



The long-term effects of hip fusion on the adjacent joints

John M. KIRKOS, Kyriakos A. PAPAVALIOU, Margaritis J. KYRKOS, Fares E. SAYEGH, George A. KAPETANOS

From Kilikis General Hospital and Aristotle University of Thessaloniki "Papageorgiou" General Hospital, Thessaloniki, Greece

Hip fusion has served well for many years as the surgical procedure of choice to treat painful joints with severe osteoarthritis or tuberculous arthritis. This retrospective study evaluates the long-term results of hip fusion, as far as its impact on the adjacent joints is concerned. Thirty-three patients that underwent hip arthrodesis 26-52 years previously were evaluated. All patients reported being satisfied with the fusion and being able to adequately work and perform everyday activities. Twenty-five reported episodes of low back-pain, 18 reported pain in the ipsilateral knee, four in the contralateral knee and five in the contralateral hip. Back pain started after an average time interval of 24 years, and pain in the ipsilateral knee appeared 24.6 years after the fusion. Hip fusion, a procedure which is now hardly ever performed, appears to offer a painless, strong and stable hip. However, the adjacent joints, mainly the lumbosacral spine and the ipsilateral knee, will probably develop secondary degenerative arthritis.

Keywords : hip fusion ; adjacent joints ; repercussions.

INTRODUCTION

Hip fusion (HF) has served well for over half a century as the surgical procedure of choice to treat painful joints with severe osteoarthritis or tuberculous arthritis. It was first attempted in 1886 by the French surgeon Lagrane (*in 17*). However, the introduction and development of total hip replacement (THR) have now dramatically restricted the indica-

tions for HF. Nevertheless, it is still considered as an acceptable option for physically active young adult patients suffering from hip tuberculosis or, more rarely, from non-inflammatory, mono-articular hip arthritis (3,4,20,25). It is remarkable that the vast majority of the patients that underwent HF report being very satisfied with the result, despite the obvious functional disadvantages they are facing and the negative impact of a HF on the neighbouring joints. This study aims at evaluating the long-term results of hip fusion, as far as its impact on adjacent joints is concerned, in order to re-assess the long-term functional impairment caused by this surgical procedure.

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- John M. Kirkos, MD, Professor of orthopaedic surgery.
 - Kyriakos A. Papavasiliou, MD, Orthopaedic surgeon, Research fellow.
 - Margaritis J. Kyrkos, MD, Research fellow.
 - Fares E. Sayegh, MD, Assistant Professor of orthopaedic surgery.
 - George A. Kapetanios, MD, Professor & Chairman of orthopaedic surgery.

Department of Orthopaedic Surgery, Kilikis General Hospital and 3rd Orthopaedic Department, Aristotle University of Thessaloniki "Papageorgiou" General Hospital, Thessaloniki, Greece.

Correspondence : Kyriakos A. Papavasiliou, 3 Natalias Mela str., 546 46 Thessaloniki, Greece. E-mail : kyrpap2005@yahoo.com

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Fig. 1. — Preoperative AP radiograph of the pelvis of patient # 1.

PATIENTS AND METHODS

This retrospective cohort study was approved by the Hospital's Scientific Research Board. All patients signed an informed consent form before their enrolment. Standard anteroposterior (AP) and lateral (standard, active flexion and active extension) radiographs of the lumbosacral spine, a standard AP radiograph of the pelvis and standing AP and lateral radiographs of both knees were obtained (figs 1-4).

The osteoarthritic changes in the contralateral hip were classified into 4 stages according to the radiographic system of the Japanese Orthopaedic Association (JOA) (30). The knee radiographs were evaluated based on the Johnson *et al* (13) classification scheme. The presence of degenerative radiographic changes in each lumbar intervertebral space was determined using the Kellgren and Lawrence Score (21). Each intervertebral space (from T12-L1 to L5-S1) was graded (0 points for normal radiographic findings, 4 points for grade 4) and a sum-score (minimum : 0 points, maximum : 24 points) was generated.

Physical examination assessed the existence of limb-length discrepancy and clinical signs of osteoarthritis in the adjacent joints (contralateral hip, knees and lumbosacral spine). The range of motion and any varus or valgus angulation of the knee were recorded. The existence of medio-lateral or/and AP instability was also assessed. The lumbar spine was assessed with the standard Straight Leg Raising test and the range of flexion-extension (sagittal plane) and lateral flexion movements (coronal plane). The range of motion and stability of the



Fig. 2. — AP radiograph of the pelvis of patient # 1 : a) 32 years post-operatively, b) 52 years post-operatively.

contralateral hip joint were also recorded. The position of fusion in the frontal plane was measured on radiographs ; the position in the sagittal plane was measured with the Thomas test.

Since the aim of this study was mainly to evaluate the impact of HF on adjacent joints, it was decided that an established hip scoring system (that assesses among others the range of motion) could not be used for the patients' evaluation. Instead, we tried to evaluate the status of patients' daily living activities and their symptoms related to hip fusion, with the use of several simple questions that assessed exactly this : the patient's ability to adequately perform his/her everyday activities (table I).

Patients were asked to report their level of satisfaction (from extremely satisfied : 5 points to extremely dissatisfied : 0 points) regarding the long-term results of HF.



Fig. 3. — Radiographs of the lumbar spine of patient # 1 : I a) Lateral view 32 years post-operatively, I b) AP view 32 years post-operatively, II a) lateral view 52 years post-operatively, II b) AP view 52 years post-operatively.

RESULTS

Because of the long follow-up period, we were able to locate and re-evaluate only 33 (17 males, 16 females) out of a total of 108 patients that underwent HF between 1952 and 1976. These 33 patients formed our study group. Their average age was 27.5 years (range : 9 to 51) at the time of the index operation, and 64.8 years (range, 38 to 79) at the latest follow-up examination. The patients underwent hip fusion 26 to 52 years before the onset of this study (average : 37). Pain was the main reported pre-operative reason for surgical treatment (table II).

The “Brittain - Foley” (5,10) ischio-femoral procedure was used in 21 patients. Intra-articular arthrodesis combined with subtrochanteric osteotomy, also known as the “Perkins-Pyrford” procedure (2), was used in 6 patients. The “Charnley” procedure (23) was used in 6 patients. Extra-articular fusion was thus performed in 21 patients and intra-articular in 12 (table II). Upon re-evaluation, there was only one pseudarthrosis. One patient had presented a tibial graft fracture that was treated conservatively with a spica cast for 3 months.

Regardless of the difficulties that most patients were facing in everyday life activities (e.g. 28 were unable to drive a car), their satisfaction level was overall positive (mean self-reported satisfaction score : 3.97 points ; range : 3 to 5) (table II). When asked to comment on their reported satisfaction



Fig. 4. — Radiographs of the ipsilateral knee of patient # 1 : I a) Lateral view of the knee in flexion 32 years post-operatively ; I b) lateral view 32 years post-operatively ; I c) AP view 32 years post-operatively ; II a) Lateral view of the knee in flexion 52 years post-operatively ; II b) lateral view 52 years post-operatively ; II c) AP view 52 years post-operatively. Note the high flexion range of the knee despite severe radiological osteoarthritis.

level, most of them said that HF permanently relieved them from their pre-operative pain. Every patient was able to work and adequately perform his/her everyday activities even though most of them (22 patients) were manual labourers or farmers. Only one man, a farmer who developed ankylosing spondylitis after undergoing hip fusion, had to change his occupation.

Twenty-seven patients reported no difficulties with their sexual life. The remaining six however, expressed complaints. Five female patients reported difficulty mainly in abducting their hips. Nevertheless, two of them conceived and gave birth to two children each, after the hip fusion. They both had vaginal deliveries without complications. The male patient experienced psychological problems.

Twenty-two patients were able to walk without significant difficulty. The remaining 11 reported limited walking capability (range : 200 to 1000 m) because of pain. Five patients were using a cane

Table I. — The questionnaire used in the study

GENERAL INFORMATION	Name				Sex			
	Age at follow-up		Age at arthrodesis					
	Address & tel.							
	Current Occupation		Pre-operative Occupation					
	Operation date		Age when operated on		Hip		L R	
	Exact Cause of operation							
	Pre-operative problems				Onset of pre-operative problems			
	Did the pre-operative problems resolve?							
	Current difficulties and problems							
	Sexual intercourse problems							
	Preferable type of chair				Able to sit on a toilet seat		Y N	
	Walking distance without pain				Able to sit without pain & for how long		Y N	
	Married		Y N		Children post-operatively		Y N How many	
	Delivery of children				Walk on crutches or cane		Y N	
	Able to put on shoes		Y N		Put on trousers		Y N	
	Able to walk without shoes		Y N		Preferable type of shoes			
	Able to drive a car		Car modifications					
	Leg length discrepancy		Contralateral		Ipsilateral			
	Hip Fusion technique		Position of the fused hip		Flexion		Rotation	
					Abduction-Adduction			
Other operations after the hip fusion								
KNEE	Knee pain		Y N		More affected knee?		L R	
	Onset of pain				Night pain		Y N	
	Medication needed?		Y N		What kind?			
	Required hospitalization?							
	Contralateral knee		Flexion		Extension		Pain at palpation	
Ipsilateral knee		Varus		Valgus		Instability		
Contralateral knee								
Ipsilateral knee								
BACK	Back-pain		Y N		Onset of pain		Night pain	
	Medication needed?		Y N		What kind?			
	Did you at any time require hospitalization?				Constant pain?		Y N	
	SLR Left		Flexion		Flexion to the left			
	SLR Right		Extension		Flexion to the right			
HIP	Contralateral hip pain		Y N		Onset of pain		Night pain	
	Medication needed?		Y N		What kind?			
	Did you at any time require hospitalization?				Constant pain?		Y N	
	Flexion		Extension		Flexion contracture		Trendelenburg	
	Abduction		Adduction		Int. Rotat.		Ext. Rotation	
Overall personal impression		Very satisfied		Moderately dissatisfied				
		Satisfied		Dissatisfied				
		Moderately satisfied		Very dissatisfied				

while walking. Twenty-six patients were able to comfortably sit in a hard-backed chair for one-half hour or more. Nineteen were able to sit for more than two hours without any discomfort. The average anatomical limb-length discrepancy was 2.89 cm (range : 0 to 10) while the functional discrepancy ranged from 0 to 12 cm (average : 2.62) (table II). Twelve patients were using orthotic shoes with a lift.

Back-Pain

The majority of the patients (25 out of 33) reported repeated episodes of low back-pain. All of them reported at least one episode during the month prior to their re-evaluation. Back-pain started after an average period of 24 years after the fusion (range : 16 to 32). Eighteen patients reported pain after prolonged sitting, the other 7 after prolonged standing or walking. They all reported the use of medication (mainly paracetamol, muscle relaxants and non steroid anti-inflammatory drugs) on several occasions, but none required medication on a regular basis, physical therapy or hospitalisation. The patients with back-pain had their hip fused in an average of 27.2° of flexion and 0.7° of adduction ; those without in an average of 32° of flexion and 5.3° of adduction. Further analysis showed no statistically significant difference between the patients that reported suffering from back-pain and those who did not, as far as the position of their hip following HF was concerned (flexion $p = 0.278$, adduction $p = 0.235$).

Radiographs of the lumbosacral spine revealed intervertebral joint space narrowing in 7 patients (10 intervertebral levels). One of them had narrowing of the L5-S1 disc space but did not report any episode of back-pain. Traction osteophytes were found in 15 patients (44 levels). Thirteen of these patients reported back-pain. The patients' average Kellgren and Lawrence Score (21) was 7 points (range : 2 to 14) (table II). This score was not used in the case of the patient with ankylosing spondylitis. The average value of that same score, in the group of patients with repeated episodes of low back-pain was 7.25 points (range : 2 to 14), versus 6.25 (range : 2 to 10) in those not reporting such episodes. Degenerative spondylolisthesis occurred

in 2 patients and 5 patients had degenerative lumbar scoliosis (the convexity of the scoliosis was pointing towards the fused side in 3 patients and towards the normal side in 1). Thirteen patients had normal radiographs of the lumbar spine, of which only 3 did not report back pain.

Knee pain

Twenty-two patients reported knee pain : 18 in the ipsilateral knee and 4 in the contralateral knee. The pain had started immediately after cast removal in three patients. The remaining 19 reported gradual onset after an average period of 24.6 years (range : 16 to 32) for the ipsilateral knee and 29.5 years (range : 26 to 34) for the contralateral knee. The pain mainly occurred after prolonged standing, sitting or stair climbing. Five patients reported anterior knee pain while the remaining 17 described their knee pain pattern as diffuse. Twenty patients required anti-inflammatory medication (at least once) in order to continue with their everyday activities, but none required hospitalisation or underwent any surgical operation.

The average Johnson *et al* (13) score for the ipsilateral knee was 2.33 points (range : 1 to 4) and for the contralateral knee 1.81 (range : 1 to 3) (table II). Patients reporting pain in the ipsilateral knee had an average score of 2.44 (range : 1 to 4) and in the contralateral knee of 2.5 points (range : 2 to 3). Patients not reporting pain in the ipsilateral knee had an average score of 2.2 points (range : 2 to 3), and 1.72 points (range : 1 to 2) in the contralateral knee. Patients reporting pain in the ipsilateral knee had their hip fused in an average of 27° of flexion and 2.2° of adduction ; those without pain in an average of 28° of flexion and 4.6° of adduction. Further analysis showed no statistically significant difference between the patients that reported suffering from ipsilateral knee pain and those who did not, as far as the position of their hip following HF was concerned (flexion $p = 0.289$, adduction $p = 0.267$).

Contralateral hip pain

The contralateral hip showed narrowing of the joint space along with other radiological signs of

Table II. — Results of the study. The average value(s) together with the range (in parentheses) is reported wherever applicable. (pts = patients)

Patients		Fused Hip	Average Duration of Fusion in years (range)		Average Age at Fusion in years (range)	Average Age at Follow-up in years (range)	Intra- or extra-articular fusion					
All	33	R=14 L=19	37 (26-52)		27.5 (9-51)	64,8 (38-79)	Extra-articular=21 Intra-articular=12					
Male	17	R=8 L=9	39.7 (27-52)		24.1 (9-47)	63,8 (38-79)	Extra-articular=14 Intra-articular=3					
Female	16	R=6 L=10	34.1 (26-47)		31.2 (12-51)	65,9 (49-77)	Extra-articular=7 Intra-articular=9					
Patients	Sexual Dysfunction		Use of cane		Average Self-reported Grade of Satisfaction (range) <i>Very Dissatisfied=0, Moderately Dissatisfied=1, Dissatisfied=2, Moderately Satisfied=3, Satisfied=4, Extremely Satisfied=5</i>							
	No	Yes	No	Yes								
All	27	6	28	5	3,97 (3-5)							
Male	16	1	15	2	3,94 (3-5)							
Female	11	5	13	3	4 (3-5)							
Patients	Average Limb-Length Discrepancy in cm (range)				Reported Walking Capability							
	Left Limb		Right Limb		Unlimited	≤100cm	≤500m					
	Anatomical	Functional	Anatomical	Functional								
All	3.06 (1-8)	2.33 (0-9)	2.66 (0-10)	2.92 (0-12)	22 pts	3 pts	8 pts					
Male	3.14 (1-8)	3.14 (0-9)	3.42 (2-10)	4 (0-12)	13 pts	2 pts	2 pts					
Female	3 (1-6)	1.62 (0-4)	1.6 (0-2)	1.66 (0-5)	9 pts	1 pt	6 pts					
Patients	Lumbar Spine Radiographic Findings Classification according to the 'Kellgren and Lawrence' Score (8)				Contralateral Hip Radiographic Findings Classification according to the 'Japanese Orthopaedic Association' Grading system (6)							
	Average (range)				Average (range)							
All	7 (2-14) points				1,6 (1-4) points							
Male	6,5 (2-14) points				1,76 (1-4) points							
Female	7,5 (2-14) points				1,4 (1-3) points							
Patients	Ipsilateral Knee Radiographic Findings Classification according to the 'Johnson et al.' grading system (7)				Contralateral Knee Radiographic Findings Classification according to the 'Johnson et al.' grading system (7)							
	Average (range)				Average (range)							
All	2,33 (1-4) points				1,81 (1-3) points							
Male	2,52 (1-4) points				1,82 (1-3) points							
Female	2,12 (1-3) points				1,81 (1-3) points							
Patients	Back pain			Contralateral Hip Pain			Ipsilateral Knee Pain			Contralateral Knee Pain		
	+	±	-	+	±	-	+	±	-	+	±	-
All	14	11	8	3	2	28	11	7	15	2	2	29
Male	7	6	4	2	1	14	8	3	9	1	2	14
Female	7	5	4	1	1	14	3	4	6	1	0	15

osteoarthritis in 11 patients. Twenty-two out of 33 patients were classified as JOA (30) grade 1. The average score of all the patients was 1.60 points (range : 1 to 4). Only 5 patients reported pain in the contralateral hip (table II) ; their average JOA (30) score was 3.4 points (range : 3 to 4). The reported delay in onset of pain in the contralateral hip aver-

aged 29 years. Their physical examination showed marked restriction in both active and passive hip joint range of motion. The remaining 28 patients had an average JOA (30) score of 1.28 points (range : 1 to 3). Two patients classified as JOA (30) grade 3, did not report any pain or any restriction in the range of motion.

DISCUSSION

Although most reports on HF have focused on the technical aspects of this surgical procedure (1,5,10,23,28), others have presented the long-term results of HF and its impact on the contiguous joints (6,16,22,24). Hip fusion certainly has very limited indications at present (3,4,25,29). The age and occupation of the patient is a critical parameter to be considered (2), and the contiguous joints should be in excellent condition, as they are expected to compensate for the loss of motion in the hip joint.

Several early reports on HF showed high rates of pseudarthrosis (15 to 30%) (16,23,24) but the technique gradually progressed (1). There was only one case of pseudarthrosis among our patients and one case of tibial graft fracture. The exact position of the fused hip influences the ability of the patient to sit and walk. It appears that 30 to 35° of flexion and approximately 5° of adduction is the ideal position for the fused hip (22,24). Patients with their hip fused in a more flexed position can sit more comfortably for a longer period of time, whereas less flexion makes it possible to walk longer distances without complaint.

In theory, a fused hip is bound to have a negative impact on the neighbouring joints. This indeed appears from our results.

Hip fusion clearly has a negative impact on the lumbar spine. Back pain affected the majority of our patients. Those reporting back pain had their hip fused in an average of 27.2° of flexion, those without back pain in an average of 32°. Even though Callaghan *et al* (6) reported that patients without back pain tended to have a somewhat more flexed position (33°) compared to those who had back pain (29°), statistical analysis showed no significant difference regarding the position of the hip following HF between patients reporting back pain and those who did not. Overall, back pain was not considered by the patients as a major problem, even though its incidence was substantially higher (75.7%) than reported in surveys performed on the general population (7.9 to 31.5%) (9,11,14). Stranjalis *et al* (26) in a large cross-sectional study performed in our country, reported an incidence of low back pain of 40.7% in patients between 46 and

65 years of age and of 46.9% in patients older than 65 years. Wijnhoven *et al* (29) interviewed 3,664 Dutch citizens aged 25-65. The overall incidence of chronic low back pain was found to be as low as 21.8%. The incidence of low back-pain among the 17 patients younger than 65 years in our study group was more than 4 times higher (88.2%).

It appears that hip fusion negatively affects the ipsilateral knee as well, since ipsilateral knee pain was also reported by the majority of our patients (18/33). Those reporting pain in the ipsilateral knee had their hip fused in an average of 2.2° of adduction, versus 4.6° in those not reporting knee pain. Even though Callaghan *et al* (6) reported that the position of the fused hip in abduction plays a significant role in the development of knee pain, no statistically significant difference was found between patients reporting ipsilateral knee pain and those who did not, as far as the position of their hip was concerned. Jinks *et al* (12) reported an overall incidence of knee pain among the general population (average age of 65 years) as high as 47%. These findings, which come close to our results, contrast with several others studies. Thomas *et al* (27) reported that 36.3% of 6,903 patients between 50 and 79 years of age were suffering from knee pain. Thirty of our patients were within the same age limits; 16 of these (53.3%) reported pain in the ipsilateral knee. Peat *et al* (19) reported a 25% overall prevalence of knee pain among adults aged from 40 to 79 years. Sixteen out of a total of 32 of our patients in the same age range reported repeated episodes of pain in the ipsilateral knee. Wijnhoven *et al* (29) reported an overall incidence of knee pain of 11%. The incidence in the comparable subgroup of our patients was more than five times higher (58.8%). Carmona *et al* (7) reported a 10.2% incidence of knee osteoarthritis among adults older than 20 years, almost 5 times lower than our findings (54.5%).

Four patients experienced mild pain in the contralateral knee after an average period of 29.5 years. The pain was not severe enough to interfere with their everyday activities. Our data suggest that hip fusion may not have an impact on the contralateral knee. Nevertheless a larger cohort of patients is needed in order to secure this conclusion.

Only 5 patients reported having episodes of pain in the contralateral hip after an average time interval of 29 years. Linsell *et al* (15) reported an 8.3% incidence of hip pain among a random sample of adults, aged 65 years and above. The incidence in the comparable subgroup of our patients was 11.7%. Wijnhoven *et al* (29) reported an incidence of chronic hip pain of 7.1% in individuals aged 25 to 65 years, versus 23.5% in our patients younger than 65 years. In patients aged 50 to 79 years, Thomas *et al* (27) reported an incidence of hip pain as high as 33.8%, versus 10.3% of our patients. We believe that our sample is too small to find out whether hip fusion truly has an impact on the contralateral hip as well.

When evaluating patients that underwent HF in the past, we must keep in mind that this surgical procedure was one of the best treatment options at that time, and we should not compare the results of HF with those of currently available surgical techniques. Hip fusion has relieved the hip pain in all our patients ; therefore it is fair to say that it has successfully achieved its primary goal. The vast majority of our patients reported high levels of satisfaction, despite the self-reported functional problems they are facing in their everyday life. Even though they were informed about the possibility of converting hip fusion to a THR, none of them decided to proceed to a second operation. Nevertheless, we must also realise that HF was performed at that time in patients with different needs and life-styles. The lack of hip flexion would now be considered a major impairment.

This study has several limitations. First, the number of patients is relatively small, owing to the long follow-up period. A larger number would have been needed to reach more secure conclusions with respect to the possible correlation between the exact position of the fused hip and the development of pain in the contralateral hip, the knees and the lumbar spine. As a result, the statistical analysis performed, should be read and interpreted with caution as a type 2 error (related with the small number of cases) might exist. Moreover, in order to evaluate the overall function of the patient, we had to rely on every patient's recall ; hence our data may not be 100% accurate. In order to compensate for this,

when planning this study, and instead of using some of the well-established functional level scores, it was decided that we would better rely on several simple questions that could be easily answered by each patient (table I).

In this era of THR, hip fusion has very limited indications. Nevertheless, when performed in carefully selected patients, especially hard-working labourers, it remains an acceptable option which provides pain relief and return to function in the majority of cases (25). A patient with a fused hip is able to function at a high level for many years and is able to work in a number of occupations. Nevertheless, most young patients today would no longer accept to undergo HF, as they would consider the resulting impairment unacceptable.

Hip fusion may be performed as a permanent solution or as a 'bridge' to THR. In the latter case, it is essential to use modern techniques that preserve the abductor mechanism (25), limit the post-operative pelvis deformity (25) and preserve the bone stock (3,18). As pain and degeneration in the contiguous joints are expected to occur after the second post-operative decade, hip fusion offers at least twenty years of painless working capacity. After that period, a THR can be performed. The patient is certainly going to face several difficulties owing to his fused hip. In return, hip fusion will spare him (multiple ?) revision surgeries, usually at the expense of the bone stock of the proximal femur and acetabulum (5).

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