# Preoperative Risk Factors of Persistent Pain Following Total Knee Arthroplasty

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## Abstract

# Purpose

Despite good results of total knee arthroplasty (TKA) number of patients (16–33%) complain of persistent pain. It has been theorized that certain preoperative factors may increase risk of persistent pain, hence their identification should improve preoperative education regarding results of TKA.

# Methods

Patients scheduled for TKA were examined one day prior to surgery. Demographics, comorbidities, pressure pain thresholds, pain intensity and duration, radiographic OA grade and range of motion were recorded. Beck Depression Inventory (BDI) and Knee injury and Osteoarthritis Outcome Score (KOOS) were collected. Study cohort was evaluated 6 months following surgery. Patients were assigned to group A if they had no pain and to group B if they complained of any pain.

# Results

64 patients were included in final analysis. There were no statistically significant differences regarding preoperative factors except for duration of preoperative pain, which was shorter in group A [36 (12–180) vs 72 (24–180), p = 0,011294]. Every 12 months of preoperative pain were found to increase risk of persistent pain by 1,27 (p = 0,008779).

# Conclusions

Preoperative duration of pain is a risk factor for chronic pain following TKA. Should the surgical treatment of knee arthritis be postponed, intensive and individualized pain management is highly recommended.

## Introduction

Knee osteoarthritis (OA) is one of the leading and highly prevalent causes of pain and disability in developed populations [1]. It is recommended to begin with non-operative treatment, which consists of pharmacotherapy, physical therapy, bracing etc. [2] Should conservative treatment prove ineffective, arthroplasty is considered a treatment of choice in severe, symptomatic OA of the knee [3]. Based on data from arthroplasty registries, hundreds of thousands knee arthroplasties are being performed annually worldwide. Since 1975 over 2.5 million primary total knee arthroplasties were performed in Europe according to Lübbecke et al. [4].

Despite high cost-effectiveness, total knee arthroplasty may render suboptimal results, such as chronic knee pain, described as pain lasting 3–6 months after surgery. This may occur in 16–33 % of patients undergoing total knee arthroplasty (TKA) [5]. Given the high number of procedures worldwide, chronic pain after TKA is a major issue affecting thousands of patients. Therefore, efforts have been undertaken to identify pre- and postoperative risk factors of chronic pain following TKA, which may allow better education and developing realistic expectations in patients scheduled for TKA.

# Material And Methods

From March to December 2016 patients admitted to the orthopedic department and scheduled for total knee arthroplasty were recruited for the study. Inclusion criteria were as follows: idiopathic, severe, symptomatic osteoarthritis of the knee and anticipated cruciate retaining implant. Exclusion criteria included lack of informed consent, symptomatic osteoarthritis of the ipsilateral hip, sacroiliac joint as well as severe sciatica.

Patients were assessed preoperatively by trained orthopedic surgeons according to the standardized protocol, which comprised of detailed anamnesis (demographics, comorbidities, pain duration etc.) and physical examination of the knee (including range of motion measurement with the goniometer). Pressure pain thresholds (PPTs) assessments in the medial joint line of the knee and over extensor carpalis brevis on the contralateral forearm were performed using pressure algometer (Force Dial Algometer, Wagner Instruments). Varus/valgus deformity and Ahlback OA grade were evaluated on the preoperative standing AP X-rays. Participants were given Beck Depression Inventory (BDI), Knee injury and Osteoarthritis Outcome Score (KOOS) and a Visual Analogue Scale (VAS).

Total knee arthroplasty was performed according to a standard surgical technique. Postoperative x – rays were taken in the first postoperative day. Radiological parameters, such as medial distal femoral angle (MDFA), medial proximal tibial angle (MPTA), implant size (notching, overhang), sagittal position of the femoral implant (flexion, extension or neutral) as well as tibial slope and posteriori condyle offset ratio (PCO ratio) were assessed. Patients were discharged from hospital 5–7 days after surgery.

Participants were assessed in an outpatient setting after 6 months following surgery. Standing AP and lateral x-ray of both knees were obtained to exclude loosening, periprosthetic fracture, catastrophic polyethylene wear etc. PPTs were measured and BDI, KOOS questionnaires along with VAS scale were collected. Patients were asked whether they are satisfied with an outcome of the surgery and whether pain significantly limits their daily activity. Moreover, physical examination of the operated knee joint was performed and range of motion as well as presence of any abnormal laxity were recorded. Then, patients were divided in two groups. Group A consisted of patients with no pain in the operated knee, whereas group B consisted of those, who suffered from a painful knee.

Obtained data was analyzed by a biostatistician using StatSoft, Inc. (2014). STATISTICA version 12 with significance level set for p = 0,05. For a parametrical variable with a normal distribution t-Student and

Cochrane Cox were used. U Mann Whitney test was used to compare nonparametrical data. For dichotomic, nonparametrical variables, Chi2 and Fisher exact test were used. Correlations were tested with Spearman's Rank correlation coefficient. Logistic regression was performed for statistically significant variables.

All procedures were in accordance with the ethical standards of the responsible committee on human experimentation

# Results

64 patients were included in the final analysis. Five were excluded from the study: one patient was diagnosed with early periprosthetic join infection, there was one case of metal hypersensitivity and three patients were lost to follow up. There were 76,6% (49 pts) of females and 23,4% of males (15 pts) in study population and mean age was 67,6 yrs. (48–84, ± 7,42). Mean follow up time was 231,6 days (181–318, ± 34,3). 67,2% of patients were diagnosed with arterial hypertension, 26,6% suffered from circulatory diseases other than hypertension, whereas 18% were diagnosed with diabetes mellitus. 14% of patients had hypothyroidism and 1,5% suffered from epilepsy. There were no cases of ischemic stroke or depression in study cohort [Table 1].

Table 1
Demographics and comorbidities of the study population (with range and standard deviation in brackets where applicable).

| **Age, yrs** | **67,6 (48–84, ± 7,42)** |
|---|---|
| Female | 76,7% |
| Male | 23,3% |
| Follow-up, days | 231,6 (181–318, ± 34,3) |
| Hypertension | 67,2% |
| Circulatory diseases (other than hypertension) | 26,6% |
| Diabetes mellitus | 18% |
| Hypothyroidism | 14% |
| Epilepsy | 1,5% |
| Ischemic stroke/TIA | 0 |
| Depression | 0 |

After the follow up there were two groups of patients: group A (pain-free) comprised of 21 (33%) patients and group B (any pain), which consisted of 43 (67%) patients. There were no statistically significant differences in terms of age (69,9 ± 6,2 vs 66,5 ± 7,8, p = NS) or gender (females 76% vs 77%, p = NS, males 24% vs 23%, p = NS).

There were no statistically significant differences between groups A and B in respect of arterial hypertension (62% vs 69,8%, p = NS), circulatory diseases (28,6% vs 25,6%, p = NS), diabetes mellitus (14,3% vs 21%, p = NS), hypothyroidism (14,3% vs 14%, p = NS) and epilepsy (0% vs 2,3%, p = NS). In terms of preoperative VAS score [7 (4,5–9,5) vs 7 (3–10); p = NS], as well as total WOMAC score [57 (33–80) vs 58 (9–83) p = NS] no significant differences were observed. Duration of preoperative pain was significantly shorter in group A than in group B [36 mo. (12–180) vs 72 mo. (24–180), p = 0,011294]. Preoperative flexion (101,2 ± 13,3 deg vs 105 ± 13,2 deg, p = NS) and flexion contracture [10 deg (0–20) vs 10 deg (0–30), p = NS], as well as Ahlback grade [3 (1–5) vs 2 (1–5), p = NS] did not differ between study groups.

In KOOS subscale such as pain [44,0 (19,0–67,0) vs 42,0 (14,0–86,0), p = NS], other symptoms [39,0 (18,0–75,0) vs 36,0 (4,0-100,0), p = NS], activities of daily life [41,0 (9,0–72,0) vs 40,0 (12,0–90,0), p = NS] and quality of life (20,8 ± 14,8 vs 25,7 ± 13,5, p = NS) patients from group A and B had similar results.

No correlation was found between BDI score and postoperative pain intensity. No statistically significant differences between groups A and B was observed in terms of PPTs in the joint line [2,1(1,0–5,5) vs 2,5 (1,0–10,0), p = NS] and on the contralateral forearm [3,2(1,0–8,0) vs 3,2(1,5–7,2), p = NS]. Study groups were fairly similar in respect of radiological parameters of the operated knee [Table 2].

Table 2
Comparative analysis of preoperative parameters (in brackets range and standard deviation where applicable). Kgf – Kilogram-force

| | Group A | Group B | p |
|---|---|---|---|
| Age, yrs | 69,9 ± 6,2 | 66,5 ± 7,8 | NS |
| Female | 76% | 77% | NS |
| Male | 24% | 23% | NS |
| Hypertension | 62% | 69,8% | NS |
| Circulatory diseases | 28,6% | 25,6% | NS |
| Diabetes mellitus | 14,3% | 21% | NS |
| Hypothyroidism | 14,3% | 14% | NS |
| Epilepsy | 0% | 2,3% | NS |
| VAS | 7 (4,5–9,5) | 7 (3–10) | NS |
| WOMAC | 57 (33–80) | 58 (9–83) | NS |
| KOOS pain | 44,0 (19,0–67,0) | 42,0 (14,0–86,0) | NS |
| KOOS other symptoms | 39,0 (18,0–75,0) | 36,0 (4,0-100,0) | NS |
| KOOS activities of daily life | 41,0 (9,0–72,0) | 40,0 (12,0–90,0) | NS |
| KOOS quality of life | 20,8 ± 14,8 | 25,7 ± 13,5 | NS |
| Ahlback grade | 3 (1–5) | 2 (1–5) | NS |
| PPTs knee, kgf | 2,1(1,0–5,5) | 2,5 (1,0–10,0) | NS |
| PPTs forearm, kgf | 3,2(1,0–8,0) | 3,2(1,5–7,2) | NS |
| Flexion, ° | 101,2 ± 13,3 | 105 ± 13,2 | NS |
| Flexion contracture, ° | 10 (0–20) | 10 (0–30) | NS |
| Pain duration, mo | 36 (12–180) | 72 (24–180) | 0,011294 |

6 months after the surgery patients were examined in terms of range of motion and no differences in flexion [100 deg (80–120) vs 110 deg (90–120), p = NS] and flexion contracture [0 deg (0–20) vs 0 deg (0–15), p = NS] were observed. No signs of loosening or periprosthetic fracture were found. In respect of KOOS subscales such as pain (88,1 ± 7,5 vs 63,2 ± 19,0, p < 0,0001), other symptoms (79,7 ± 11,2 vs 58,8 ± 16,8, p < 0,0001), activities of daily life (84,9 ± 11,6 vs 61,2 ± 18,5, p < 0,0001) and quality of life (68,3 ± 16,1 vs 46,8 ± 17,4, p < 0,0001) significant differences were observed, which was also seen in WOMAC total score (14,7 ± 9,0 vs 35,4 ± 16,0, p < 0,0001). PPTs were significantly higher in group A compared to group B both in the joint line [4,6 (2,5–8,0) vs 3,0(1,0–10,0), p = 0,000277] and on the contralateral

forearm [5,5 (3,2–9,0) vs 3,6(1,0–10,0), p = 0,000675]. None of patients in group A described pain as severely limiting daily life compared to 25,6% of patients in group B confirming such limitations (p = 0,0149). Satisfaction rate in group A was 95,2% compared to 67,4% in group B (p = 0,03151). Logistic regression was performed for duration of preoperative pain and odds ratio was calculated. 1,27- fold increase in prevalence of chronic post-surgical pain with every 12 month of preoperative pain duration was found (p = 0,008779) [Table 3].

Table 3
Comparative analysis of postoperative parameters (in brackets range and standard deviation where applicable). Kgf – Kilogram-force

| | Group A | Group B | p |
|---|---|---|---|
| Flexion, ° | 100 (80–120) | 110 (90–120) | NS |
| Flexion contracture, ° | 0 (0–20) | 0 (0–15) | NS |
| KOOS pain | 88,1 ± 7,5 | 63,2 ± 19,0 | < 0,0001 |
| KOOS other symptoms | 79,7 ± 11,2 | 58,8 ± 16,8 | < 0,0001 |
| KOOS activities of daily life | 84,9 ± 11,6 | 61,2 ± 18,5 | < 0,0001 |
| KOOS quality of life | 68,3 ± 16,1 | 46,8 ± 17,4 | < 0,0001 |
| WOMAC | 14,7 ± 9,0 | 35,4 ± 16,0 | < 0,0001 |
| PPTs knee, kgf | 4,6 (2,5–8,0) | 3,0(1,0–10,0) | 0,000277 |
| PPTs forearm, kgf | 5,5 (3,2–9,0) | 3,6(1,0–10,0) | 0,000675 |
| Severe limitation of daily life | 0% | 25,6% | 0,0149 |
| Satisfaction | 95,2% | 67,4% | 0,03151 |

# Discussion

The most relevant finding of the present study was establishing the impact of preoperative duration of pain on prevalence of unexplained chronic pain after TKA. Chronic pain following TKA has been widely investigated in recent decade in an attempt to estimate its prevalence and possible causes [6–9]. Percentage of patients suffering from CPSP varies between studies within range of 13–53%. Methodology in available studies is inconsistent and authors implement various assessment tools and follow-up periods. For example, Baker et al. investigated patients one year after the surgery [10] while Wylde et al. assessed study cohort after 3–4 years [7]. In our study percentage of painful knees 6 month following TKA was very high (68%), although patients with mild pain constitute 25% of study group (first quartile). This may be attributed to relatively short follow-up (6 months). According to Heiberg et al. the most substantial recovery takes place in the first 6 months but some patients require up to one year to fully recover [11]. No evidence of gender or age impact on CPSP was found which is consistent with

previous studies [6,12,13]. Neither comorbidities nor depression have proven to influence CPSP, although the latter has been shown to be a risk factor in some studies [6,14–16]. This discrepancy may be due to a lack of diagnosed depression in study cohort. Despite some evidence suggesting predictive value of PPTs [17–19]we haven't been able to reproduce those results. It has been suggested that static QSTs are not appropriate to diagnose central sensitization and dynamic methods such as cuff algometry should be implemented [19]. Interestingly, preoperative pain intensity did not differ between study groups, which is inconsistent with some of the previous studies [12,16,20]. This discrepancy is confusing because of two methods of pain assessment – VAS and KOOS pain subscale, both of them showing no significant differences between study groups. However, there are studies that also found no impact of preoperative pain intensity on CPSP [21,22]. In our study preoperative pain duration was the only factor that predicted CPSP, with every year of pain increasing the risk of CPSP by 1,27. Similar finding were confirmed by Puolakka et al, where it has been proven that every 12 months of preoperative pain increase probability of CPSP by 2,99 [8].

The major limitation of this study is a relatively small number of patients included which was attributed to large exclusion rate at the time of recruitment (patients with posttraumatic OA, OA secondary to rheumatoid arthritis, revision surgeries after HTO or UKA etc). Short follow up may be perceived as a limitation, although 6 months are sufficient to meet the criteria of persistent pain.

# Conclusions

Preoperative duration of pain is a risk factor for CPSP following total knee arthroplasty thus patients should be operated on as soon as indications arise and conservative treatment proves ineffective. Should the surgical treatment of knee arthritis be postponed, intensive and individualized pain management is highly recommended.

# Declarations

### Availability of materials and data

All data generated or analysed during this study are included in this published article (and its Supplementary Information files).

### Acknowledgements

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### Conflict of interest statement

On behalf of all authors, the corresponding author states that there is no conflict of interest.

### Author contributions:

Conception and study design – PC, JK

Acquisition and analysis – PC

Manuscript drafting – PC

Critical review of the manuscript – JK

Preparation of tables – PC

**Ethics approval:**

The study was approved by the Institutional Review Board (Komisja Bioetyczna przy Uniwersytecie Medycznym im. Karola Marcinkowskiego w Poznaniu). Authors confirm that the study was performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

**Consent to participate:**

Informed consent was obtained from every person recruited for this study.

**Consent for publication:**

No images or personal data are included in this manuscript. Therefore, consent for publication does not apply

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