Flexion Contracture Following Primary Total Knee Arthroplasty: Risk Factors and Outcomes

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abstract

Function and satisfaction after total knee arthroplasty (TKA) are partially linked to postoperative range of motion (ROM). Fixed flexion contracture is a recognized complication of TKA that reduces ROM and is a source of morbidity for patients. This study aimed to identify preoperative risk factors for developing fixed flexion contracture following TKA and to quantify the effect of fixed flexion contracture on outcomes (Oxford knee score 12-60 and patient satisfaction) at 2 years. Pre-, intra-, and postoperative data for 811 TKAs were retrospectively reviewed. At 2 years postoperatively, the incidence of fixed flexion contracture was 3.6%. Men were 2.6 times more likely than women to have fixed flexion contracture ($P=0.012$), and patients with preimplant fixed flexion contracture were 2.3 times more likely than those without to have fixed flexion contracture ($P=0.028$). Increasing age was associated with an increased rate of fixed flexion contracture ($P=0.02$). Body mass index was not a risk factor ($P=0.968$). Incidence of fixed flexion contracture for those undergoing computer navigated TKA was 3.9% compared with 3.4% for those having conventional surgery ($P=0.711$). Patients with fixed flexion contracture had poorer outcomes with a median [interquartile range] Oxford Knee Score of 25 [15] compared with 20 [11] for those without ($P=0.003$) and lower patient satisfaction ($P=0.036$). These results support existing literature for incidence of fixed flexion contracture after TKA, risk factors, and outcomes, indicating that these figures can be extrapolated to a wide population. They also clarify a previously contentious point by excluding body mass index as a risk factor.

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Total knee arthroplasty (TKA) is considered a successful operation with beneficial outcomes for patients with disabling arthritis of the knee. Postoperative function and satisfaction are partially linked to postoperative range of movement (ROM). Fixed flexion contracture is a recognized complication of TKA, which reduces ROM and is a source of morbidity for patients.

Fixed flexion contracture prevents the knee from achieving full extension. It is thought to be a result of abnormalities in bony anatomy, as well as soft tissue contracture and tightness around the joint. This causes quadriceps muscle fatigue, anterior knee pain, altered gait mechanics, and lower knee outcome scores and patient dissatisfaction with the arthroplasty.

With conservative management, fixed flexion contracture can improve for up to 3 years postoperatively, but not all resolve satisfactorily. Revision surgery can produce reasonable improvement in ROM, but the risk of complications with additional operative procedures is high. The best method of combating the problems created by fixed flexion contracture is primary prevention.

In a study of 5622 conventional TKAs, Ritter et al found the incidence of postoperative fixed flexion contracture to be 3.6%. They identified sex, increasing age, and greater preoperative fixed flexion contracture as risk factors and quantified the risk in each case. They identified that reduced body mass index (BMI) was positively associated with increased fixed flexion contracture but doubted the validity of this finding because they reported that their measurements of the larger legs of patients with high BMIs may have been inaccurate.

Theoretically, fixed flexion contracture deformity can be corrected during TKA by a combination of cutting more bone from the distal femur and proximal tibia to increase the extension gap, soft tissue release, and precise component positioning.

Computer-navigated surgery has led to an improved ability to recreate neutral coronal alignment of the lower limb, with comparison of conventional techniques showing increased accuracy of femoral component positioning with a narrower range of results and fewer outliers in computer-navigated cohorts. Computer navigation illustrates the size of bone cuts, aids soft tissue balancing, and allows intraoperative flexion and extension to be accurately quantified. It may be expected that use of computer navigation in TKA would reduce the incidence of postoperative fixed flexion contracture. However, as far as we are aware, no studies have investigated whether computer navigation in TKA has an effect on the incidence of postoperative fixed flexion contracture.

The primary aim of this study was to identify preoperative risk factors for developing fixed flexion contracture following TKA. The secondary aim was to quantify the effect of fixed flexion contracture on outcomes at 2 years.

**MATERIALS AND METHODS**

This work was performed under the clinical governance procedures of our institution.

All patients in our institution who underwent TKAs between December 2003 and January 2007 and had attended their 2-year follow-up appointment were identified using the hospital’s computerized database (Excelicare; AsSys Technology Ltd, Paisley, United Kingdom).

Case notes and Excelicare were routinely used to access data recorded during admission for operation and at 2-year follow-up. Demographic data collected included age, BMI, sex, and operated side. Preoperative data collected were maximum active knee extension, maximum active knee flexion, and Oxford Knee Score (scale from 12-60, with higher score indicating worse function).

Perioperative data collected included preimplant fixed flexion contracture measured with the patient under anesthetic to the nearest 5° by the operating surgeon, type of implant used as chosen by the surgeon based on preference (cruciate retaining or cruciate sacrificing/posterior stabilized), whether the operation was performed using computer navigation, and whether the patient was referred for outpatient physiotherapy after hospital discharge.

At 2-year follow-up, patient satisfaction (as assessed with a 4-point Likert scale: very satisfied, satisfied, unsure, and dissatisfied) and maximum active knee flexion and extension were recorded. Active knee joint ROM was measured by specialist arthroplasty practitioners independent of this study. Measurements were taken using plastic goniometers on the lateral aspect of the leg with patients in the supine position, using the vertical mid points of the thigh and lower leg as reference points for the arms of the goniometer.

Knees were grouped according to Ritter et al’s classification of fixed flexion contracture based on measured active extension at 2-year follow-up:

1. No fixed flexion contracture: maximum extension angles of 6° hyperextension to 5° flexion.
2. Intermediate fixed flexion contracture: maximum extension angles of 6° to 19° flexion.
3. Severe fixed flexion contracture: maximum extension angles of ≥20° flexion.

These criteria were also used to categorize the intraoperative preimplant flexion contracture.

**Statistics**

Data were analyzed using SPSS version 17.0 software (IBM 2010, Chicago, Illinois) and Excel 2003 (Microsoft, Redmond, Washington). Groups were compared statistically using Mann-Whitney
for continuous variables and chi-squared or Fisher’s exact tests for categorical variables. Odds ratios were calculated where appropriate when a statistically significant difference was identified. Data were incomplete for preoperative Oxford Knee Score, preoperative maximum flexion, preoperative extension, and referral to outpatient physiotherapy. Therefore, only descriptive statistics were calculated for these variables.

RESULTS

The inclusion criteria were fulfilled by 815 primary TKAs. Four of these had not had active extension measurements recorded at follow-up, so they were excluded. The study cohort was 811 knees (806 patients, 5 bilateral TKAs). The mean time between operation and follow-up was 24.3 ± 1.2 months (range, 19.0–29.7 months). Twenty-nine knees (3.6%) had an intermediate or severe fixed flexion contracture (24 intermediate, 5 severe) measured at 2-year follow-up. Due to the small numbers of severe fixed flexion contracture, the cohort was analyzed as no fixed flexion contracture and fixed flexion contracture where fixed flexion contracture included both intermediate and severe.

Comparison of the demographics of the fixed flexion contracture and no fixed flexion contracture group found that sex and age differed significantly (Table 1). Men were more likely to have fixed flexion contracture at 2 years, with an odds ratio of 2.6, compared with women. Older patients were more likely to have fixed flexion contracture. However, no significant difference existed in the BMIs of the 2 groups (Table 1).

The intraoperative data were compared and showed that preimplant fixed flexion contracture and implant type were significantly different (Table 2). Those with a preimplant fixed flexion contracture were more likely to have a fixed flexion contracture at 2 years, with an odds ratio of 2.3. Proportionally, more posterior-stabilized implants were used in the fixed flexion contracture group. No statistical differences existed in the proportion of navigated surgeries in either group.

The 2-year follow-up outcomes for each group were compared and showed that the Oxford Knee Score was significantly higher and maximum flexion and satisfaction were significantly lower in the fixed flexion contracture group (Table 3).

The preoperative data indicated that Oxford scores and maximum flexion were similar in the 2 groups and that maximum extension was worse in the fixed flexion contracture group. More patients with fixed flexion contracture at 2 years had been referred for outpatient physiotherapy on discharge (Table 4).

DISCUSSION

The incidence of postoperative fixed flexion contracture at 2 years was 3.6% in our series of 811 primary TKAs. These results are similar to those of Ritter et al, who found the incidence of fixed flexion contracture at 3 years to be 3.6% in a study of 5622 knees. It has been shown that a continued improvement of fixed flexion contracture can be expected for up to 3 years, so our figure may be a slight overestimate.

This study was a retrospective review of data collected as part of routine clinical practice. Therefore, several limitations
exist. Data sets were not always complete. This was particularly true for preoperative data because several patients in our cohort had been reassessed in other hospitals. It is not known whether any trends exist in these missing data.

Also, it was not possible to assess all risk factors for developing fixed flexion contracture. Theoretically, patients with bilateral arthritis and fixed flexion contracture on the contralateral side are more susceptible to developing a fixed flexion contracture in the operated knee as a result of a flexed knee stance dictated by the nonoperated side. Effective postoperative physiotherapy can help restore good ROM. Pain or poor compliance can hamper this. These factors create a situation where fixed flexion contracture can arise regardless of operative technique. In our cohort, we were not able to collect complete data sets for these variables.

Comparisons between subgroups must be interpreted with care because patients were not randomized to different groups. For example, selection of the surgical technique varied between surgeons with some tending to use navigation only in difficult cases while others used it for all. The choice of implant type also varied between surgeons. It was not possible to correct for these variables between subgroups.

Male sex, increasing age, and the presence of a preimplant fixed flexion contracture preoperatively were at 2.9 times greater risk of developing a postoperative fixed flexion contracture. Lam et al. 2 also showed a correlation with a similar trend.

Ritter et al. 2 identified a statistically significant 35% decrease in the chance of a postoperative flexion contracture >10° for every 5-unit increase in BMI. They thought that this correlation was tenuous due to inaccuracies encountered when using goniometers to measure larger legs. Our results support this explanation because we did not find any significant link between increasing BMI and reduced risk of postoperative fixed flexion contracture.

A strength of our cohort was its wide range of BMIs (range, 15-51 kg/m^2) and having all measurements made by experienced arthroplasty practitioners, using a standardized technique, working independently from the study. In the study by Ritter et al. 2 the surgeon measured the extension angle at follow-up appointments.

Despite the theoretical advantages, computer navigation did not significantly affect the overall rate of fixed flexion contracture. Incidence was 3.9% in the computer-navigated group and 3.4% in the conventional group. There were proportionally more posterior-stabilized implants in the fixed flexion contracture group. However, this was driven by sur-
geon choice and may indicate that knees that are likely to develop fixed flexion contracture have other problems that require the use of a posterior-stabilized implant rather than any direct relationship between posterior-stabilized implants and fixed flexion contracture.

These results confirmed that patients with a postoperative fixed flexion contracture ≥6° following TKA have poorer outcomes in terms of Oxford score, ROM, and satisfaction. This has also been shown by Ritter et al² and highlights the importance of addressing this issue to minimize the number of patients who suffer this complication.

The 2 greatest contributors to fixed flexion contracture deformity from a mechanical point of view are bone deformity and soft tissue tightness. Both of these factors can be addressed during TKA and satisfactory extension confirmed intraoperatively. Therefore, it would appear that contributory factors are involved that are not easily identified intraoperatively. During intraoperative examination of the knee, the passive properties of skeletal muscle are the most readily appreciated and are used to guide clinical decisions. However, passive tension is not a good predictor of function.¹⁸ The fixed flexion contracture group of patients also had a reduced average maximum active knee flexion at 2-year follow-up, which may add evidence to the hypothesis that it is difficult to control some patient-specific musculoskeletal properties at the time of surgery.

This study found the incidence of fixed flexion contracture following TKA to be 3.6%. Sex, increasing age, and the presence of a preimplant fixed flexion contracture increased the risk of having a fixed flexion contracture at 2 years postoperatively. However, whether BMI was high or low did not appear to be a risk factor. Our results add weight to the findings of Ritter et al² and indicate that these figures can be extrapolated to a wide population. Further work on intra- and perioperative musculoskeletal properties may shed some light on the residual number of fixed flexion contractures after TKA.

REFERENCES