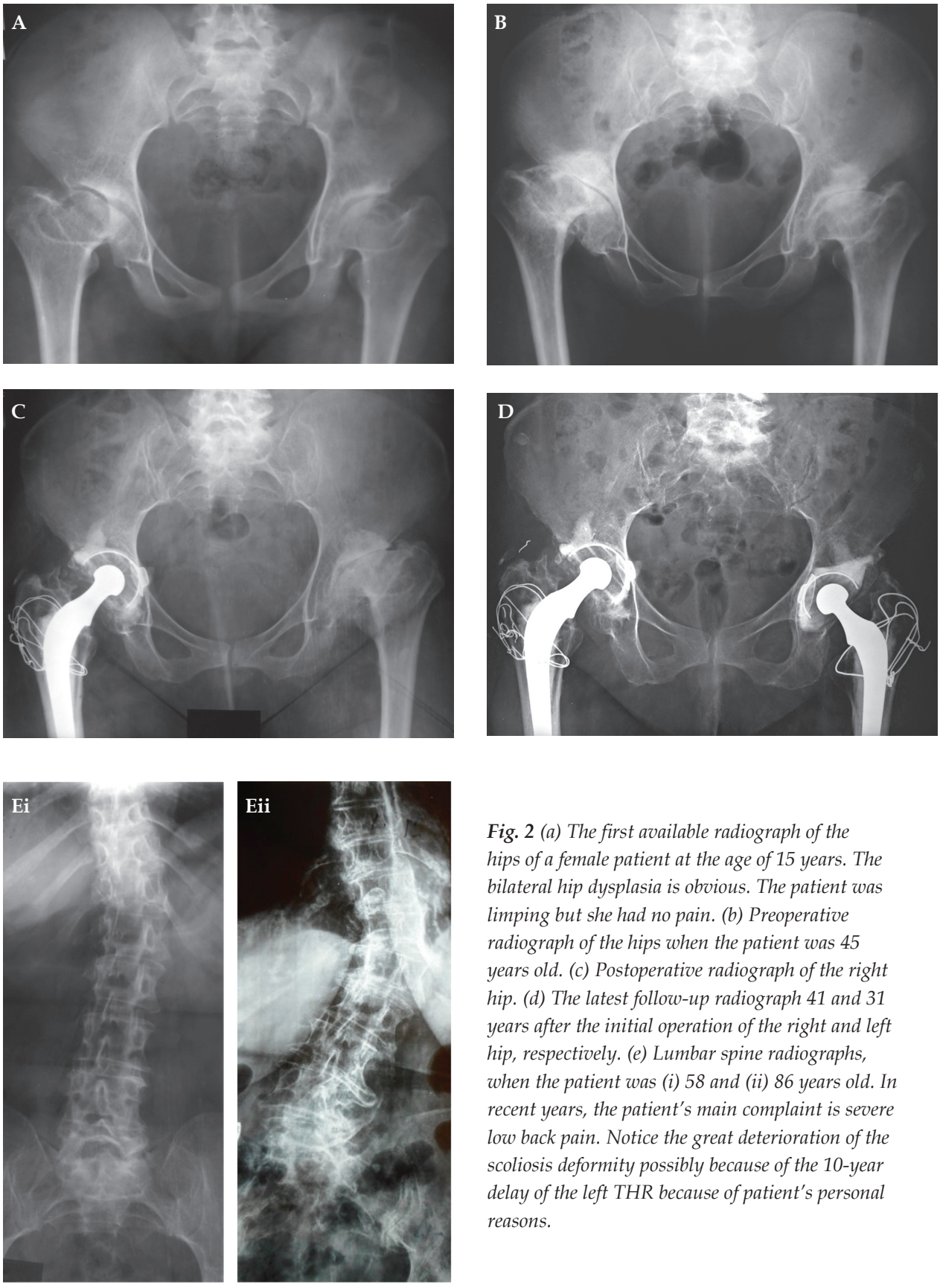

Fig. 2 *(a) The first available radiograph of the hips of a female patient at the age of 15 years. The bilateral hip dysplasia is obvious. The patient was limping but she had no pain. (b) Preoperative radiograph of the hips when the patient was 45 years old. (c) Postoperative radiograph of the right hip. (d) The latest follow-up radiograph 41 and 31 years after the initial operation of the right and left hip, respectively. (e) Lumbar spine radiographs, when the patient was (i) 58 and (ii) 86 years old. In recent years, the patient's main complaint is severe low back pain. Notice the great deterioration of the scoliosis deformity possibly because of the 10-year delay of the left THR because of patient's personal reasons.*

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the biomechanics of the artificial joint, and besides offer a wide exposure facilitating the creation of an artificial joint resembling as much as possible the normal joint. Bone cement was acting as a paste to fill the gap between the bone and the implants, rather than a glow, resulting in an elastic construction, in contrast to the rigid construction resulting when cementless components are used. Finally, the use of small diameter femoral heads, articulating with the thick ultra-high molecular weight polyethylene (UHMWPE) acetabular component resulted in a low frictional torque [7]. The original Charnley LFA, and generally cemented THR, has been modified several times as far as the components, bearing surfaces, and surgical technique are of major concern. One of the most effective modifications was the introduction of cross-linked polyethylene (HXLPE) decreasing considerably the rate of wear, and limiting the subsequent osteolysis and the loosening of the implants as presented by Glyn-Jones et al [13]. Another significant alteration during the years was the improvement of cementing technique (four generations of cementing technique) [14].

The senior author of the present study (GH) was started using the first generation of LFA at the Orthopaedic Department of the University of Athens, KAT Hospital, Greece, early in 1973, and continued using this method following its modifications introduced the next years. In 2015, he published with his colleagues the 30 to 40 years survivorship of 241 primary LFAs performed the period between 1973 and 1984 [15]. It is of interest that the survival rate of this series of consecutive hips operated in these early years, with revision for any reason or removal of the components as the end point, was 91% at ten years, 73% at 20 years, and 53% at 30 years when 40 hips still remained at risk. A common reason for failure during the first years of our experience was periprosthetic infection, and fracture of the stem. Of note, prophylactic antibiotics were not used in THRs performed until December 1977, and the risk of fracture of the stem was much higher when flat back stems with sharp corner from stainless steel were used, before the introduction of round-back stems from CoCr [15].

To the best of our knowledge, LFA is the only method with published data of 30 to 40 years survival. In 2009, Wroblewski et al [16] reported results from Wrightington Hospital, UK from 110 LFAs performed in 94 patients under the age of 65 years followed for more than 30 years. A total of 13 hips (12%) were revised for any reason at a mean follow-up of 32 years. In the same year, Callaghan et al [17], from the Iova University, published the updated results at a minimum of 35 years of 330 LFAs implanted by one surgeon in 262 patients. The average age of patients at the time of surgery was 65 years old (ranged, 29 to 86). A survivorship of 78% at 35 years was reported. The relatively lower survivorship of 53% at 30 years in our previously mentioned study [15] compared to these studies was probably due to the relatively high number of hips with CHD (31% of all hips) of whose most of them are considered challenging cases.

However, even in the favourable results of LFA, certain complications have been described using this early method of THR, such as polyethylene wear and the associated periprosthetic osteolysis leading to the aseptic loosening of the implants, implant failure/rupture, infection and dislocation [7, 18-20]. Additionally, THR attracted the attention of the industry because of its wide use that is increasing with the years [3-5]. For these reasons, researchers and industry started to develop new designs and techniques of THR with different materials of implants, bearing surfaces, biological cementless fixation methods, and minimally invasive surgical techniques [21, 22]. The transtrochanteric approach have been replaced with other approaches and minimally invasive surgery, the small 22.225 mm femoral head have been replaced by heads with greater diameter and the cemented implant fixation have been replaced in many cases by cementless fixation.

In the ’80s, and especially when the early aseptic loosening of cemented components was associated with the so called “cement disease” [23, 24], new designs of cementless THRs based on biologic fixation with bone ingrowth or ongrowth to obtain stability started to replace cemented THRs. However, since cementless THRs did not achieve to solve the problem of osteolysis and loosening [25],

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further studies highlighted the role of polyethylene debris and the related local macrophage response in osteolysis [26]. New bearing surfaces including new generations of ceramic-on-ceramic (CoC), metal-on-metal (MoM) and ceramic-on-polyethylene (CoP) started to develop [21, 22].

Soon, it was recognized that all bearing surfaces had advantages and disadvantages. More severe complications raised from the use of MoM designs. It was proved that MoM friction caused increased metal ions in patients serum and urine, metal hypersensitivity, pseudotumor formation, and a novel complication of aseptic, lymphocyte-dominated vasculitis-associated lesion (ALVAL) leading to increased rate of revision [27]. Few years later the product was recalled and many patients were asking to remove MoM implants [28].

For that reason, we should remember that there is not yet an ideal bearing surface and type of fixation of implants. Long-term clinical experience is the best way to lead our choice concerning the use of the surgical technique, implants and approach. Additionally, the type of prosthesis, bearing surface and implant fixation that is used mainly depends on the experience and the preference of the surgeon. The experience of the surgeon and the accurate surgical technique seems to play a primary role in the long-term survival of a THR.

It is of general agreement that THR is a successful and cost-effective operation, and has been considered as the operation of the century. However, it should be performed only after clear indication and "on time", meaning nether too early not too late. No operation can succeed if it is performed when not needed. The reported favorable long-term results do not only recognize the contribution of Charnley to the modern Orthopaedics but also help us to appreciate the causes of failure of the previous designs and reinforce our effort to create even better artificial joints. For this reason, there is a conviction that newer methods of THR promise even better results and there is a valid indication that THR is indeed the operation of the century.

Conflict of interest disclosure

The authors declared no conflicts of interest

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