



## Outcome of patellofemoral arthroplasty, determinants for success

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**The primary aim of this study is to document whether patellofemoral arthroplasty is a good treatment option for patellofemoral osteoarthritis and to identify prognostic outcome factors. Secondary aim is to investigate the influence of preoperative tibiofemoral osteoarthritis on the clinical outcome.**

**From 2004 to 2010, 37 Avon patellofemoral prostheses were implanted in 32 patients. Clinical outcome was evaluated with five questionnaires: KOOS, Kujala, VAS, OKS and Satisfaction Score. Radiographs were analyzed using the IWANO and Kellgren-Lawrence classification. To identify determinants of outcome, subgroups were examined according to sex, age, diagnosis, BMI and prior surgery.**

**Patellofemoral arthroplasty is a valuable treatment for patellofemoral osteoarthritis. After prosthesis placement, KOOS, Kujala, VAS and OKS improved significantly (all  $p < 0.001$ ). Patients with prior patellofemoral surgery were clinically worse ( $p < 0.05$ ). Patients with preoperative Kellgren-Lawrence grade 2 tibiofemoral osteoarthritis had a significantly worse outcome compared to grade 1 ( $p < 0.05$ ). Further research is necessary to determine whether patellofemoral arthroplasty is indicated in these patients.**

**Keywords:** arthroplasty ; Avon ; osteoarthritis ; patellofemoral ; tibiofemoral.

### INTRODUCTION

Patellofemoral osteoarthritis (OA) is a relatively common condition. Degeneration of the anterior

compartment occurs in almost 10% of people over 40 years of age (6). McAlindon *et al* (17) described it, together with isolated medial joint disease, as one of the two most common radiographic patterns of OA and pointed out that women were more than twice as likely as men to have degeneration in the patellofemoral compartment (24% vs. 11%).

If the patient does not respond to conservative measures, including weight reduction, physical therapy, analgesics, anti-inflammatory medications and intra-articular injections, surgery such as realignment of the soft tissues, arthroscopic debridement, grafting techniques, microfracture, patellectomy and facetectomy can be performed. If these operations turn out to be unsuccessful or contraindicated, arthroplasty is appropriate (21,22). Total knee arthroplasty (TKA) has shown to be a reliable treatment for isolated patellofemoral OA (14). However, there has been a lot of controversy as this technique includes an excision of the anatomically normal,

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undamaged condyles of femur and tibia and both cruciate ligaments. It is considered too invasive, especially in younger patients (3,13,21,22). Because of these drawbacks, there is an increasing interest in patellofemoral arthroplasty (PFA) (18).

As with any surgery, the first requirement for achieving a successful PFA is appropriate patient selection. The ideal candidate for this type of implant has isolated, non-inflammatory patellofemoral OA, resulting in pain and functional limitations that persist, despite fair attempts of conservative or other, less invasive operative treatments.

The primary aim of this study was to document whether PFA is a good option for people with patellofemoral OA and to identify possible prognostic factors. Throughout the years, the design of the PFA has improved. The many complications associated with the early prostheses are greatly reduced and many studies demonstrate that degeneration of the tibiofemoral joint remains the primary cause of failure and conversion to TKA (12,14,15,23,25). The secondary aim is to investigate the effect of the degree of this tibiofemoral degeneration on the clinical outcome after patellofemoral joint replacement. Therefore, the two research questions were :

- (1) What is the evolution of clinical outcome after PFA and which subgroups are at risk of worse results ?
- (2) What is the influence of tibiofemoral OA degree on clinical outcome after PFA ?

#### PATIENTS AND METHODS

The Avon prosthesis (Fig. 1, Stryker Orthopaedics, Allendale, New Jersey) is approved by the United States Food and Drug Administration (FDA). Its design is based on the sustainable patellofemoral articulation of the Kinemax Plus TKA (Stryker Orthopaedics), which had a revision rate of 7.76% (6.56-9.19) at 5 years according to the 'National Joint Registry of England and Wales', 2012 report (1, 20).

In this retrospective, non-controlled study, 37 consecutive Avon patellofemoral joint replacements were performed on 32 patients between 2004 and 2010 at the Department of Orthopaedic surgery and Traumatology of Ghent University Hospital (Fig. 2). 20 left (54.1%) and 17 right (45.9%) knees were operated on. Five women underwent bilateral procedures. One patient with bilat-



Fig. 1. — Avon patellofemoral prosthesis, Stryker orthopaedics

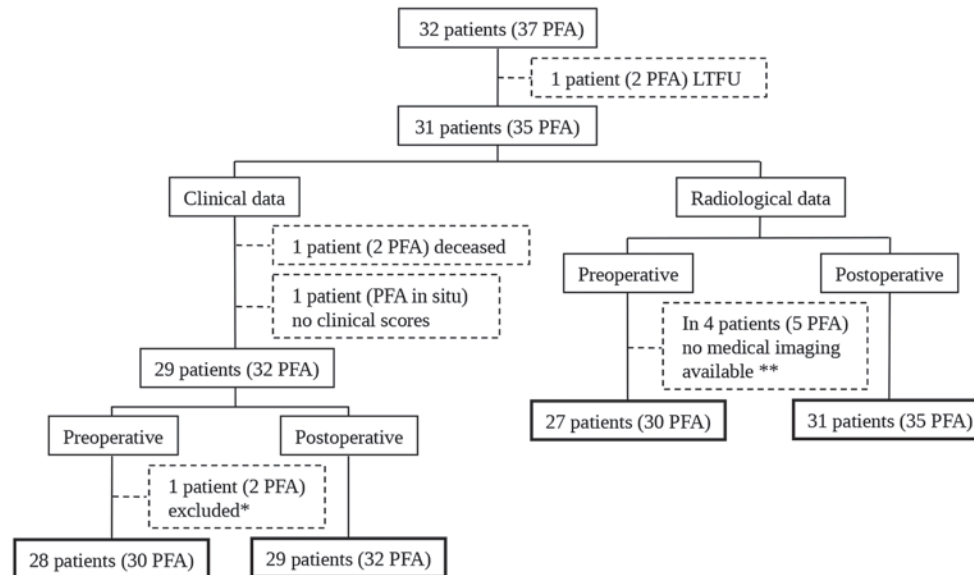
eral implants was lost to follow-up, thus 31 patients were available for clinical and radiological evaluation. The series included 26 women and five men (35 PFA), with a mean age at surgery of 49 years (26 to 66). One patient with a bilateral implant died of an unrelated cause prior to the start of the study and another patient refused to fill out the clinical scores, because of dissatisfaction with the prosthesis. Since the necessary medical imaging of these two patients was available, they were not excluded.

All patients gave informed consent, and the study was authorized by the Ethical Committee of Ghent University Hospital (IRB reference number : B670201111636).

In order to establish clinical and radiological determinants of poorer outcome, the population was subdivided according to sex, age, diagnosis of rheumatoid arthritis (RA) and diabetes, BMI and prior arthroscopic debridement, trochleoplasty and tibial tuberosity transposition (TTT) (Table I).

The main preoperative etiology was anterior knee pain due to patellofemoral OA Iwano grade 3 or 4 in 29 patients (82.9%) whilst three patients (8.6%) were operated for pain related to trochlear dysplasia. The remaining indications each occurred only once (2.9%) : reconstruction after osteosarcoma resection, revision after loosening of a previous PFA and trochlear avascular necrosis.

Clinical data was obtained using five questionnaires. The KOOS (Knee injury and OA Outcome Score), Kujala (Anterior Knee Pain Scale), VAS (Visual Analogue Scale) and OKS (Oxford Knee Score) were completed



\* Patient with rheumatoid arthritis ; preoperative questionnaires were considered unrepresentative for this study.

\*\* Iwano classification could not be determined in one patient because of a previous PFA.

**Fig. 2.** — This flowchart shows how patients were selected for this study.  
Abbreviation : LTFU = lost to follow-up.

both pre- and postoperatively. To assess the patients' satisfaction after prosthesis implantation, the Satisfaction Score, part of the Knee Society Score (KSS), was filled in postoperatively. Both the latter questionnaire and the OKS were surveyed by phone.

Radiological data was obtained by use of available axial, anteroposterior (AP) and lateral X-rays. Patellofemoral OA was assessed on preoperative axial X-rays, using the Iwano classification (1990, modified version SOFCOT 2003) (Table II, Fig. 3) (7,10). The Kellgren-Lawrence (K-L) classification was used for the identification and classification of tibiofemoral OA. (Table III, Fig. 4) (9,11).

The research questions were examined as follows :

- (1a) Comparison of pre- and postoperative surveys for the entire population.
- (1b) Comparison of pre- and postoperative surveys after division into subgroups.
- (2) Comparison of pre- and postoperative surveys of patients with preoperative K-L grade 1 versus grade 2 tibiofemoral OA.

## Statistical Analysis

Statistical analysis was performed with SPSS Statistics 21 (SPSS Inc, Chicago, IL, USA). Statistical tests included following non-parametric tests, because of a non-normal data distribution : Wilcoxon matched-pairs signed-rank test, Mann-Whitney U-test, Kruskal-Wallis test, Fischer's Exact test and Chi-square test. Statistical significance was set at  $p < 0.05$ .

## RESULTS

The mean follow-up in this series was 4 years and 7 months (23 to 105 months). According to the Kaplan Meier survival analysis and life tables, the mean survival is 8 years (95% CI : 91 months – 105 months). Three prostheses (8.6%) were converted to TKA after 23, 66 and 99 months respectively. Two because of loosening of the trochlear

Table I. — Division of the study population into subgroups

	Knee count	% of total population		Knee count	% of total population
Age $\geq$ 50 y	18	51.4	Diabetes	3	8.6
Sex (♀/♂)	30/5	85.7/14.3	Prior arthroscopic debridement	10	28.6
BMI $\geq$ 30	10	28.6	Prior trochleaplasty	7	20
RA	4	11.4	Prior TTT	6	17.1

Table II. — Stages of patellofemoral osteoarthritis ; Iwano classification

Grade 1	Patellofemoral remodelling
Grade 2	Joint space narrowing $>$ 3 mm
Grade 3	Joint space narrowing $<$ 3 mm
Grade 4	Bone-to-bone (one facet)

component and one because of symptomatic tibiofemoral disease progression.

### Results of the research questions :

(1a) Statistical analysis showed a significant clinical improvement in all the questionnaires (KOOS :  $p < 0.001$ , Kujala :  $p < 0.001$ , VAS :  $p < 0.001$ , OKS :  $p < 0.001$ ). After prosthesis placement, KOOS and Kujala respectively improved from 32.9 to 57.6 and 35.0 to 55.0. VAS and OKS improved from 7.6 to 4.1 and 10.5 to 32.1 (Table IV A, Fig. 5).

(1b) In order to identify determinants of poorer outcome, the population was divided into several subgroups. There was no significant correlation of clinical or radiological outcome with gender, age, diabetes, RA, BMI or prior arthroscopic debridement (all  $p > 0.05$ ). After prosthesis placement, patients who underwent prior TTT were clinically worse than those who did not undergo prior TTT (KOOS :  $p = 0.038$ , OKS :  $p = 0.024$ , Satisfaction Score :  $p = 0.031$  ; Table IV B). Prior trochleaplasty was associated with less satisfactory postoperative results (Satisfaction Score :  $p = 0.044$  ; Table IV C).

(2) The preoperative tibiofemoral OA degree was determined in 27 patients (30 PFA). Grade 1 K-L was observed in 14 knees (46.7%), grade 2 in 16 knees (53.3%). The postoperative tibiofemoral OA

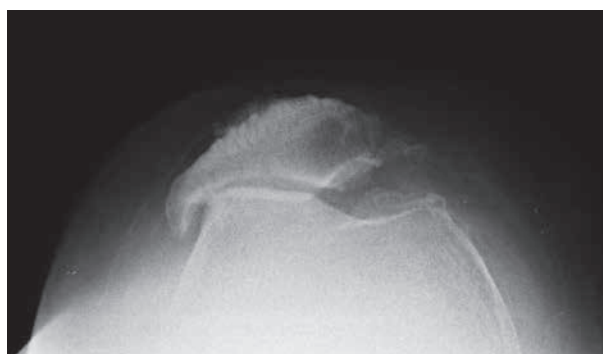
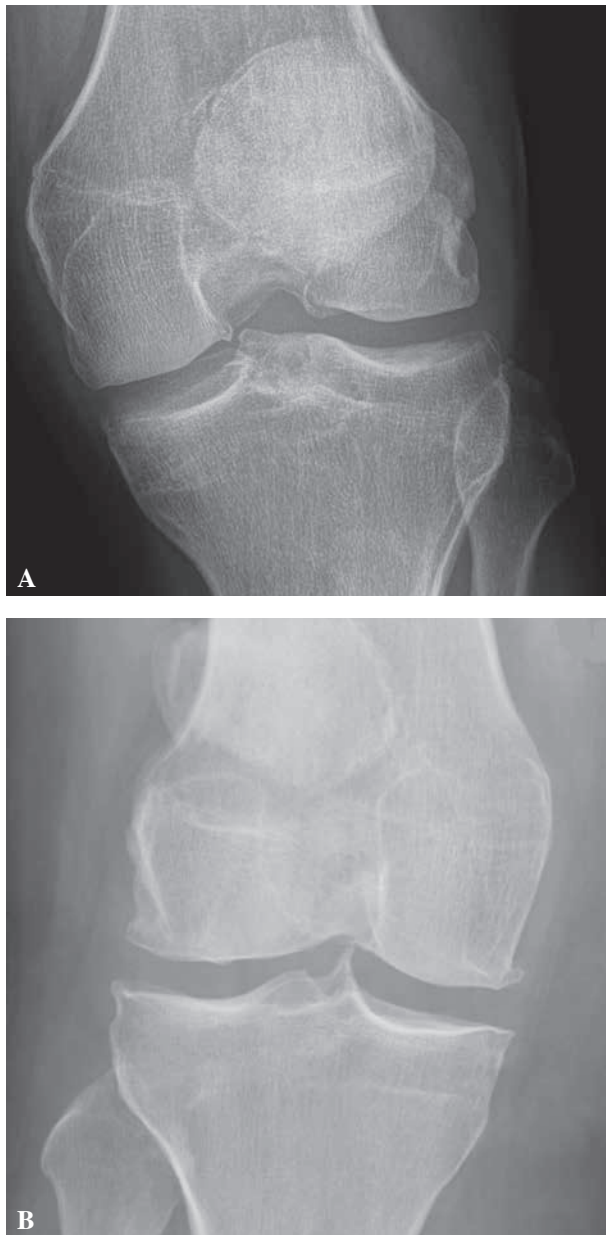


Fig. 3. — This axial view radiograph shows an Iwano grade 4 patellofemoral osteoarthritis.

degree was scored in the entire study population (35 PFA). Grade 1 K-L was noted in nine knees (25.7%), grade 2 in 20 knees (57.1%), grade 3 in four knees (11.4%) and grade 4 in two knees (5.7%) (Table V). When comparing preoperative tibiofemoral OA degree 1 vs. 2, both clinical improvement after prosthesis placement (KOOS :  $p = 0.002$ , Kujala :  $p = 0.134$ , VAS :  $p = 0.001$ , OKS :  $p = 0.001$  ; Table IV D) and postoperative scores (KOOS :  $p = 0.007$ , Kujala :  $p = 0.014$ , VAS :  $p = 0.001$ , OKS :  $p = 0.007$  ; Table IV E) were significantly better in patients with a preoperative grade 1 K-L (Fig. 6). However, when only preoperative K-L grade 2 tibiofemoral OA was considered, it still showed - although less pronounced as in grade 1 - a significant improvement of the postoperative patient reported outcome compared to the preoperative (KOOS :  $p = 0.060$ , Kujala :  $p = 0.021$ , VAS :  $p = 0.010$ , OKS :  $p < 0.001$ ) (Table IV F/G, Fig. 6).

Table III. — Stages of tibiofemoral osteoarthritis; Kellgren-Lawrence classification

Grade 0	No features of osteoarthritis
Grade 1	Doubtful narrowing of joint space and possible osteophytic lipping
Grade 2	Definite osteophytes and possible narrowing of joint space
Grade 3	Moderate multiple osteophytes, definite narrowing of joint space and some sclerosis and possible deformity of bone ends
Grade 4	Large osteophytes, marked narrowing of joint space, severe sclerosis and definite deformity of bone ends



**Fig. 4.** — Tibiofemoral osteoarthritis : A. Kellgren-Lawrence grade 1 ; B. Kellgren-Lawrence grade 2.

## DISCUSSION

Lonner (14) described the Avon prosthesis, comparing it to the Lubinus PFA (Link, Hamburg, Germany). He concluded that the incidence of poor results due to patellofemoral dysfunction, subluxation, clicking and considerable pain dropped to 4%, compared to 17% in the Lubinus prosthesis. Ackroyd *et al* (1) reported clinically good results with the Avon prosthesis in a group of 109 patients, with a 5-year survival rate of 95.8%. This result has been confirmed by several independent centers (19, 22). In general, the published results are encouraging, but further studies with longer follow-up are necessary in order to determine whether these results persist.

This study evaluates 37 patellofemoral prostheses, implanted in 32 patients. The relatively small population is a limitation of this study. Besides, it is a retrospective study without control group. Alignment of the legs could not be determined as full leg recordings were not performed. The strengths of this study are the many surveys used and the fact that only one patient dropped out. This ensures a fairly complete clinical and radiographic evaluation of the patellofemoral prostheses, performed at Ghent University Hospital.

The first aim of this study was to investigate the patient's direct benefit from the prosthesis placement. Comparison of pre- and postoperative surveys showed clinical improvement after the operation (all  $p < 0.001$ ). In order to identify determinants of poorer outcome, the population was divided into several subgroups. In this study, neither gender nor age influenced clinical or radiological outcomes, which is consistent with the literature (12,16,24). Even though RA is considered an absolute contraindication for PFA by some authors (12,15), in this

Table IV. —

A : Comparison between pre- and postoperative scores in the entire study population

B : Comparison of postoperative scores between patients that did and did not undergo TTT

C : Comparison of Satisfaction Score between patients that did and did not undergo trochleaplasty

D : Comparison of improvement in scores between patients with preoperative Kellgren-Lawrence grade 1 and 2 osteoarthritis ;  $\Delta$  = improvement in questionnaire score (difference between pre- and postoperative questionnaire scores)

E : Comparison of postoperative scores between patients with preoperative Kellgren-Lawrence grade 1 and 2 osteoarthritis

F : Comparison between pre- and postoperative scores in patients with preoperative Kellgren-Lawrence grade 1 osteoarthritis

G : Comparison between pre- and postoperative scores in patients with preoperative Kellgren-Lawrence grade 2 osteoarthritis

A. Total population		Mean	IQR	P-value
KOOS	Preoperative	32.9	25.0 to 42.0	< 0.001
	Postoperative	57.6	42.3 to 72.5	
Kujala	Preoperative	35.0	27.5 to 44.0	< 0.001
	Postoperative	55.0	40.3 to 73.3	
VAS	Preoperative	7.6	6.7 to 8.5	< 0.001
	Postoperative	4.1	2.3 to 5.8	
OKS	Preoperative	10.5	7.0 to 14.0	< 0.001
	Postoperative	32.1	24.3 to 39.0	
B. Total population		Mean	IQR	P-value
KOOS	No TTT	60.9	50.5 to 73.2	0.038
	TTT	43.3	27.1 to 54.5	
OKS	No TTT	33.7	30.3 to 39.5	0.024
	TTT	25.0	17.8 to 31.8	
Satisfaction	No TTT	30.0	24.0 to 38.0	0.031
	TTT	22.0	17.0 to 26.0	
C. Total population		Mean	IQR	P-value
Satisfaction	No trochleaplasty	29.8	24.0 to 38.0	0.044
	Trochleaplasty	23.7	22.0 to 30.0	
D. Total population		Mean	IQR	P-value
$\Delta$ KOOS	Pre K-L grade 1	38.5	28.9 to 45.3	0.002
	Pre K-L grade 2	14.6	-0.3 to 26.2	
$\Delta$ Kujala	Pre K-L grade 1	31.8	14.0 to 43.0	0.134
	Pre K-L grade 2	15.4	-2.3 to 26.8	
$\Delta$ VAS	Pre K-L grade 1	5.3	3.8 to 6.4	0.001
	Pre K-L grade 2	2.0	0.0 to 3.1	
$\Delta$ OKS	Pre K-L grade 1	28.6	24.5 to 33.5	0.001
	Pre K-L grade 2	14.8	2.0 to 24.0	
E. Total population		Mean	IQR	P-value
KOOS	Pre K-L grade 1	69.9	58.3 to 83.3	0.007
	Pre K-L grade 2	49.7	36.4 to 61.3	
Kujala	Pre K-L grade 1	67.4	52.0 to 81.8	0.014
	Pre K-L grade 2	49.1	40.0 to 56.5	
VAS	Pre K-L grade 1	2.3	1.2 to 3.4	0.001
	Pre K-L grade 2	5.1	3.2 to 7.1	

OKS	Pre K-L grade 1	37.1	33.3 to 43.0	0.007
	Pre K-L grade 2	28.1	20.0 to 33.0	
F. Pre K-L grade 1		Mean	IQR	P-value
KOOS	Preoperative	32.5	25.0 to 41.1	< 0.001
	Postoperative	69.9	58.3 to 83.3	
Kujala	Preoperative	37.2	25.5 to 47.0	0.001
	Postoperative	67.4	52.0 to 81.8	
VAS	Preoperative	7.6	6.7 to 8.3	< 0.001
	Postoperative	2.3	1.2 to 3.4	
OKS	Preoperative	8.7	5.5 to 10.5	< 0.001
	Postoperative	37.1	33.3 to 43.0	
G. Pre KL grade 2		Mean	IQR	P-value
KOOS	Preoperative	34.6	18.3 to 48.7	0.060
	Postoperative	49.7	36.4 to 61.3	
Kujala	Preoperative	33.8	26.5 to 44.0	0.021
	Postoperative	49.1	40.0 to 56.5	
VAS	Preoperative	7.4	6.4 to 8.6	0.010
	Postoperative	5.1	3.1 to 7.1	
OKS	Preoperative	12.8	8.3 to 14.0	< 0.001
	Postoperative	28.1	20.0 to 33.0	

Abbreviation : IQR = Interquartile range.

study there were no significant differences in clinical outcome. Similarly, three diabetic patients showed no significant clinical differences compared to patients without diabetes. However, as stated before, numbers are low. Clinical improvement, experienced by patients with a BMI greater than 30, was comparable to the non-obese. Although it is generally assumed that obesity has a negative effect on the clinical outcome of knee prostheses (5,8), several authors conclude this is not the case (2,4). Even radiographically, no significant differences were noted between obese and non-obese patients. This is contrary to a body of literature, which states that BMI over 30 is an important factor that may contribute to the progression of tibiofemoral OA and subsequent failure of the prosthesis. Prior arthroscopic debridement was not associated with significant differences in the clinical or radiological parameters. However, patients who underwent prior TTT or trochleaplasty were significantly less satisfied with the result of the prosthesis. Furthermore,

patients who underwent prior TTT had a significantly poorer outcome. This is concurrent with the observation that several previous operations can adversely influence the clinical outcome (12).

The secondary aim of this study was to explore the effect of preoperative tibiofemoral OA degree on the clinical outcome. Obviously, degeneration in this compartment cannot be too extensive prior to PFA. Progression of OA is indeed the main cause of failure of PFA (16,23). At Ghent University Hospital, the PFA was performed in patients with K-L grade 1 and 2 tibiofemoral OA. Although patients with tibiofemoral OA grade 2 still showed a significant improvement in clinical parameters after PFA, this improvement was significantly better in those with K-L grade 1. One of the three converted study patients received a TKP because of progression of tibiofemoral OA. This patient had indeed a preoperative K-L grade 2 tibiofemoral OA. Leadbetter *et al* (12) consider grade 2 tibiofemoral OA as an absolute contraindication for PFA. Despite the

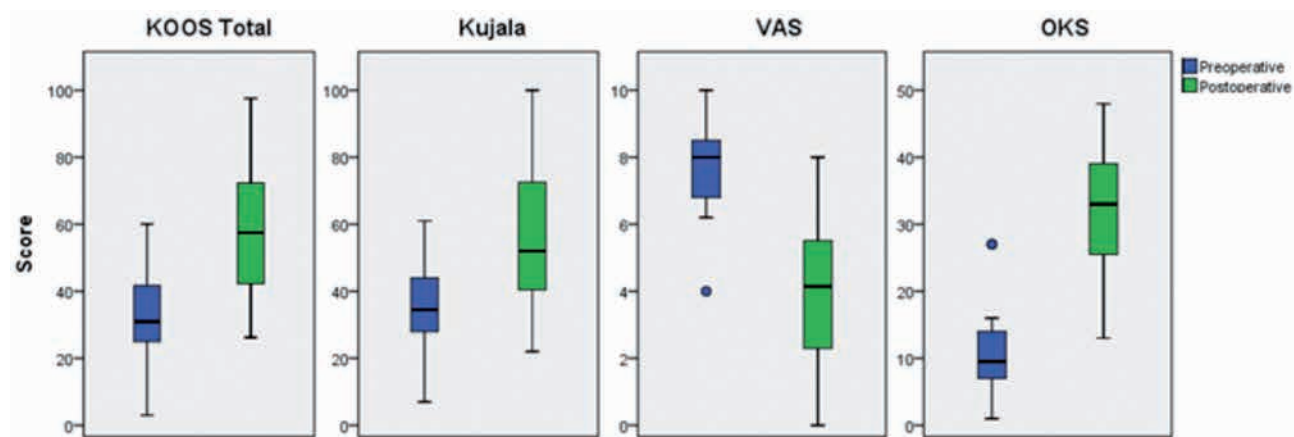


Fig. 5. — These boxplots show the evolution in questionnaire scores after prosthesis placement ; total study population

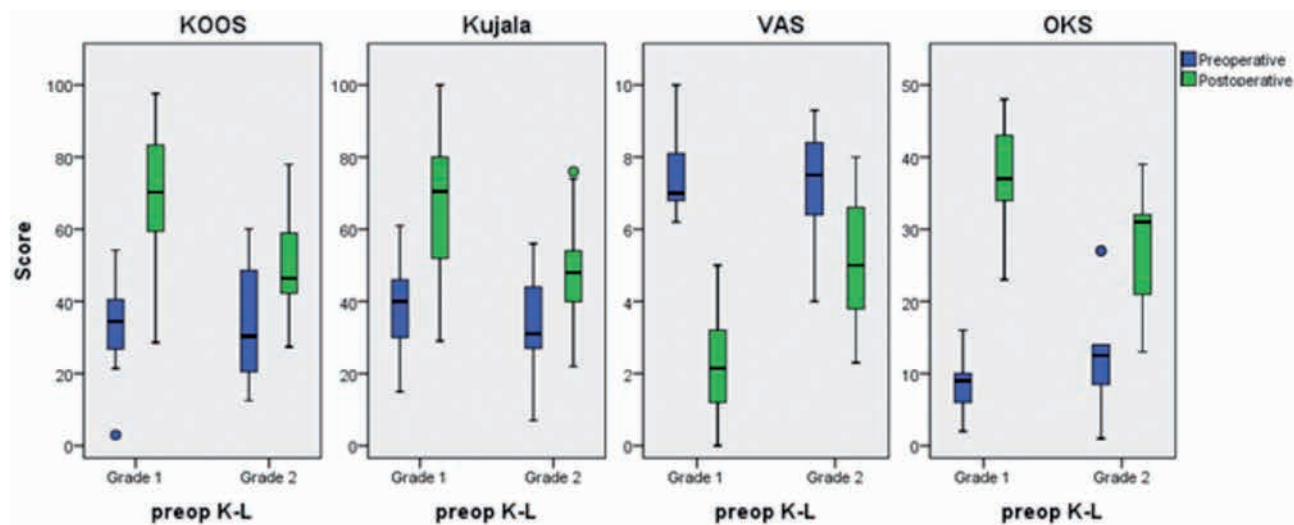


Fig. 6. — These boxplots show the evolution in questionnaire scores after prosthesis placement; population subdivided in preoperative Kellgren-Lawrence grade 1 vs. grade 2.

Table V. — Evolution between pre- and postoperative Kellgren-Lawrence grading

		Postoperative Kellgren-Lawrence				Total
		Grade 1	Grade 2	Grade 3	Grade 4	
Preoperative Kellgren-Lawrence	Grade 1	7	5	1	1	14
	Grade 2	0	13	3	0	16
	Imaging n.a.	2	2	0	1	5
Total		9	20	4	2	35

Abbreviation : n.a., not available.



clinical improvement shown in this study, it remains questionable whether PFA is indicated in greater than grade 1 tibiofemoral OA.

### CONCLUSIONS

After implantation of the patellofemoral prosthesis, a significant improvement in knee function was established in a retrospective series ( $p < 0.001$ ). Patients with preoperative grade 2 K-L tibiofemoral OA had a significantly worse clinical outcome than those with grade 1 tibiofemoral OA. Nevertheless, these patients still had a clinical improvement post-operatively. Further research will be necessary to determine whether PFA is indicated in patients with grade 2 K-L tibiofemoral OA.

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