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Low grading of the severity of knee osteoarthritis pre-operatively is associated with a lower functional level after total knee replacement

A PROSPECTIVE COHORT STUDY WITH 12 MONTHS' FOLLOW-UP

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The optimal timing of total knee replacement (TKR) in patients with osteoarthritis, in relation to the severity of disease, remains controversial. This prospective study was performed to investigate the effect of the severity of osteoarthritis and other commonly available pre- and post-operative clinical parameters on the clinical outcome in a consecutive series of cemented TKRs. A total of 176 patients who underwent unilateral TKR were included in the study. Their mean age was 68 years (39 to 91), 63 (36%) were male and 131 knees (74%) were classified as grade 4 on the Kellgren–Lawrence osteoarthritis scale. A total of 154 patients (87.5%) returned for clinical review 12 months post-operatively, at which time the outcome was assessed using the Knee Society score.

A low radiological severity of osteoarthritis was not associated with pain 12 months post-operatively. However, it was significantly associated with an inferior level of function (p = 0.007), implying the need for increased focus on all possible reasons for pain in the knee and the forms of conservative treatment which are available for patients with lower radiological severity of osteoarthritis.

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The prevention and treatment of pain are important challenges in achieving and maintaining patient satisfaction after total knee replacement (TKR).[1] Several parameters are crucial for successful TKR in patients with osteoarthritis (OA). These include pre-operative patient parameters, the implants, the surgical procedure, post-operative treatment and rehabilitation.[2-5] Several factors besides the pathology have been found to be influential in the appreciation of pain in the knee. Anxiety and 'catastrophising' are poor prognostic factors, implying that the pre- and post-operative mental well-being of the patient affects the outcome.[1] In a consecutive series of patients with TKRs, it was recently found that pre-operative education of the patient may reduce joint stiffness and arthrofibrosis post-operatively.[6]

The indications for TKR are traditionally based on age, function, severity of disease, and the response to other forms of treatment.[7-11] Previous studies have shown that female gender, a younger age at the time of surgery (< 60 years), obesity, depression and anxiety are associated with an inferior outcome after TKR,[2,12-15] which emphasises the importance of careful patient selection.[8-11] The timing of surgery has also been found to be crucial.[16] Waiting too long may cause central pain sensitisation and functional decline, whereas excessively early surgery increases the risk of a poor outcome.[17] This prospective cohort study was designed to evaluate the association between the outcome 12 months after TKR and clinical parameters normally available to the surgeon, in order to improve patient selection.

Patients and Methods

This study was based on systematically collected data which were routinely obtained pre- and post-operatively and involved 188 consecutive patients who underwent unilateral primary TKR for OA at the Department of Orthopaedic Surgery, Clinic Frederikshavn, Aalborg University Hospital between November 2007 and September 2009. The indications for TKR were pain that limited function and had not responded to treatment, in conjunction with severe cartilage loss demonstrated by radiography or arthroscopy. A total of 12 patients were

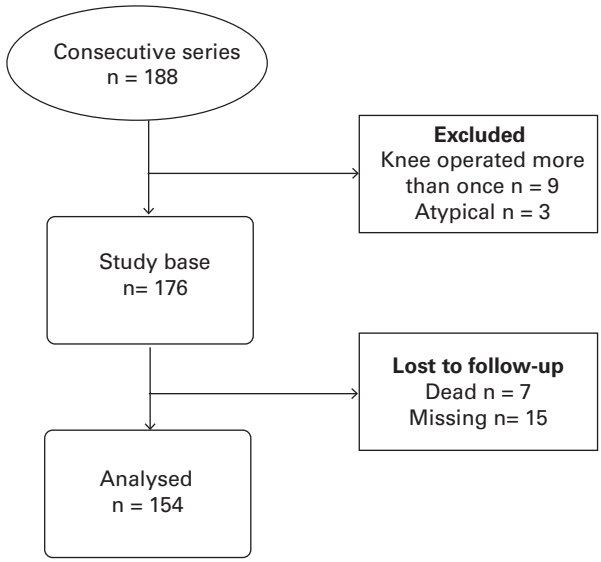

Fig. 1

Flow chart of patients. Follow-up data were available for 154 patients.

excluded, as they had previously undergone arthroscopy or patellectomy of the knee, or amputation of the contralateral leg. A total of 22 patients were lost to follow-up (Fig. 1). The loss to follow-up was similar for patients with grades 0 to 3 and grade 4 radiological osteoarthritis (Kellgren–Lawrence).[18] Hence 16 (12%) grades 4 and 6 (13%) grades 2 to 3 patients were lost to follow-up.

Anaesthesia and surgery. A standardised technique was used for all operations. The Nexgen prosthesis (Zimmer, Warsaw, Indiana) was used, with Rebofacin cement (Biomet, Warsaw, Indiana) and patellar resurfacing in all patients. All surgery was performed under spinal anaesthesia with a tourniquet, using a medial parapatellar approach. Tranexamic acid (10 mg/kg) was given intravenously before release of the tourniquet, and three hours later. Patients were mobilised into the sitting or standing position a few hours after surgery. Active exercises and mobilisation started the day after the operation.

Pre-operative data. The radiological severity of the OA (Fig. 1) was assessed from pre-operative radiographs (standing anteroposterior (AP) view in 15º of flexion and a supine lateral view in 45º of flexion) by an experienced radiologist (OS) and graded according to the Kellgren–Lawrence (KL)[18] and Ahlbäck systems.[19] Patient-reported Body mass index (BMI) was dichotomised as either obese (≥ 30 kg/m^2) or not obese (< 30 kg/m^2). Patient-reported pre-operative pain after walking 50 metres was assessed using a visual analogue scale (VAS; 0 to 10, best to worst) and dichotomised at ≤ 5 and > 5 points. Pre-operative KSS pain has been presented in seven categories (1 to 7, best to worst) as baseline information (Table I).

Immediate post-operative data. The circumference (cm) of the knee was measured at the mid-patellar position in the supine position. Swelling was calculated as the difference between the values pre-operatively and two days post-operatively. Blisters were assessed two days post-operatively and were dichotomised as either no treatment required or blisters requiring treatment. Bruising was assessed two days post-operatively and was dichotomised as either none/ minimal discoloration or marked discoloration. Drainage (> 275 ml) was recorded the morning after the operation between 7 am and 8 am. Reduction in the level of haemoglobin (mmol/l) post-operatively was calculated from the values pre-operatively and at discharge after a median of three days (IQR 2 to 4) and analysed as a continuous variable. The range of flexion (º) was assessed as active movement in the supine position at discharge.

Outcome measures. Pain and function were assessed using the original Knee Society score (KSS) 12 months post-operatively.[20] The pain component of the KSS was dichotomised as either none to mild, or moderate to severe. Function was dichotomised as either low (0 to 80 points) or high (81 to 100 points).

Statistical analysis. Continuous parameters are presented as the mean and range if normally distributed, otherwise the median and interquartile ranges are given. Dichotomised parameters are presented as the count (%). Descriptive differences in levels of pain 12 months post-operatively between patients with severe OA, and those with non-severe OA according to the pre-operative KL grading, were compared using Pearson's chi-squared test. In binary logistic regression models, we analysed the unadjusted and

Table I. Baseline characteristics are presented as numbers (%), means and range (R)), or medians and interquartile range (IQR)

Demographics	n = 176 (%)
Kellgren–Lawrence[18] (grade 0)	1 *(1)*
Kellgren–Lawrence (grade 1)	10 *(6)*
Kellgren–Lawrence (grade 2)	11 *(6)*
Kellgren–Lawrence (grade 3)	23 *(13)*
Kellgren–Lawrence (grade 4)	131 *(74)*
Ahlbäck[19] (grade 0)	8 *(5)*
Ahlbäck (grade 1)	48 *(27)*
Ahlbäck (grade 2)	60 *(34)*
Ahlbäck (grade 3)	46 *(26)*
Ahlbäck (grade 4)	9 *(5)*
Ahlbäck (grade 5)	5 *(3)*
Median KSS function score (0 to 100 points)	35 (IQR 30 to 55)
Median KSS pain score (1 point = low, 7 points = high)	6 (IQR 6 to 7)
Mean age (yrs)	68 (39 to 91)
Gender (male)	63 *(36)*
BMI (≥ 30 kg/m^2)	73 *(41)*
Median pre-operative visual analogue score for pain (after 50 m walk)	6 (IQR 4 to 8)

KSS, American Knee Society score

Table II. Unadjusted pre-operative and immediate post-operative findings analysed in a binary logistic regression model as predictors for high Knee Society function scores and low knee society pain scores at 12 months presented as unadjusted odds ratios (OR) with 95% confidence intervals (CI)

Pre- and immediate post-operative parameters	High function score (American Knee Society score) OR (95% CI)	p-value function score	Low pain score OR (95% CI)	p-value pain score
Kellgren–Lawrence[18] (grade 4)	1.19 (0.58 to 2.45)	0.633	3.02 (1.13 to 8.10)	0.028
Ahlbäck[19] (grades 3 to 5)	2.41 (1.22 to 4.76)	0.011	2.42 (0.76 to 7.70)	0.133
Age (yrs)	0.94 (0.91 to 0.98)	0.001	1.01 (0.96 to 1.06)	0.720
Gender (male)	2.47 (1.24 to 4.91)	0.010	0.57 (0.22 to 1.51)	0.262
BMI (≥ 30 kg/m^2)	0.76 (0.40 to 1.45)	0.403	0.74 (0.28 to 1.94)	0.542
Pre-operative pain (VAS > 5)	0.49 (0.26 to 0.94)	0.031	0.40 (0.15 to 1.09)	0.071
Swelling (> 4.5 cm)	0.86 (0.46 to 1.63)	0.650	1.03 (0.40 to 2.70)	0.949
Blisters (requiring treatment)	1.26 (0.61 to 2.61)	0.531	0.55 (0.20 to 1.52)	0.253
Bruising (marked discoloration)	0.52 (0.26 to 1.03)	0.061	0.99 (0.35 to 2.78)	0.983
Drainage (> 275 ml)	1.51 (0.80 to 2.85)	0.204	0.94 (0.36 to 2.46)	0.901
Haemoglobin decrease (mmol/l)	1.07 (0.61 to 1.86)	0.821	0.53 (0.20 to 1.38)	0.192
Range of flexion (°)	1.00 (0.99 to 1.00)	0.364	1.00 (0.98 to 1.03)	0.718

Age, haemoglobin decrease and range of flexion were analysed as continuous variables

adjusted effects of the parameters on the 12-month post-operative KSS function and pain scores. Construction of multivariate models followed the 'purposeful selection of variables' proposed by Hosmer et al.[21] It was decided by all authors to adjust for age, gender and BMI, as these parameters were considered to have clinical significance. Pre-operative KSS scores were included in the models if they caused a change in estimates of > 10%. The size of the study group allowed us to include a further 12 previously defined potential parameters using a ratio of approximately 15 patients per parameter.[21] Parameters with a p-value < 0.20 in the unadjusted analysis were included in the multivariate analysis. The parameters in the final model with a p-value > 0.05 were only kept in the model if they caused a > 10% change in the estimate of the other variables in the multivariate model. Analyses were performed using Stata 10.0 (Stata Corporation, College Station, Texas). The level of significance was set at $p < 0.05$.

Results

Severe narrowing of the joint line (KL grade 4) and bone attrition (Ahlbäck[19] grades 3 to 5) were found in 131 (74%) and 60 (34%) of the patients, respectively (Table I). Among the patients with pre-operative KL grade 4 changes, 104 (91%) had no or mild pain 12 months post-operatively, compared with 31 (78%) in those with KL grades 0 to 3 ($p = 0.028$). All predictors are presented in unadjusted binary logistic regression models (Table II).

After adjusting for other explanatory parameters, a severe Ahlbäck radiological grading was associated with a high functional score 12 months post-operatively (OR 2.77, $p = 0.007$), as were lower age and male gender. How-

Table III. Adjusted odds ratios (OR) with 95% confidence intervals (CI) between parameters collected pre-operatively and at 12 months post-operatively. Kellgren–Lawrence[18] and Ahlbäck[19] grades are not included in the same model. All other parameters are adjusted for the Kellgren– Lawrence grade.

Pre- and immediate post-operative parameters	High function score (American Knee Society score) OR (95% confidence interval)	p-value function score	Good pain score OR (95% confidence interval)	p-value pain score
Kellgren–Lawrence (grade 4)	1.48 (0.67 to 3.27)	0.334	2.80 (1.00 to 7.84)	0.050
Ahlbäck (grades 3 to 5)	2.77 (1.32 to 5.83)	0.007	2.42 (0.74 to 7.94)	0.145
Age (yrs)	0.94 (0.90 to 0.98)	0.002	1.01 (0.96 to 1.07)	0.586
Gender (male)	2.19 (1.03 to 4.68)	0.042	0.68 (0.24 to 1.93)	0.465
BMI (≥ 30 kg/m^2)	0.67 (0.31 to 1.42)	0.295	0.79 (0.27 to 2.29)	0.659
Pre-operative pain (VAS > 5)	0.59 (0.29 to 1.20)	0.149	0.35 (0.12 to 1.04)	0.059
Drainage (> 275 ml)	1.34 (0.65 to 2.76)	0.425	*	*
Haemoglobin decrease (mmol/l)	*	*	0.48 (0.17 to 1.39)	0.176
Range of flexion (°)	*	*	1.00 (0.99 to 1.04)	0.698

*Not included in the final model because p > 0.20 in the unadjusted analyses. Pre-operative Knee Society scores were only included in the models if they changed the estimates > 10%. Age, haemoglobin decrease and range of flexion were analysed as continuous variables

ever, radiological grading, age, gender and the other possible predictors could not significantly predict KSS pain after 12 months (Table III).

Discussion

In this study of patients undergoing unilateral TKR it was found that a less severe radiological OA grading was associated with worse function 12 months post-operatively, as were higher age and female gender. Increased severity of swelling, blisters, bruising, drainage, decreased level of haemoglobin, and range of flexion post-operatively were not associated with the outcome at this time.

We used the KSS as the outcome measure because the KSS knee and function scores are routinely recorded in the National Knee Arthroplasty Register.[22] Although it is a widely-used scoring system,[23] it has a weaker content validity and responsiveness than others.[24] It is divided into a knee score, including pain, mediolateral stability, flexion contracture and alignment, and a function score, including walking distance and stair climbing. Whereas the knee score has poor reproducibility, the function score has good reproducibility.[25] A study of the reliability of the different components of the knee score found the pain component to offer moderate to good inter- and intra-observer reproducibility, whereas components such as mediolateral stability and flexion contracture only offered poor to fair reproducibility.[26] Therefore, we decided to keep the function score as an outcome measure and to use the pain component from the knee score as our other outcome measure. We accept that post-operative data on malposition, instability, infection and loosening might have added to the interpretation of post-operative pain and function. Information on conditions such as bursitis or tendonitis, referred pain from the lumbar spine, vascular claudication and fibromyalgia could also have contributed to extra-articular causes of pain and function post-operatively.

If more patients had been included with normal, doubtful or minimal OA, it could have allowed the inclusion of the traditional threshold cut-off (KL< 3). However, owing to insufficient numbers of knees in these categories, this analysis would not have been meaningful.

Our study is the first to investigate the radiological severity of OA as a predictor of pain in a consecutive series. Knees with a lower radiological grade of OA pre-operatively had a lower KSS function score 12 months post-operatively. This study is not directly comparable with previously reported non-consecutive series, which also included patients undergoing bilateral TKR. In earlier studies Chang et al[16] found severe pre-operative pain and poor pre-operative function scores to be associated with worse 12-month post-operative pain and function scores. Among 97 patients with unilateral and 143 patients with bilateral TKR, they found no significant associations between the pre-operative radiological severity of OA and the outcome. However, the trend in most recent publications is that patients with less severe OA of the knee have inferior results after TKR. In one study, 860 patients who had undergone unilateral or bilateral TKR were reviewed. The presence of a low radiological grade of OA (KL < 3) resulted in a significantly increased risk of severe pain at three years' follow-up measured using the Western Ontario and McMaster Universities Osteoarthritis Index.[27,28] In a selected group of 63 patients undergoing TKR, a lower pre-operative Ahlbäck OA grading was associated with more pain on knee movement 18 months post-operatively. There was a significant association with the Ahlbäck classification but not the KL classification.[29] In our study we found a borderline significant association between pain 12 months post-operatively (p = 0.05) for the KL classification (KL< 4). This trend is further supported by a recent study involving 309 patients[30] where a less severe pre-operative grading of OA was associated with pain 12 months post-operatively after uncomplicated and technically optimal TKR. Among the patients with less severe OA (KL grade < 3), 49% had persistent post-operative pain.

Our study supports the most recent findings of an association between less severe pre-operative radiological OA and a poorer outcome after TKR.[27,29,30] Recognising this

and avoiding premature surgery could assist in reducing the number of patients who are dissatisfied[14] following TKR. Further research is needed to determine the optimal cut-off point in OA grading to obtain the best possible outcome after TKR.

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