Original Research Article

Factors influencing knee flexion range after primary total arthroplasty. Study of a consecutive series over ten years

Abstract

Introduction: Knee flexion after total arthroplasty is not always satisfactory. Our hypothesis: many factors can influence it. Some of these factors have been studied, but with controversial results.

Methodology: It was a monocentric prospective and comparative study. All primary total knee replacement were included. For each factor, we compared a group of patients with above mean flexion to those with smaller flexion, using comparison of means, regression analysis and the chi square test.

Results: We had 110 arthroplasties from 88 patients. Three preoperative factors affected the outcome: pre-operative knee flexion $\leq$ 110°, flexum deformity > 5° and a body mass index above 30kg/m^2. The respective Pearson coefficient value for these three factors were +0.50, +0.05, and -0.13.The chi square values were respectively 12.019 ($p<0.001$) and 6.091 ($p<0.02$) for the first two ones. Mean postoperative flexion values were significantly low for the patients with high body mass index ($p<0.03$) and for those with knee flexion $\leq$ 110° ($p<0,001$).

Conclusion: Such studies should be carried out in other settings to prepare later meta-analysis. The effect of early physiotherapy in knee arthritis treatment in preventing knee stiffness at the time of total knee replacement should be evaluated.

Key words: total knee arthroplasty, flexion, factors

Introduction

Obtaining a good amplitude of knee flexion after total arthroplasty is one of the key elements of the functional success of the operation [1,2].

For example, the minimum amplitude of knee flexion necessary on a daily basis is [3]:

- 67° for the oscillation phase during walking,
- 83° for climbing stairs,
- 90° for descending stairs,
- 90° for everyday activities and
- 93° for getting up from a chair.

Several pre-, per- or post-operative factors are likely to influence the range of flexion obtained after total arthroplasty. They have been mentioned in various publications: epidemiological factors [1], degree of severity of osteoarthritis [2], prosthesis model [1], neurological and psychological factors [4]. We identified these different factors in a continuous, single-centre, single-operator series of primary knee arthroplasty to find those that have the greatest influence on the range of flexion obtained after arthroplasty.

Materials and methods

Only primary total arthroplasties performed between January 2002 and December 2011 were included. Unicompartmental prostheses, revision surgeries and patients lost to follow-up were excluded.Data were prospectively collected using pre-, intra-, and postoperative data sheets. The objective functional score [5] of the International Knee Society Score (IKSS) was assessed through walking, going up and down stairs, and the need to use canes. Angular measurements were made with a goniometer. The evolutionary stage of osteoarthritis was determined according to Ahlbäck's radiological classification[6].
The following data were retained: age, sex, side, body mass index (BMI), objective score of the IKSS, site of osteoarthritis, evolutionary stage, amplitude of preoperative flexion, the preoperative flexum, the mechanical axis, the resurfacing or not of the patella, the amplitude of flexion at the end of the intervention and during the latest consultation.
For each factor, patients who achieved lower than average range of flexion are compared to those with above average range. The statistical study of the differences between these two groups used the reduced-difference test, the calculation of the Pearson correlation coefficient or the $\chi 2$ test.
All our patients had antibiotic prophylaxis, a pneumatic tourniquet from incision to closure and an internal (knee varum) or external (knee valgum) parapatellar approach. The femoral target was centromedullary and the tibial extramedullary. A tibial slope of 5° was provided for in the instrumentation. The spaces in extension and flexion after cutting were comparable and rectangular. Release of the concavity and release of any posterior osteophytes were systematic. The prosthesis was a cemented Scorpio™ with a posterior stabilized mobile plate. Only the kneecaps very deformed by osteoarthritis were resurfaced.
The joint capsule was closed with the knee flexed at 90 degrees. Physiotherapy aimed at mobilizing the knee began on the first postoperative day.

Results

A. General

We included 110 arthroplasties in 88 patients who were followed for an average of 23 months [2-141]. Twenty-two arthroplasties were bilateral. The age of the patients was on average 70 years [33-87] (table 1). The female/male ratio was 2.55. The right knee was operated in 60 patients and the left in 50. The mean body mass index (BMI) was 31.54 kg/m2 [22.34-48.45].

Sixty-two of our patients had a varied general pathological history (56.37%). Regarding the local history, there were 16 meniscectomies, 2 patella fractures, one articular fracture of the femur, 3 internal tibial valgus osteotomies, 2 anterior cruciate ligament surgeries, rheumatoid arthritis and chondrocalcinosis As general history, 25 arterial hypertensions, 5 diabetes, 2 myocardial infarction, 2 deep vein thrombosis, and 2 pulmonary embolisms were found in the patient history. Five were taking anticoagulants and 4 had varicose veins in the lower limbs. The mean preoperative objective functional score (IKSS) was 61.23 out of 100 [25-100].

Internal femorotibial osteoarthritis (AFTI) accounted for 66.36% of cases, external femorotibial (FTE) 14.55%, patellofemoral (FP) 36.36% and tricompartmental 12.73%. Concerning the radiological classification of Ahlbäck[6], there were: 9.09%; 54.55%; 24.55% and 11.82% for osteoarthritis of stages I, II, III and IV respectively.

Mean preoperative flexion amplitude was 110.19°[40-130], flexum 6.46°[0-25] and recurvatum 0.14°[0-5]. A genu varum was present in 76.36% of cases against 20% for genu valgum and 3.67% for normoaxial knees.

Patella resurfacing was performed for 64 knees (58.18%). A test was performed before knee closure. The "no thumb test" was satisfactory in 94.55% of cases and the "kissing test" in 93.64%. Mean flexion at end of surgery was 124.90°[120-130] and extension at end of surgery was 0° in all patients.

Incidents and complications noted: 2 fractures of the femur, 2 disinsertions of the patellar tendon on the anterior tibial tuberosity, 2 fractures of the tibial plateau, 1 section of the internal lateral ligament and 2 postoperative hematomas. All these patients, on the other hand, had postoperative flexion amplitudes greater than or equal to 100°.

The mean postoperative functional score (IKSS) was 83.44 out of 100 [20-100]. The patient was very satisfied in 80.91% of cases and the surgeon in 82.73%. The average postoperative flexion amplitude was 111.68° [60-140].

B. Influence of the factors studied

The differences in flexion amplitude measured at the last consultation between the two groups are presented in Table 2, according to each of the factors studied. The values of the reduced difference, of the Pearson correlation coefficient and of the chi-square were calculated and make it possible to demonstrate that the difference between the two groups is statistically significant for the three factors which are the body mass index, the pre-operative flexion amplitude and the existence of a pre-operative flexion greater than 5 degrees.

Twenty-two patients had bilateral arthroplasties. The average gap between the two operations was 22.18 months[3-77]. The mean postoperative flexion angle was 111.25°[85-135] in this subgroup of bilateral prostheses. This mean postoperative flexion angle was 114.32° on the right versus 108.18° on the left, the difference not being significant (reduced-gap test for small samples).

The specific search for patients with poor postoperative flexion reveals that nine knees had postoperative flexion less than or equal to 90°. Their clinical history is dominated by the three pejorative factors identified above, the advanced evolutionary stage, and the notion of previous bone trauma to the knee. Similarly, the study of 13 patients with postoperative flexion > 130° found the absence of these three harmful factors, except that six of these 13 had a preoperative flexum >5°. Of the 15 patients with BMI <30 kg/m2 and preoperative amplitude >110°, only one had postoperative flexion <110°, i.e. 95°.

In sum, the three pejorative factors identified are (Table 2): a preoperative flexion amplitude < 110°, a preoperative flexum > 5° and a body mass index > 30 kg/m2 with respective Pearson correlation coefficients of +0.50, +0.05 and -0.13. Comparison of the means by the reduced-gap test revealed a significant difference for BMI ($p<0.03$) and for preoperative flexion amplitude ($p<0.001$). The $\chi 2$ test found a significant difference for

flexum ($p<0.02$) and for preoperative flexion amplitude ($p<0.001$). The other analyzes did not reveal any statistically significant difference.

Discussion

The weak points of our study: all the factors that could influence the amplitude of postoperative flexion were not tested. The strong points of our work reside in its monocentric and monooperator character. Verification of the initial research hypothesis: there are factors determining the amplitude of postoperative flexion of the knee after total arthroplasty. Comparison of our main results with those of the literature. Regarding age, Kantial et al. [1] in 2013, found no relationship with flexion during a study of 248 so-called "high flexion" knee prostheses. Farahini et al. [6] found a correlation in univariate analysis by studying 92 prostheses at one year's follow-up, but this correlation was not found in multivariate analysis. For Schurman et al. [7] who studied 164 arthroplasties, the younger ones have better flexion but their follow-up was only 3 months. Anouchi et al. [8] found no correlation. We had a very slight difference, otherwise not significant, in favor of those aged 70 and under. Regarding sex, Kantial et al. [1] find a slightly higher amplitude in men, the difference being non-significant at 6 months and at one year (like us) postoperatively. Kotani et al. [9], found no difference at two years' follow-up in a study of 219 prostheses. Obesity, for Frankin et al. [4] who studied the registry of total knee prostheses in the United States between 2000 and 2005, reduced postoperative flexion of the knee by interposition of soft tissues between the thigh and the leg. Kantial et al. [1] find that patients with a high BMI have low postoperative flexion amplitude [1]. We also found a weak negative correlation between these two variables and a difference when comparing means ($p<0.03$). Kotani et al. [9], find no difference. Several studies [1] have found, like us, that a large amplitude of preoperative flexion favors a better amplitude of postoperative flexion. For several authors [8, 9, 10] the knee scores before and after the prosthesis are the most important factor in predicting postoperative flexion. We found a very weak positive correlation between the preoperative functional score of the knee and the postoperative flexion ($R= +0.12$). Ritter et al. [10] studied 4727 knees between 1983 and 1998 and found that preoperative flexion decreased postoperative flexion, and that internal release in the case of genu varum, release of the posterior osteophytes and capsule, on the other hand, increased it. Our results are similar for the flexum and all our patients had a release of the posterior capsule, of the posterior osteophytes and of the concavity (in the frontal deformities) when necessary. Concerning the use of the tourniquet, Wakankar et al. [11] in England carried out a randomized study in 1999 of 77 arthroplasties divided into two groups (with and without a tourniquet) and found that the non-use of a tourniquet is beneficial for flexion only at one week postoperatively, no significant difference being noted at 6 weeks and 4 months postoperatively. Kantial et al. [1] found that releasing the tourniquet before closure also had an early positive effect. Our patients all had a tourniquet from incision to closure. Bellemans in 2006 [12] finds that the spaces in extension and flexion after the bone cuts are made should be equal and rectangular. This principle was respected for almost all of our patients. Concerning the resurfacing or not of the patella, Burnett et al. in 2007 [13] in Washington, conducted a prospective randomized study in 32 patients with 64 primary prostheses (left and right) with a follow-up of 10 years. They found no difference in flexion, postoperative score, satisfaction, revisions and anterior pain. Only osteoarthritic patellae were resurfaced in our series and the difference in postoperative flexion was not significant. Possible recommendations: At the end of this work, we recommend the continuation of

similar studies in other centers, which will later make it possible to carry out high-powered meta-analyses that can lead to predictive scores. We also suggest evaluating the interest of the combination of physiotherapy in the medical treatment of incipient knee osteoarthritis to prevent stiffness which ultimately leads to the reduction of preoperative flexion and the formation of the flexum.

Table 1 : Description of stydy variables

Sample size	88 patients	66 unilatral	bilateral (44)	110 prostheses
Recul	Minimum 2 months	Maximum 141 months	Average 22.59 months	
Age	Minimum 33 years	Maximum 87 years	Mean 69,9 years	
Sex ratio	Female 79(71,82%)	Male 31(28,18%)	Ratio 2,55	
Operated side	Right 60(54,55%)	Left 50(45,45%)		
Body mass inidex (kg/m^2)	Minimum 22,34	Maximum 48,45	Mean 31,54	
Pre-operative functional score over 100	Minimum 25	Maximum 100	Mean 61,23	
Arthritis localisation	Medial 55(66,36%)	Lateral 8(14,55%)	Femoropatellaire 40(36,36%)	Tricompartimental 14(12,73%)
Evolutive stage on Ahlbäck classification	Stade I 10(9,09%)	Stade II 60(54,55%)	Stade III 27(24,55%)	Stade IV 13(11,82%)
Pre-operative flexion	Minimum 40°	Maximum 130°	Mean 110,19°	
Pre-operative flexum	Minimum 0°	Maximum 25°	Mean 6,46°	
Pre-operative recurvatum	Minimum 0°	Maximum 5°	Mean 0,14°	
Frontal deformation	Varum 84(76,36%)	Valgum 22(20%)	Normal 4(3,67%)	
Arthritic patella surfacing	Yes 64(58,18%)	No 46(41,82%)		
End of surgery flexion	Minimum 120°	Maximum 130°	Mean 124,90°	
Post-operative functional score over 100	Minimum 20	Maximum 100	Mean 83,44	
Post-operative flexion	Minimum 60°	Maximum 140°	Mean 111,68°	

Table 2: Summary of the influence of variables (NA=non applicable, //= versus)

	Factor	Mean	Ecart réduit	Correlation	Chi square
1	Age > 70 // ≤ 70 years	111,35°//111,84°	0,05	**+0,03**	0,004
2	Sex female//male	111,65°//111,77°	-0,04	NA	0,001
3	Side left//right	110,50°//112,67°	0,82	NA	0,440
4	**Body mass index > à 30//≤30 kg/m^2**	109,91°//115,11°	**2,2(p<0,03)**	**-0,13**	1,910
5	**Pre-operative functional score ≤ 60//>60**	111,56°//111,89°	0,11	**+0,12**	0,565
6	Localisation lateral//medial	111,56°//112,19°	0,2	NA	0,493
7	Evolutive Stage (3 et 4)//(1 et 2)	109,38°//113,00°	1,29	NA	1,604
8	**Pre-operative flexion amplitude ≤ 110°//>110**	106,67°//116,57°	**-4,17(p<0,001)**	**+0,50**	**12,019(p<0,001)**
9	**Pre-operative flexum > 5°//<5°**	109,89°//113,39°	1,38	**-0,05**	**6,091(p<0,02)**
10	Genu varum versus genu valgum	110,00°//110,91°	0,2	NA	0,716
11	Arthritic patella surfacing yes//no	110,32°//113,26°	1,06	NA	0,628
12	**End of surgery flexion** ≤ 125°//>125°	110,27°//113,80°	-1,27	**+0,14**	1,787
13	First versus second knee in case bilateral	114,09°//108,41°	-1,8	NA	2,316
14	Left side //right in case bilateral	108,18°//114,32°	1,65	NA	2,316

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